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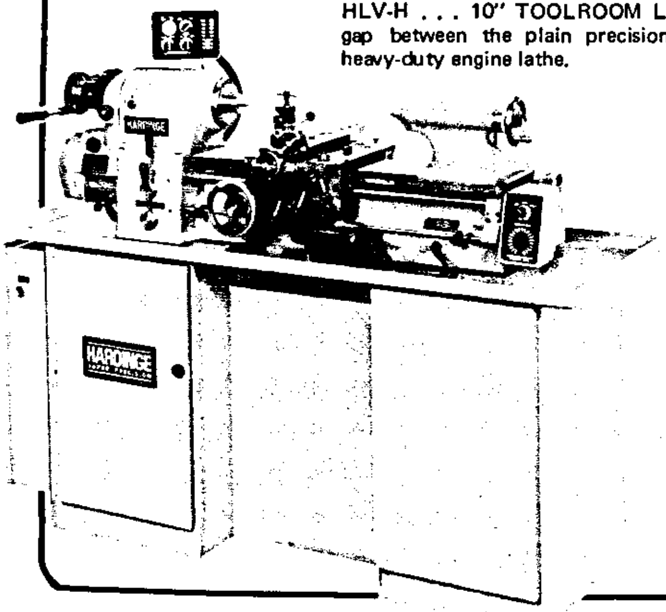

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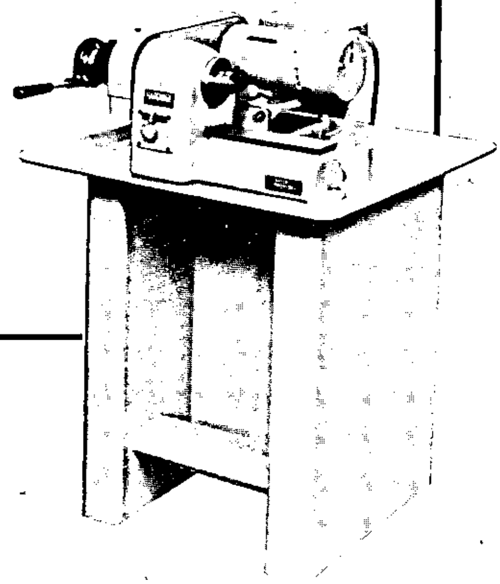

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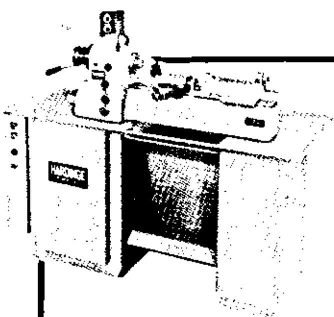

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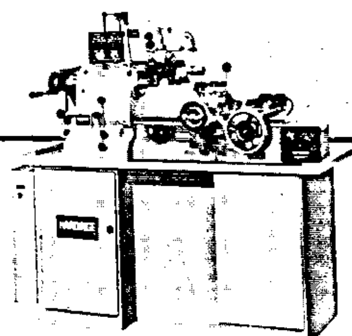

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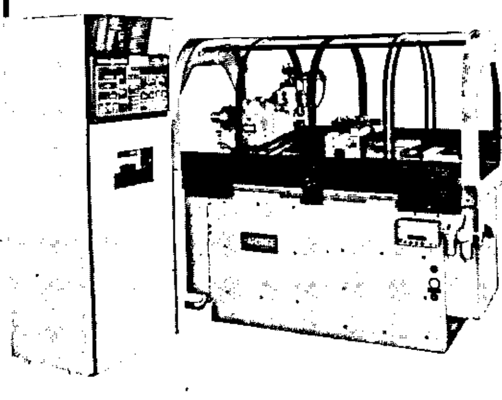

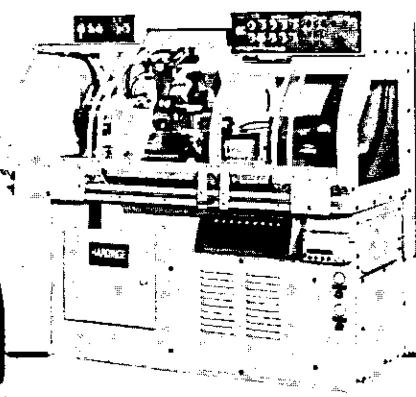

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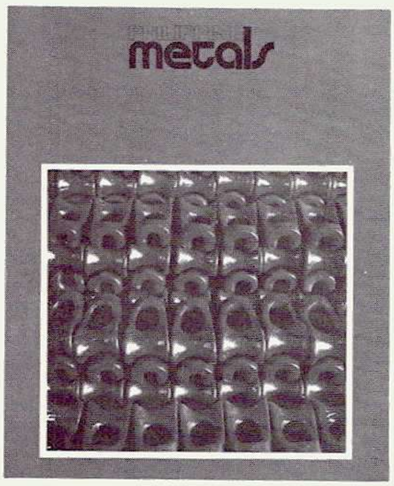

On the Cover:
Malaysia-bound ESCO rigging equipment manufactured under license by EEI.

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INSTRUMENTATION & PROCESS CONTROL: FRONTIERS FOR PROGRESS

As the representative of the National Science Development Board, I feel deeply honored and privileged to be with you this morning at the opening of the Second Annual Convention of your Society. Looking over the objectives and activities of your Society, I find that they are very much related to some of the NSDB programs. As a Ministry that is mandated to coordinate and support our national scientific and technological programs, NSDB places great importance to the role that societies such as yours undertake.

It is often claimed, and it is perhaps true, that in order to achieve our national aspirations for self-sufficiency and higher socio-economic level, a certain degree of sophistication in technology is needed. Without the necessary technological support, whether indigenous or transfer, our economic growth would be severely limited and your individual role in instrumentation and control systems serves as crucial factors in raising our technical capabilities.

For in a sense, we can say a country can only grow as well as its ability to measure itself. Accuracy, precision and efficient designs are indispensable to a sustained effort of a country to expand and raise its economic levels.

The ability to measure accurately and to control systems are directly related to our economic activity which have to conform to certain standards to meet the demands of all. Unless these standards are met, the fruit will be of little value or no economic value to anyone. This is true of the fruits of nature, as well as the products of hand and the output of industry.

In your particular case, you play an even more crucial role, for you are to pass judgment on the quality of goods produced by factory or by hand, and you are also expected to oversee that the instruments for measurement work are always reliable. For some of you, I am sure that it is even your responsibility to design and produce the instruments for measurement.

In the past, we have depended mainly upon the foreigners to do this job of yours. But our society has transformed in order that we undertake this task on our own. You may therefore consider yourselves pioneers in this endeavor. Your association is the first of its kind. It is young in age, not more than two years old, and like the youth, yours is the vision of the future. You belong to a frontier in our process of development which dramatize the sophistication our industry has attained. Indeed, it is not merely wishful thinking to say that your work will profoundly affect the even more dramatic growth of industrialization in our country.

It is perhaps more because of your labors that many of our local products are becoming or/and have become popularly accepted now. Because of the key role you perform in seeing that our local products meet quality control standards, our people are now placing more confidence in the standards of local goods.

But it is not correct for us to just reflect and look back at what we have achieved. We still have many challenges to face and we can immediately cite a few: the first is to make our products meet the standards demanded by foreign markets. We mention this as an initial priority because one of our country's principal concerns is to expand our export base not only to cushion us from the impact of more dollar outflows arising from oil price increases, but also to improve our productivity and with it, the quality of our own lives.

Raising standards of products implies quality control, and a quality control program demands sophisticated instrumentation.

It may interest you to know that the Commission of Small & Medium Scale Industries which is under the Ministry of Industry, in collaboration with other ministries such as NSDB, is now currently conducting an in-depth study of quality control capabilities of certain industrial sectors throughout the country. The ultimate goal of the study is to have a network of testing centers that can cater to the needs of particular industries. The network of testing centers will involve both government and private laboratories and I foresee some of your active involvement in these centers.

You are all familiar with the function of MIRDC, one of the agencies of NSDB. I will venture to say that we shall continue to support this linkage between MIRDC and your Society. We shall always encourage a very important interlink cooperation and close cooperation between government agencies, which may have the resources such as MIRDC, and the private sector.

The government also recognizes the importance of the science of measurement and quite recently a bill was passed at the IBP to set up a ' metrology" center for our country. Following this mandate, the NSDB allocated ₱6M to develop what may eventually be considered a center for fundamental quantities. At the moment, this is based at our National Institute of Science & Technology or NIST. The important interlink and cooperation on metrology with other countries are likewise being strengthened. The NIST is currently being expanded with the help of the United States National Bureau of Standards. We also have a tie-up with the National Laboratory for Standards Research in Japan and the Korean Standards Research Institute in Seoul. These links are vital not only in terms of exchanging personnel but also in developing our intercalibration capability. Our ability to measure accurately and to conform to standards will determine our degree of involvement in foreign trade.

The second challenge to us is to make available the sophistication that we possess to the countryside where industrial development is still something to be wished for and not a reality. I am happy to note that one of the objectives of your association is the promotion, diffusion and exchange of information about industrial instrumentation and automatic process control. On this score, we can probably seek your assistance as the NSDB mounts a more formidable technology transfer program from urban areas to the countryside this year.

You may not know it but this is an all-embracing program that harnesses all the media of information and tools of communication: from extension workers, classrooms, the popular media of communications like radio and TV, audio-visual presentations, and by means of the printed medium.

Our past experience has indicated that mere news releases and technical publications have not been effective media for the transfer of technology from our laboratories to end-users. The reason is easy to find: the depth and range of association between the sources of science knowledge and the potential users have grown deeper and longer these past years; the task of connecting one with the other is too vast for the printed word alone to bridge. Hence, there is now a need to adopt a variety of media approach for greater awareness of the technology now in our possession, and for more effective diffusion of technology from our laboratories to the active entrepreneurs, big and small.

At this point, I would like to draw for your consideration, or shall I say a "food for thought", on the issue of appropriate technology, and at that I would like to read directly from the article I have before me which says, "Modern technology developed when natural resources were abandoned and human labor was relatively scarce." Since natural resources now are sinking and worldwide unemployment is growing, society is seeking ways to adopt its technology to the new conditions. That is a major underlying reason for the appropriate technology movement which is now growing rapidly across the world. The movement may be expected to lead eventually to a new technological order and hopefully, an easing of the many problems that mankind now has at hand. An example of appropriate technology is a project which is sponsored by the World Bank to develop a manually operated air trap for lifting irrigation water. The diesel pumps now available cost about $1,300 a piece and create maintenance problems due to the difficulty of procuring spare parts. The new irrigation pump now in the prototype stages is made of cheap corrosion resistant plastic instead of cast iron and will cost only about $100 each. It will operate with human labor rather than diesel power. The use of human labor reduces the need for using fuel, thus easing the farmer's capital outlays, this country's need for foreign exchange and the world's energy problem.

That was just an example of trend and what is called appropriate technology and some of you may be able to set your sights along that line.

Most of you or some of you are with big companies. There is a crying need for development of technology on a smaller scale. One of our most precious natural resources lies in the availability of manpower. In reality, man is the greatest and most important of any country's natural resources: the man who thinks and plans, the man who manages and directs. We hope to grow to more labor intensive activities instead of the energy intensive ones.

The thrust of the NSDB is to develop the full creative and productive energies of the people so that as more jobs are created, new processes can be utilized and more products can be produced. We trust that through your efforts, some of these goals of production can be better achieved.

After underscoring the role of instrumentation on quality control, allow me to congratulate your Society for being in the front line of this most crucial activity. As I see the enthusiasm this morning among all the participants in this conference I have no doubt that you will have a most fruitful deliberation during your two days stay here. May this conference open up more successful ventures for subsequent benefit to our people. **PM**

**Speech delivered by Dr. Segundo V. Roxas, Deputy Minister , National Science Development Board, at the Second Annual Conference of the Philippine Instrumentation and Controls Society on 23 February 1979 at the Manila Garden Hotel.*

In order to achieve our national aspirations for self-sufficiency and higher socio–economic levels, a certain degree of sophistication in technology is needed. Without the necessary technological support, whether indigenous or transfer, our economic growth would be severely limited. As such, the individual role of instrumentation and process control systems serves as a crucial factor in raising the country's technical capabilities. This and other factors are further expounded in "Instrumentation and Process Control: Frontiers for Progress," by Dr. Segundo V. Roxas, Deputy Minister, National Science Development Board.

As stated by Dr. Roxas, "the ability to measure accurately and to control systems is directly related to our economic activity, which has to conform to certain standards to meet the demands of all. Unless these standards are met, the fruits will be of little or no value to anyone." This is true of the fruits of nature, as well as the products of manual labor and the output of industry.

Two challenges related to these efforts are now being confronted by the metals industry with the help of several government agencies. The first is to make local products conform to the standards demanded by international markets. This is an initial priority because one of our country's main concerns is the expansion of our export base – not only to cushion us from the impact of more dollar outflows arising from oil price increases, but also to improve our productivity and the quality of our own lives. The next challenge, no less important than the first, is making available the sophistication possessed by the metropolitan area to the countryside, where industrial development is still something to be wished for.

The benefits of high productivity in blast furnaces can only be fully realized when it is associated with long campaign life. A major consideration in relation to the achievement of a long campaign life is the full integration of operating conditions with design features such as the furnace structure, the refractory lining, cooling, and the design of ancillary equipment. In the article "Developments in Blast Furnace Design," C.H. Best of Davy Ashmore International sets out to show how blast furnace design has progressed to meet these requirements. Special reference is made to the two blast furnaces constructed by Davy Ashmore International in Latin America for Altos Hornos de Mexico S. A. (Ahmsa) at Monclova, and for Aco Minas Gerais S.A. (Acominas) at Belo Horizonte.

Werner Deppert of FESTO, in his paper "Rationalization with Pneumatics," expounds on the problems and solutions encountered in the use of pneumatic equipments. Areas covered include how to conduct three operations during one downward stroke of a press, and locating and clamping pneumatically. This article is the first of a series dealing with how–to's in pneumatics.

Steve Bukovinsky, Manager for Sandvik Western Pacific Area, describes the properties and characteristics of an outstanding alloy in "253 MA – A Special Stainless Steel to Combat High Temperature Corrosion." 253 MA is an austenitic high-temperature steel alloyed with silicon, nitrogen and rare earth metals. The combination of good corrosion resistance and high creep strength makes this alloy a very suitable material for purposes where

18Cr/8Ni steels are insufficiently resistant to oxidation and carburisation, and where stainless chromium steels lack the necessary creep strength. Moreover, because of its high structural stability, 253 MA is recommended as a substitute for embrittlement-prone steels such as AISI 309, 310 and 310S. AISI 330 is also surpassed by 253 MA in terms of both creep and oxidation properties. For certain purposes, the alloy is also a suitable alternative to such materials as Alloy 800H and Alloy 601.

Studies of the market for drilling indicate that approximately half the cost for drilling tools are for the diameter range below 20mm. Less than 10% of tool costs are for diameters above 60mm. If the distribution of drilling depth or length in relation to diameter is noted it will be found that the majority of holes have a length smaller than three times the diameter. Oly 50% have lengths exceeding six times the diameter. In "A New Machining Area for Modern Tool Technology," Kurt Faber, Manager for Coromant Tools Development of Sandvik AB, presents some developments during the last few years which have brought drilling up to modern machining standards. Emphasis is also placed on the much needed revolutionary changes which are currently being undertaken.

"The FMC Coke Process and its Impact on the World Steel Industry" by Russell G. Ellis, Business Development Specialist of Arthur G. McKee & Co., Cleveland, Ohio, presents the economic advantages of form coking over conventional coking for selected geographical areas.

The FMC coke process is a proven method for converting non-coking coals to metallurgical coke. An 80,000 TPY FMC coke process plant has been in operation for over 16 years, and the product has been successfully tested in ironmaking blast furnaces. The paper presents the process development, discussion of the process, and the future of the process as related to steelmaking.

Our "Cover Story" this quarter features the Foundry Division of Engineering Equipment, Inc. (EEI). The Division prides itself in being the largest commercial foundry in the Philippines, producing wearing parts for the mining, cement, sugar, and allied industries, as well as acting as manufacturing licensee for ESCO International (USA) and Warman International (Australia). The Division classifies itself mainly as a jobbing foundry, operating at a rated capacity of 700 MT/month. Its product lines include parts for ore dressing, cement/aggregate industries, sugar milling, Esco earthmoving, rigging and dredging parts, specialty products, and Warman pumps.

This issue's interviewee for "Men in the Metals Industry" is Juventino S. Perfecto, Vice President for Engineering of Benguet Consolidated, Inc. A true member of the working class, "Big Pec" starts his day at 5 a.m. and will usually be found in his office at around 7 a.m. Unless, of course, he is scheduled on one of his four plane trips per week to oversee his pet project, the Benguet-Dizon Mines in San Marcelino, Zambales.

Also featured in this issue is the WEBO BR 50 radial drilling machine, used by MIRD's Mechanical Workshops and Training Department in Bicutan, Taguig, Metro Manila. The BR 50 is only one of several fast, reliable, high-powered, and precise drilling machines in the WEBO line.

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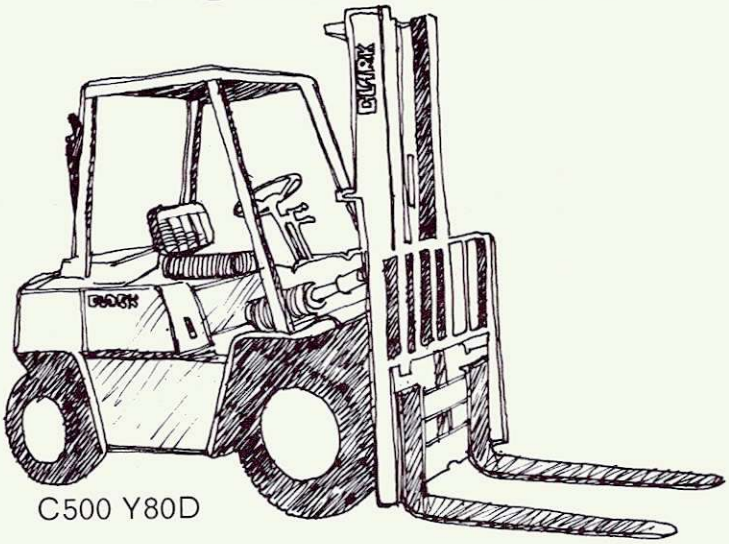

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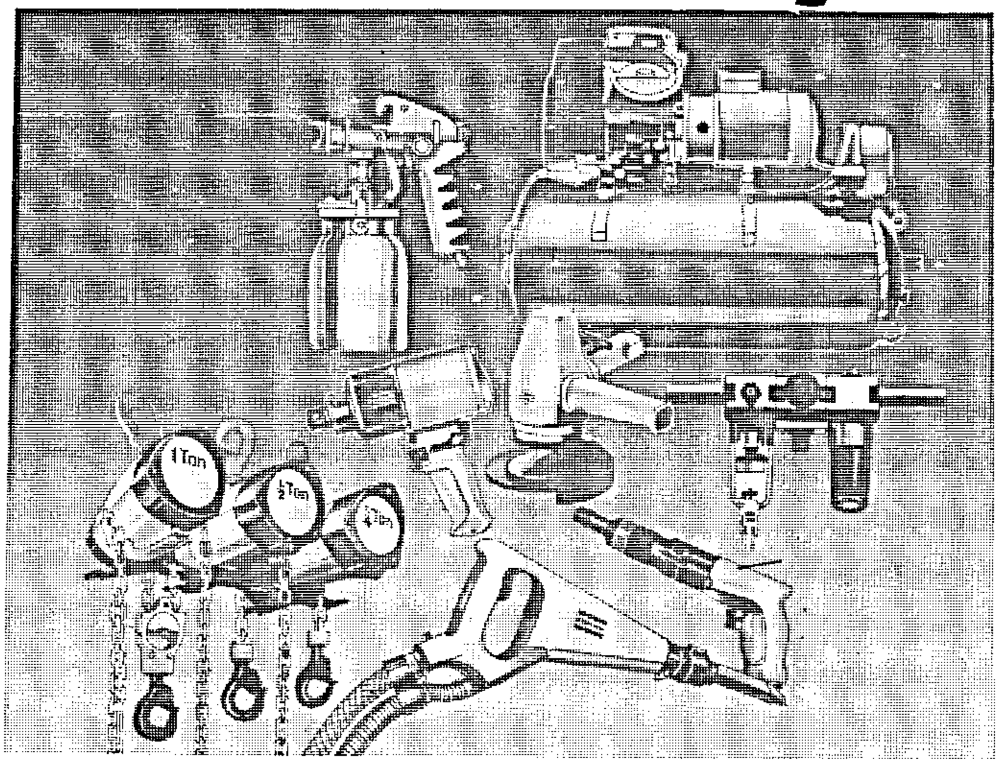

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DEVELOPMENTS IN BLAST FURNACE DESIGN

C. H. BEST
Davy Ashmore International

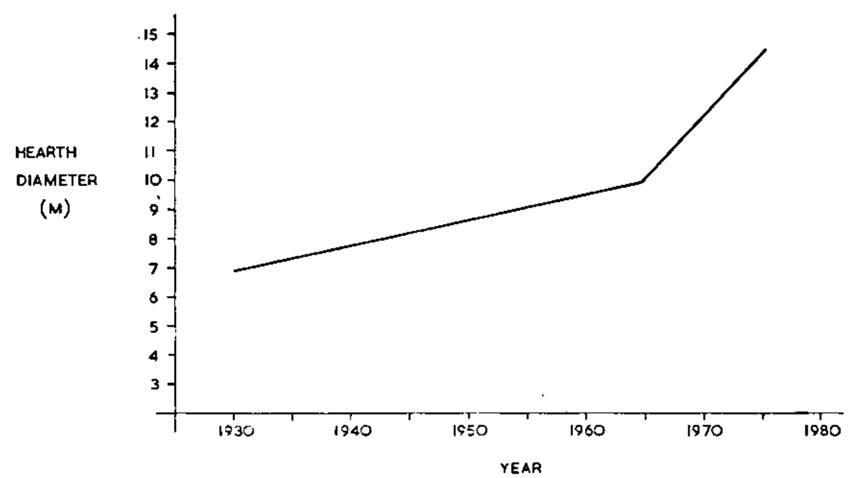
INTRODUCTION

By far the most significant factor influencing blast furnace development over the past decade has been the rapid increase in furnace size. The rate of this increase as compared to that which occurred prior to this period is shown in Figure 1. The graph shows the general trend in furnace size although it is appreciated that isolated cases do not conform.

In order to realize fully the economic benefits of large blast furnace operation it is necessary to achieve high productivity and high campaign tonnage.

A pre-requisite of high productivity is the attainment of smooth and regular furnace operation. This condition is obtained primarily as a result of charging to the furnace a well prepared burden which in turn requires close control of metallurgical and physical properties. Productivity is also influenced by furnace operating conditions and of particular significance are those which lead to a reduction in fuel rate, the most important being the maximum use of increased blast temperature. In addition the injection of oil at the tuyeres is more efficient in combination with high blast temperatures and oxygen injection.

As furnace size increases it is necessary to raise the furnace operating top pressure to obtain maximum benefit from the increased furnace volume. Increased top pressure enables a greater volume of wind to be blown leading to a further increase in productivity.



1. INCREASE IN BLAST FURNACE SIZE

The benefits of high productivity can only be fully realized when it is associated with long campaign life. A major consideration in relation to the achievement of a long campaign life is the full integration of operating conditions with design features such as the furnace structure, the refractory lining, cooling and the design of ancillary equipment.

This paper sets out to show how blast furnace design has progressed to meet the requirements set out above.

Special reference is made to the two blast furnaces constructed by Davy Ashmore International in Latin America for Altos Hornos de Mexico S.A. (Ahmsa) at Monclova, and for Aco Minas Gerais S. A. (Acominas) at Belo Horizonte.

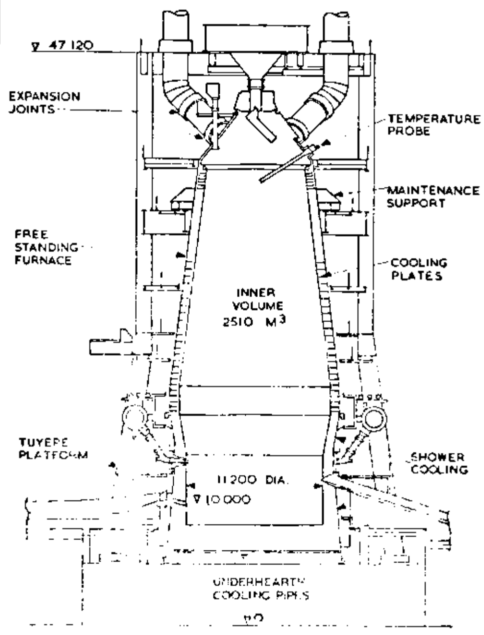
A technical specification of these furnaces appears in Appendix 1. (refer to part II of the this article in PM April-June 79 issue)

BLAST FURNACE PROPER

Furnace Construction

In general the furnaces built by Davy Ashmore in the period up to the mid 1960s were of the mantle column type.

A heavy mantle in the form of a horizontal circular girder encircled the furnace at top of bosh level and was supported on columns from the foundations. The furnace casing extended from the mangle up to top ring level, the furnace top equipment being supported on the casing. Below the mantle the hearth, tuyere belt and bosh were encased in their separate jackets. The whole of the inwall refractory lining was carried on the mantle.



2. FURNACE SECTION
AHMSA No. 5 B.F.

The design had the following inherent limitations:

1. The columns restricted access around the furnace at cast house floor level.
2. The columns influenced the number of tuyeres which could be installed.
3. The columns limited the positions available for iron notch locations and, therefore, the cast house floor layout.
4. The change in the thickness of the refractory lining at mantle level made the uniform cooling of this vulnerable area difficult.
5. The entire top equipment was supported on the furnace shell.

In the event of local loss of refractory, the overheating and possible buckling of the shell assumed more serious proportions.

In an attempt to overcome the limitations outlined above, a form of support was developed comprising a ring girder system in conjunction with a four column tower.

A heavy ring girder was incorporated into the furnace shell at about mid height. This girder was supported on a square framework within a four column tower structure. The lower columns were splayed in two directions giving unrestricted access to the furnace at cast house floor level. More freedom was available as regards location of iron notches and the number of tuyeres could be selected to suit operational requirements. The entire furnace top could now be supported independently of the furnace shell by four columns extending upwards from the lower structure.

This design made it necessary to incorporate two expansion joints in the furnace shell to accommodate expansion between ground and ring girder level and between ring girder and furnace top. These joints have proved a source of weakness particularly on furnace working on high levels of top pressure. This has resulted in the development of the completely free standing furnace within a tower structure.

The furnaces at Ahmsa and Acominas are of this type as shown on Figures 2 and 3 respectively.

The furnace shell extends from the base of the hearth jacket to top ring level without expansion joints. Under normal conditions the furnace stands independent of the tower structure although some provision is made in the design for the furnace shell to be supported from the tower under maintenance conditions. (See Fig. 2)

Refractory Lining

The refractory lining of the blast furnace is subjected to conditions which vary in the different zones of the furnace and the refractory quality needs to be carefully selected to suit the varying conditions.

Anthracite and metallurgical coke based carbon in the form of large blocks have been introduced into the hearth and side walls. This, in conjunction with an effective cooling system, has led to the virtual elimination of problems in this area.

With a knowledge of the thermal conductivity of the lining and metal, and metal temperature, it is now possible to predict accurately the positions of the various isotherms within the carbon hearth pad. In Japan the tendency has been to install hearths 3.0 – 4.0 metres in depth whereas the European approach has been towards relatively shallow hearths with a depth of 2.0 – 2.5 metres. The latter course gives a residual depth of carbon of approximately 1 metre. The upper section of the pad which will be lost in the early stages of operation can be installed in alumina firebricks.

The tuyere breast is another area where comparatively little trouble has been experienced in recent years. The material used may be the same as for the hearth or may be alumina firebrick. The selection is usually determined by operator preference. Concern is sometimes felt as to the possible affects of oxidation of carbon due to water leakage in this area. Large blocks are adopted for ease of erection. The blocks are shaped to fit around the tuyere openings. High conductivity ramming is used between the tuyere coolers and the wall to fully utilize the cooling effect of these elements.

The bosh area of the furnace has, in many instances, been a limiting factor on the length of a furnace campaign. Both carbon and alumina materials have been installed in this area. The relative success of these materials in different plants has largely determined present trends.

Major improvements have taken place in the properties of both these materials to resist alkali and slag attack, and abrasion.

Anthracite or metallurgical coke based carbons were replaced by graphite materials to improve conductivity. Latest developments relate to improving the abrasion resistant properties of these materials. This is achieved by lowering the porosity and reducing the permeability by impregnation. In Japan, silicon carbide has been added to graphite based materials. In some instances these materials extend into the belly and lower stack area.

Regarding the use of alumina materials in the bosh, low alumina firebricks made from Scottish fireclays have been superseded by 45 – 60% alumina grades based on South African and American raw materials to improve resistance to alkali and slag attack and to abrasion whilst retaining some thermal shock resistance. In Japan, extensive use has been made of the very dense 90% alumina materials. These materials are normally used as part of a composite lining with a medium grade alumina facing. In some instances this material extends into the belly and lower stack area.

The belly and lower stack of the furnace have been high wear areas for many years and they remain the main source of present day troubles.

On furnaces of the mantle column type, the construction of the furnace was considered to be a contributory factor in that brick thickness varied and effective cooling was difficult. This large refractory mass gave rise to expansion stresses resulting in premature failure. This led to the development of a composite lining for the belly and lower stack comprising a high conductivity carbon backing to a low alumina hot face lining. This solution was continued even on furnaces without mantles to maximize the cooling effect.

Hot face linings developed in much the same way as alumina materials in the bosh in that the low alumina materials were replaced by higher grades to obtain maximum resistance to abrasion.

The middle and upper stack is usually lined with a 43 – 45% alumina abrasion resistance firebrick having a low iron content and capable of withstanding carbon monoxide attack.

The furnaces at Ahmsa and Acominas have hearth walls and pad of anthracite coke based carbon in the form of large blocks.

On Ahmsa the tuyere breast is of material similar to the hearth and the bosh is lined with a graphite based carbon. The stack is lined with a dense 45% alumina low iron abrasion resistant material.

On Acominas the tuyere breast is of 50% alumina firebrick. The bosh, belly and lower stack have a composite lining of 90% alumina faced with a 40% alumina material. The remainder of the furnace is lined with alumina.

Furnace Cooling

To ensure a reasonable life from the blast furnace refractory lining, it is essential that the refractories are adequately cooled.

The type of cooling selected for any specific area of the furnace is largely influenced by the properties of the refractory material. The intensity of cooling in any area must be such as to accommodate the maximum heat load to be extracted.

Cooling of the modern blast furnace extends from the bottom of the hearth up to approximately two-thirds of the height of the stack.

Water cooling systems on early blast furnaces were generally of the once through type. Water was pumped direct from a source and returned to drain after passing through the cooling system. The effectiveness of this type of cooling system was greatly influenced by the quality of water available and in many instances, failures occurred as a result of deposits forming in the cooling elements or by corrosion.

In areas where a supply of good clean water was not readily available open circuit cooling systems incorporating cooling towers were common. This system, however, is subject to a gradual contamination of the cooling water by the blast furnace environment.

These early types of systems are still very common where conditions are favourable to their use.

In order to maximize the efficiency and life of blast furnace cooling systems, the completely closed circuit using demineralised water is becoming increasingly attractive. In particular the closed circuit is desirable where cooling elements cannot be removed in service, as in the case of internal staves.

The closed cooling circuit includes circulating pumps and heat exchangers of the water/water or air/water type. The circuit also includes a nitrogen pressurised expansion vessel which is also used to introduce make-up water to compensate for leakage. To give operational security and to limit the water flowing in any one circuit, the furnace cooling system is subdivided into various independent circuits serving specific areas of the blast furnace. Because of the importance of an uninterrupted supply of cooling water, all circuits incorporate standby pumps, with provision for an alternative secure electrical supply, steam turbine or diesel driven pumps.

Early furnaces incorporating ceramic hearth pads were not equipped with any specific means of cooling. Instead, heat was dissipated to hearth walls and concrete foundation. As furnace size increased problems associated with large salamander formation and high foundation temperatures were encountered.

In order to combat this situation, the all carbon hearth with a means of cooling was introduced. The cooling medium may be in the form of the incorporation of a graphite layer between the foundation and the carbon pad to improve the heat flow to the walls. Alternatively, a means of cooling by air or water may be introduced.

With air, a plenum chamber extending over the full area of the hearth is used, the air being introduced at the centre and radiating outwards. Alternatively, a system of parallel ducts may be employed with air passing through adjacent ducts in opposite directions. In either case, because air has a relatively low heat transfer coefficient and low heat capacity, a large volume of air is required to affect the required cooling, necessitating large fans and ducting.

The high heat transfer coefficient and heat capacity of water means that this is a far more effective cooling medium than air. The water cooling tubes can be laid below the furnace bottom plate. However, this arrangement can cause installation problems associated with the difficulties of effectively grouting below the baseplate to ensure good heat transfer properties. Alternatively the tubes are laid directly in a graphite layer at the base of the carbon hearth. In this case, a non-ferrous membrane can be installed above the tubes to provide additional safeguards against water leakage.

The use of carbon in the hearth wall is universal. Three cooling methods are available, namely film cooling, external boxes, and internal staves. Of the three, film cooling is the most usual and problems in this area are now extremely rare.

The tuyere breast can be cooled by any of the above three methods or by inserted horizontal cooling plates. The type of cooling adopted is influenced by the methods used for cooling the upper parts of the furnace.

Film cooling can be extended to include the bosh area of the furnace when carbon is used as a lining.

Above the tuyere breast there are two basic methods adopted for cooling the large modern furnace. These methods are either internal cast iron staves or inserted horizontal cooling plates.

Staves have been incorporated in many of the world's largest furnaces and long campaigns have been achieved. The staves lining the bosh, belly and stack are castellated incorporating cast-in refractory inserts to assist the formation of scab accretions and to resist abrasion. This has allowed operation to be continued long after considerable loss of the refractory lining has taken place. In some instances the only refractories installed in front of the staves have been for blow-in protection. This design of stave was developed for use with evaporative cooling in which the system operates on a thermo-syphon principle with cold water entering at the bottom and steam being collected at the top. The rate of evaporation adjusts itself to the heat load to be removed and the system is largely independent of circulating pumps. Recent developments have shown that a forced water circulation system applied to the staves gives better control over the distribution and intensity of cooling.

As an alternative, inserted copper cooling plates can be used. The coolers are closely spaced to give a high intensity of cooling. The adoption of this system has also achieved high tonnages and long campaigns.

With both staves and horizontal plates, provision must be made for gas sealing at the connections and to provide flexibility to accommodate relative movement. In the case of cooling plates, bellows type expansion joints are incorporated.

One of the most frequent causes of unscheduled down time on the blast furnace is tuyere burning by hot metal. In an attempt to extend the life of the tuyere, alternative designs have been developed incorporating independent nose cooling. A high water velocity in the nose chamber eliminates the possibility of nucleate boiling and thus reduces the possibility of burn out. Pressure in the nose compartment is kept high for reasons of safety. Individual nose circuits incorporate flow monitoring devices to detect leakage. Modern furnaces operating at high blast temperatures adopt blowpipe nose cooling to minimise distortion at the spherical seat between blowpipe and tuyere.

The furnaces at Ahmsa and Acominas incorporate underhearth cooling by water and spray cooled hearth jackets. In the case of Ahmsa, the tuyere belt is cooled by the use of external boxes and the bosh is film cooled.

For Acominas, cooling plates are used in all areas above the hearth jacket.

FURNACE CHARGING SYSTEM

Stockhouse

Prior to the introduction of the high capacity blast furnace, the conventional method of hoisting the materials to the furnace top was by the use of skips.

Ferrous materials were drawn from the stockhouse bins by scale car and delivered direct to the skips. Coke was normally screened, weighed and charged automatically.

As furnace size increased, requiring larger tonnages of raw materials to be handled, the advantage of a fully automated charging system became apparent. It was also realised that if high outputs were to be achieved, it would be necessary to use a large proportion of agglomerates in the burden which would need to be screened after the stockhouse bins to minimise the amount of fines charged. The importance of obtaining consistent charge weights was also realised.

These requirements led to the development of the fully automatic stockhouse incorporating facilities for the screening and weighing of all materials.

Although some large furnaces are still charged by skips this has usually been determined by site considerations. Charging by conveyor has been generally accepted in that it offers many advantages. In particular the removal of the stockhouse from the furnace area permits the optimum layout of cast house and ancillary equipment.

Various arrangements of the stockhouse are possible.

The following systems are in general use:

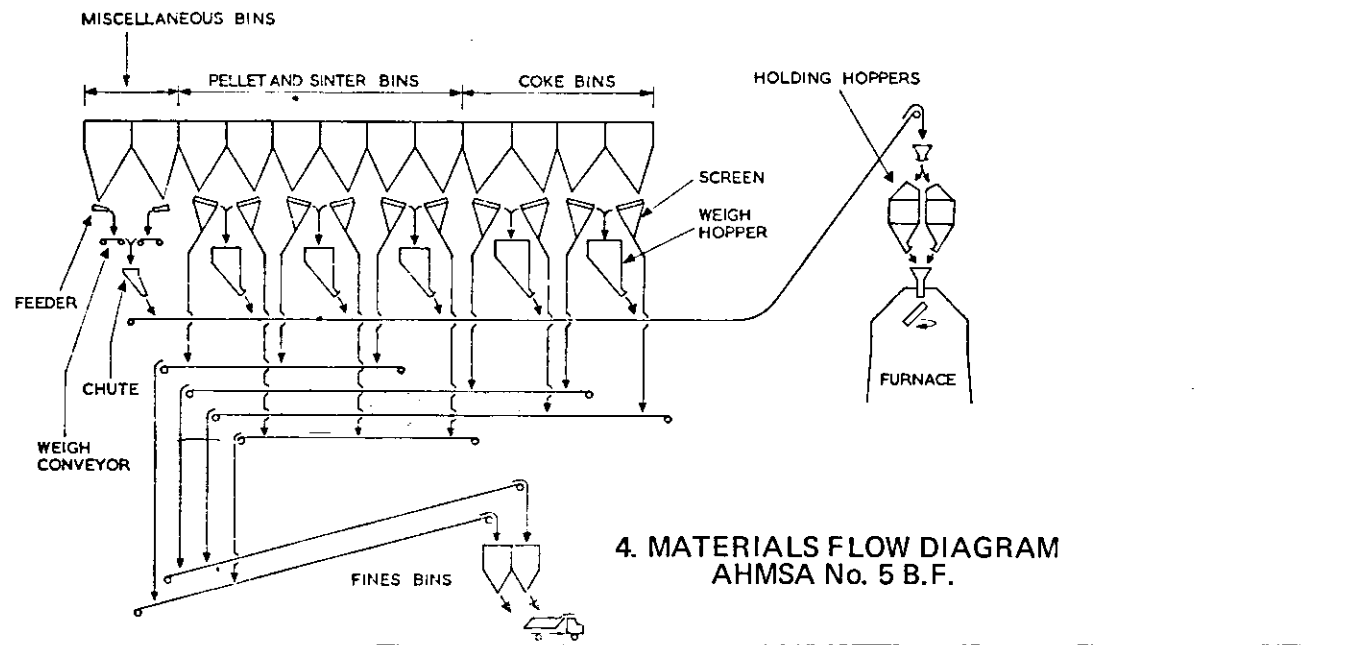
1. All materials are extracted from the bins and conveyed to a central aisle for screening and weighing. The furnace charging conveyor passes through this central aisle..
2. Screening is carried out local to each bin, the screens delivering directly into weigh hoppers. The furnace charging conveyor passes along the centre of the bin system.
3. Screening is carried out local to each bin. Screened coke is carried by conveyor to weigh hoppers located in a transfer station at the tail end of the furnace charging conveyor. Screened ferrous materials are weighed immediately following the screens then carried by conveyor to surge hoppers also located in the transfer station.

On some installations the coke and ferrous stockhouse are built as separate units.

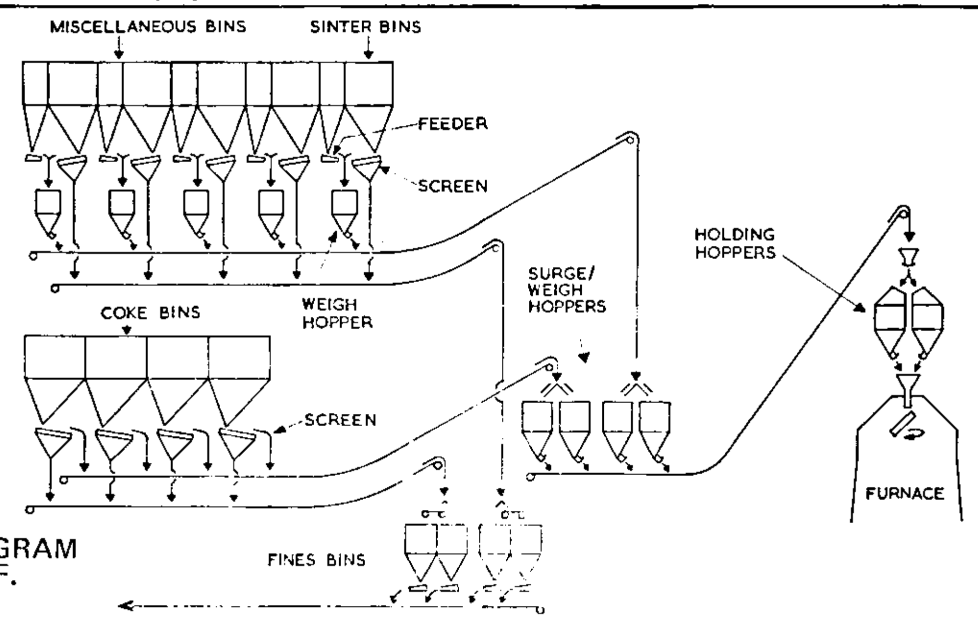
The furnaces at Ahmsa and Acominas are served by fully automatic stockhouses with underbin screening and are conveyor charged.

The Ahmsa stockhouse is of the type described in Item 2 and the material flow is shown in Figure 4. The Acominas stockhouse is of the type described in Item 3 and flow diagram is shown in Figure 5.

On both plants provision is made for withdrawing the screens from beneath the bins to facilitate maintenance.



4. MATERIALS FLOW DIAGRAM AHMSA No. 5 B.F.



5. MATERIALS FLOW DIAGRAM ACOMINAS No. I B.F.

The furnace charging conveyor belt is of the steel cord type which is particularly suited to this application because of the inherent high tensile strength and minimum elongation. The conveyor drive is of the tandem type located in a house at ground level.

Furnace Top Equipment

The purpose of the furnace top charging equipment is twofold. Firstly, to allow the introduction of materials into the furnace without the escape of gas. Secondly, to distribute the ingoing materials at the stockline in such a manner as to obtain efficient furnace operation.

The usual arrangement consisted of a two bell system comprising a large bell surmounted by a McKee type distributor which was essentially a small bell with provision for rotation in stages. This arrangement served to minimise the segregation of raw materials within the furnace.

As furnace size increased with a corresponding increase in large bell diameter, the possibility of charging materials into the centre core of the blast furnace became increasingly difficult.

Variable diameter throat armour was introduced on some large furnaces and this provided some measure of control over the distribution of materials at the stockline. Different diameter settings of the armour could be used for charging coke and sinter.

Increases in furnace size were accompanied by increased operating top pressure which was found necessary to obtain the maximum benefit from the increased furnace volume.

With the standard two bell top the bells were required to perform the dual function of gas sealing and material holding. As operating pressures were raised it became increasingly difficult to maintain a gas tight seal.

These factors led to the development of a range of tops especially designed to separate the sealing and material holding functions.

One design incorporated a separate small bell for gas sealing which enabled an increased small bell life to be achieved. However, the large bell was still subjected to the full differential pressure when the small bell was open.

A further development was the introduction of a pressure chamber above the small bell equipped with seal valves. These valves, being of relatively small diameter, were easier to keep gas tight. This development avoided the creation of a differential pressure across the large bell seat at all times. The gas sealing efficiency of the small bell was also improved by the incorporation of a soft seat.

As large bell diameter increased, the problem of manufacturing, transporting and handling the large bell and hopper became more acute. High capacity lifting gear with its associated supporting structure had to be built into the furnace top for the sole purpose of handling these components.

A more recent development has led to the introduction of a new concept in furnace top charging equipment. The bell-less top has the effect of overcoming the disadvantages outlined above.

This equipment dispenses with the conventional large bell and hopper and incorporates a rotating chute inside the furnace. The inclination of the chute can be varied as desired. The combination of rotatory and angular movement has provided a degree of flexibility and control over burden distribution at the stockline beyond anything previously possible. The charging pattern may comprise single ring, concentric rings, segmental or the charge may be dumped at one point as required to suit furnace operating conditions.

The equipment comprises two holding hoppers each with seal valves, top and bottom, and a flow control gate. Each hopper holds one charge, which in the case of coke is sufficient to raise the stockline by some 0.6/0.8 m. The hoppers are filled and discharged alternately.

As furnace pressures increased it was found necessary to equalise the pressure above the large bell to allow the bell to open. Equalising was performed by the use of semi-clean gas taken from a point following the primary gas cleaning stage. This method had two disadvantages as follows: –

1. The gas still held a certain amount of dust and moisture.
2. The pressure of the gas was below that inside the furnace due to the system loss up to the take off point.

With the introduction of the seal valve top, this latter disadvantage was overcome by providing a means of secondary equalisation by topping up with nitrogen. Alternatively the entire equalising function was performed using nitrogen alone, which overcame both disadvantages.

Similarly with the bell-less top hoppers, equalisation is performed to allow the lower seal valve to open and also to preserve the integrity of the seal valve seat.

Either system of equalisation described above is applicable.

With the introduction of the bell-less top, however, another significant feature is introduced. To prevent damage to the bell-less top gearbox from dust and convected and radiated heat at the furnace top, it is necessary to provide some form of pressurising and cooling. Cooling may be achieved using nitrogen, compressed blast furnace clean gas or natural gas. Of the above, nitrogen is the most suitable for this purpose because it is clean, dry and inert to the furnace top gases.

The quantity of nitrogen for equalisation is a relatively small amount compared to that required for gearbox cooling. The general tendency with the latest installations is to adopt nitrogen for both purposes.

The bell-less top offers the facility to distribute the charge at the stockline in a variety of patterns, which directly affects the gas flow through the furnace. It is, therefore, desirable for the operator to be fully aware of the prevailing conditions in order to optimise performance and to obtain maximum campaign life. This is of particular importance when stave cooling is adopted.

Monitoring of stave temperature is often practiced. A further means of acquiring such information is by continuously monitoring the gas temperature at various points across the stockline by using probes. Four probes are normally installed at stockline level. Infra-red cameras located in the top cone can be used to augment this information.

To facilitate the carrying out of furnace top maintenance operations which require direct access to the furnace, it is necessary to ignite the gases at the stockline. In the case of furnaces with double bell charging systems, it was comparatively easy to open the gas seal doors and light fires around the periphery of the large bell which was then dumped allowing the burning mass to enter the furnace. By holding the large and small bells open and opening the bleeders, sufficient air was drawn in to support combustion. With the introduction of the bell-less top, this simple method of top gas ignition became inappropriate.

Two methods of igniting the top gases have proved successful. A flare may be introduced manually into the furnace top or alternatively, an automatic lance may be used. Both these systems necessitate openings in the shell and additional manholes to permit the ingress of air to maintain combustion.

Provision must be made for automatically monitoring and recording the stock level. Although alternative means have been developed the mechanical type of stockline recorder still remains the most commonly used on the latest installations. Three units on a single pitch circle are normally used but on the larger furnaces in order to provide a more extensive coverage of the stockline area further units can be introduced on a second pitch circle.

The bell-less top also allows the facility for introducing a further unit at the centre of the blast furnace. This feature is currently being adopted on some of the largest furnaces.

The furnaces at Ahmsa and Acominas are both equipped with the bell less top charging system as shown in Figure 6.

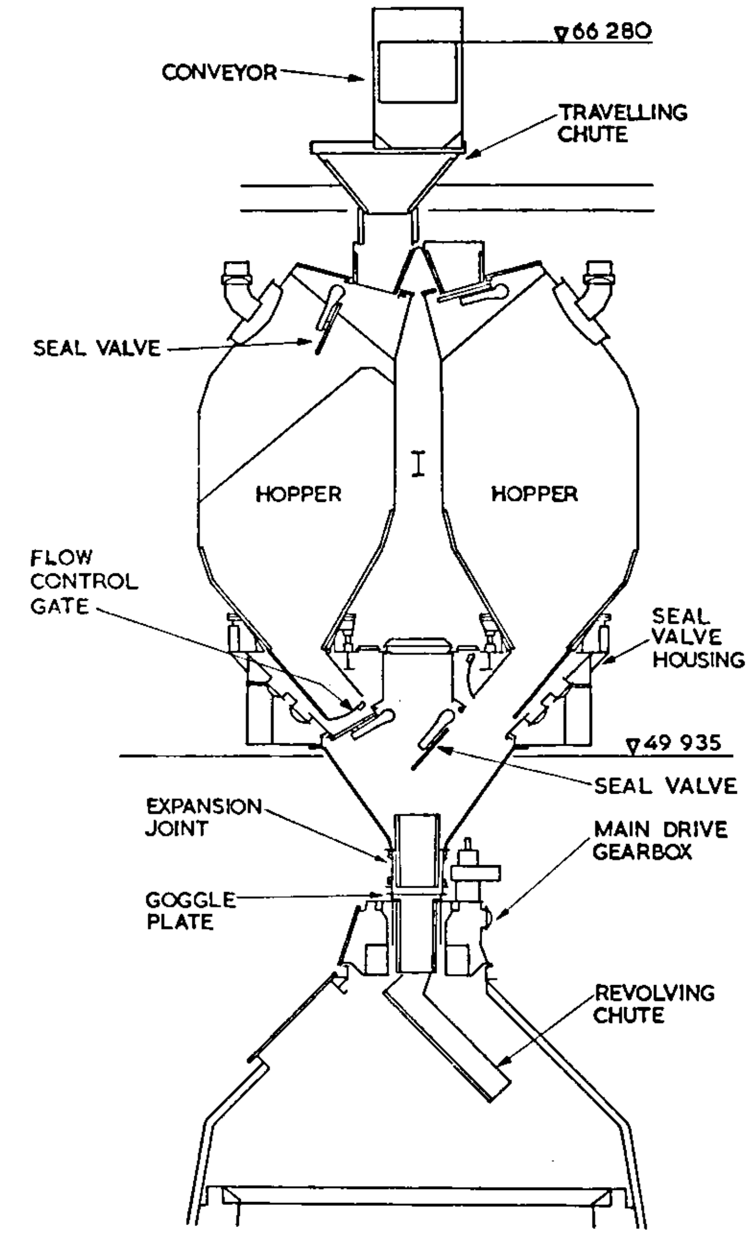
Nitrogen is used for both equalisation and cooling of the Ahmsa top. Acominas uses semi-clean gas for primary equalisation.

CASTHOUSE FLOOR

One of the most important factors in the layout of the iron-making plant is the incorporation of a cast house arrangement which will permit the hot metal and slag to be disposed of quickly and efficiently. At the same time this must be achieved with the minimum expenditure of effort and risk to operating personnel.

Early blast furnaces were equipped with one iron notch only together with one or two slag notches depending on the relative volumes of slag to be handled. For hot metal production of up to about 2,500 per day this arrangement was considered to be satisfactory.

With the increase in furnace size and output it was necessary to increase the number of iron notches to handle the hot metal and leave time for runner repairs.



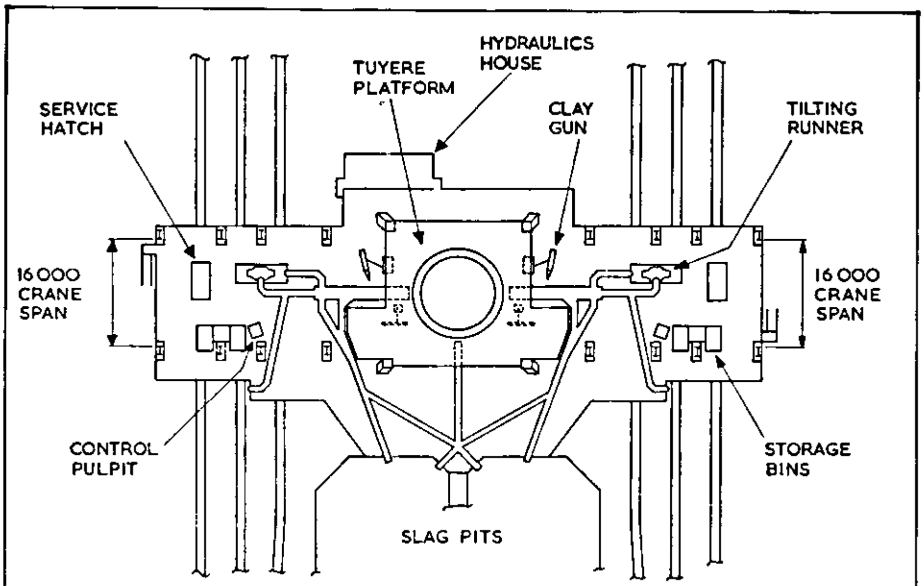
6. BELL – LESS TOP
ACOMINAS No. I B.F.

Slag notches have been a major cause of troubles in the past and as a result of modern low slag volume practice and the development of superior taphole clays all slag is now generally extracted through the iron notch.

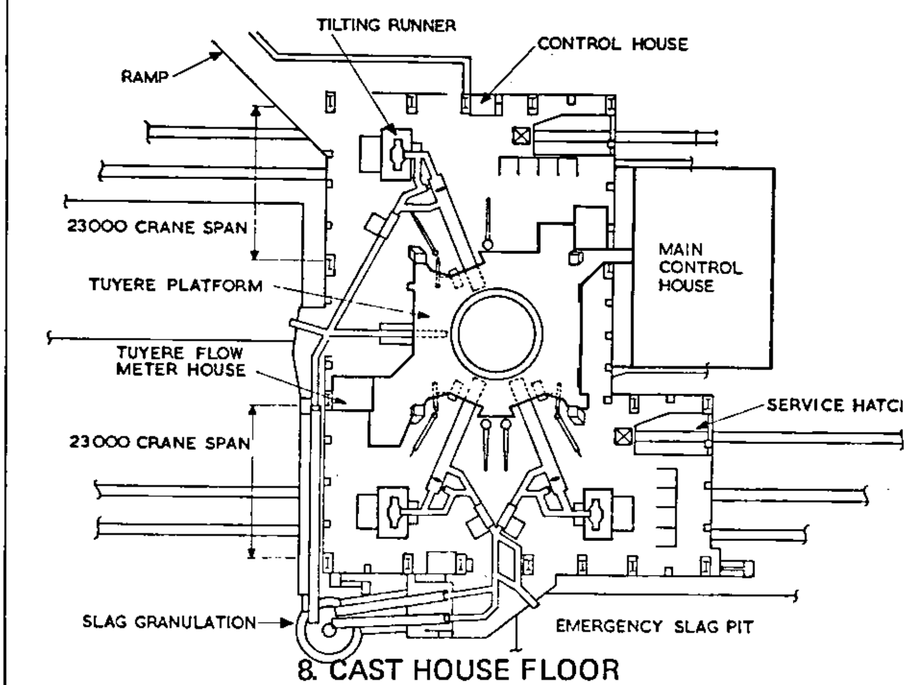
The main casting trough is now normally arranged to suit the 'deep pool' casting technique in which trough remains full of hot metal between cast and is only drained when major lining repairs are needed. This method of operation results in an incresed life of runner lining and increased availability because of reduced clean up time.

To promote good separation of hot metal and slag on large furnaces operating under high top pressure conditions the distance between the skilmer and the furnace front has been increased. On the largest units this may be as much as 16 m.

On some plants the whole of the main casting trough may be constructed in such a way as to permit removal in one piece and lining repairs affected elsewhere. This generally increases the availability of any runner but it does, however, require a heavy crane of some 70/100 t capacity with corresponding steelwork.



7. CAST HOUSE FLOOR
AHMSA No 5 B.F.



8. CAST HOUSE FLOOR
ACOMINAS No. I B.F.

To minimise the work load in respect to clean up, iron runner lengths are kept as short as possible by the increased use of moving or tilting runners.

On some furnaces provision is made in the slag runner system for secondary separation to minimise the amount of iron carried in the slag. This is particularly important when the slag is to be granulated.

Furnaces having two or more iron notches can conveniently be provided with two interconnected cast houses, generally located on opposite sides of the furnace and each containing one or more iron notches with their associated runner systems. The location of the cast houses is influenced by the layout of rail tracks and the method used for handling the slag.

Hot metal is generally removed from the furnace in torpedo ladles which may range in size from 200 to 450 or 600 t. Slab may be disposed of by casting into dry pits or by granulation. Granulation is considered to be the most satisfactory method, particularly from the viewpoint of pollution control.

On modern furnaces a continuous tuyere maintenance platform is provided within the tower structure. This allows good access by mobile equipment for servicing tuyeres and tuyere stocks.

The clay gun has been especially designed to operate in the low headroom available under the tuyere platform. Each gun is hydraulically operated and modern guns are capable of developing a clay piston pressure of up to 150 bar to handle tar bonded and resin bonded clays.

Taphole drills must be of robust design to suit the arduous operating conditions. Modern drilling units are equipped with rotary and forward and reverse hammer motions. This permits casting techniques which require only the removal of a bar to initiate casting.

Furnace control which was formerly conducted adjacent to the cast house is now being transferred to a centralized control building situated remote from the furnace. Procedures undertaken on the floor of the cast house are now generally limited to clay gun and taphole drill control and control of local lifting equipment.

On the largest units snort valve controls are located in the furnace blower house.

The arrangement of the Ahmsa and Acominas cast house floors are shown in Figures 7 and 8 respectively.

Each furnace has two interconnected cast houses located on opposite sides. In both cases the casting troughs are of the fixed type.

The Ahmsa furnace with a production rating of 4,500 t per day has two iron notches whereas Acominas has three iron notches for a production of 5,300 t per day.

Each furnace is equipped with one slag notch. At Ahmsa the slag is cast into dry pits and at Acominas all slag is granulated although a dry pit is provided for emergency use.

HOT BLAST STOVES

The traditional Cowper design of internal combustion chamber stove has been universal for many years. This design has given good service and many installations have required little in the way of maintenance over several campaigns of the blast furnace.

The call for increased blast temperature necessitated higher operating temperatures within the stove. Although higher grade refractories were installed it became apparent that the traditional Cowper stove had a number of inherent design faults at high operating temperatures.

A major constraint was associated with the design of the partition wall between the chequer chamber and the combustion chamber. A large temperature difference existed across the partition wall especially in the lower regions of the stove and temperature cycling gave rise to differential movement. Cracks developed in the partition wall and hot gas short circuited through the wall. Another feature was the tendency of the combustion chamber wall to band into the chequer chamber as a result of this steep temperature gradient.

The mechanical burner located outside the stove and firing directly at the partition wall made condititions particularly arduous.

The dome brickwork was supported direct from the stove ring wall. The difference in expansion between the stove ring wall on the combustion chamber side and on the chequer chamber side gave rise to stress and cracking in the dome.

One method adopted to overcome these limitations was the introduction of a completely new design incorporating an external combustion chamber.

The alternative was to retain the single vessel and re-design the stove refractories.

This latter course had the advantage of avoiding the problem of accommodating the differential expansion between the shells of the external combustion chamber and the chequer chamber. In addition, when re-building existing systems, foundations could be retained and alterations to adjacent equipment minimised.

The main characteristics of this design are as follows: –

1. Construction parts are separated by slip joints so that they can move independently of each other and expansion joints allow movement to be absorbed both vertically and horizontally.
2. An insulating layer is installed between the refractory layers forming the partition wall. The temperature gradient through the refractory layers is reduced thus minimising thermal stress and the tendency to bend.
3. Heat resistant alloy sheets are inserted on the cold side of the insulation layer and overlap to form a safety barrier against possible short circuiting of the gas.
4. A ceramic burner is located in the base of the combustion chamber.
5. Silica with its good volume stability is used extensively in the upper parts of the stove.
6. The dome is supported independently from the ring wall.

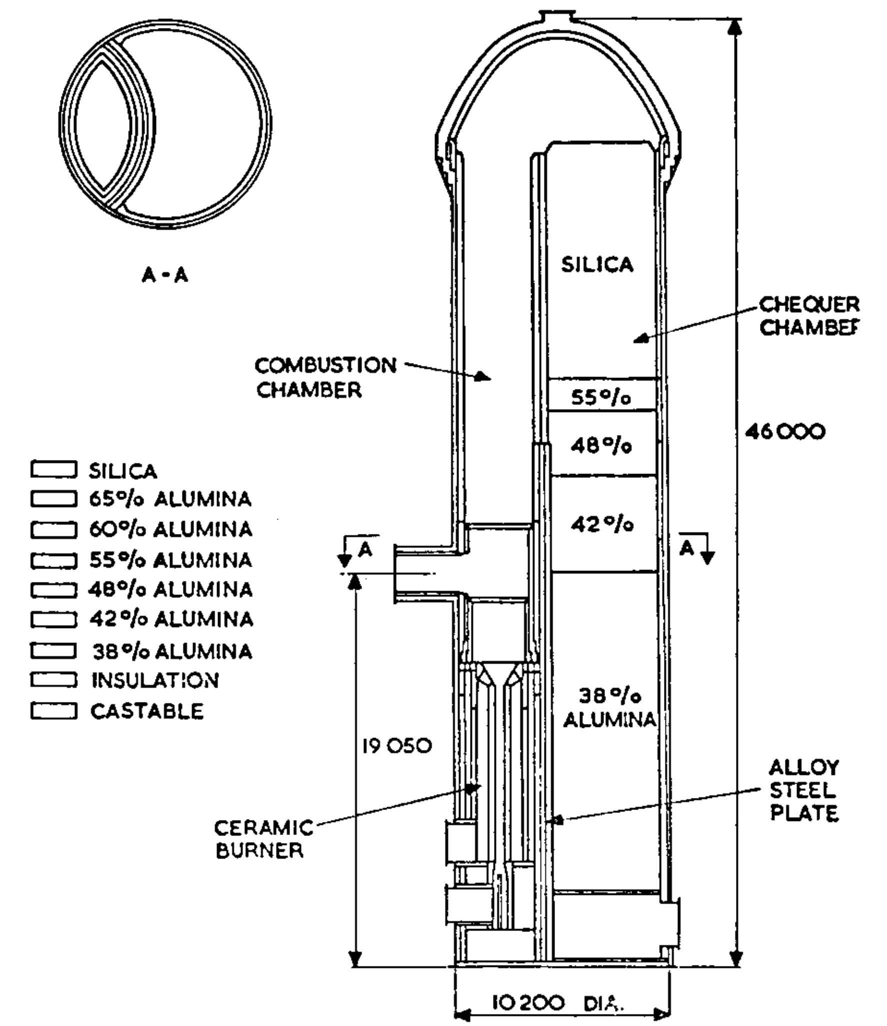
The stove shell must withstand the operating blast pressure. Additionally it is systematically pressurised and depressurised at the start of each blast and gassing cycle respectively. Stove shells are now designed using pressure vessel codes where applicable. The stove is firmly bolted to the foundation and the foundation considered an integral part of the stove.

Most installations incorporate three stoves working in cyclic mode. A number of large installations, however, incorporate four stoves working in the staggered parallel mode. This method of operation is particularly efficient in that it dispenses with the use of cold blast mixing air.

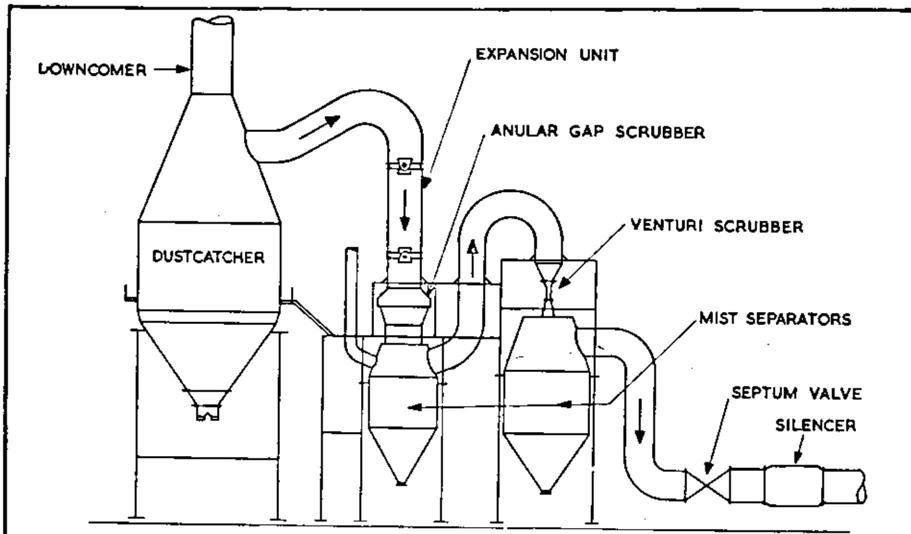
This enables a higher hot blast temperature to be achieved with the use of a specified dome temperature.

The hot blast stoves at both Ahmsa and Acominas are of the high temperature internal combustion chamber type. A typical section through the stove is shown in Figure 9.

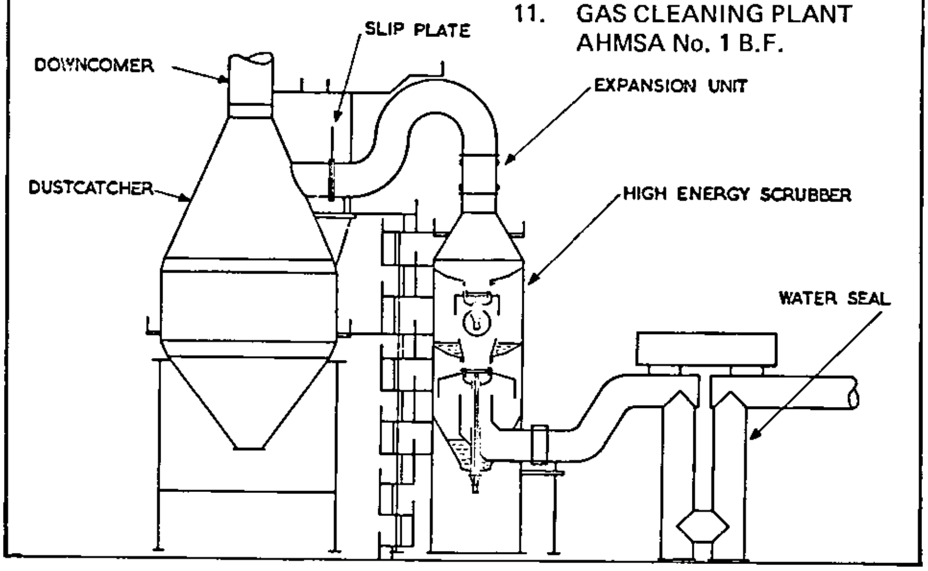
Three stoves are installed at each plant.



9. STOVE SECTION
ACOMINAS No. 1 B.F.



10. GAS CLEANING PLANT
AHMSA No. 5 B. F.



11. GAS CLEANING PLANT
AHMSA No. 1 B.F.

GAS CLEANING PLANT

The blast furnace gas cleaning system in earlier furnaces consisted of a dustcatcher followed by a secondary system comprising washers and electrostatic precipitators or Theisen disintegrators.

With the introduction of high top pressure operation a new method of secondary cleaning utilising the pressure energy of the gas became available. This type of system is now universally adopted.

Earlier types of pressure cleaning systems comprised single stage scrubber units. Wear on these initial installations was high and later designs utilised two-stage cleaning. Generally the first stage was fixed and the second variable. The fixed orifice allowed a degree of cleaning sufficient to condition the gas for use as the furnace top pressure equalising medium, the second stage variable to maintain the required pressure drop for cleaning at varying gas flow conditions.

These systems operate in conjunction with a septum valve to control the top pressure of the furnace. Initially the septum valve was located between the two scrubber stages but on later installations it is located after the secondary unit. The advantages of this rearrangement are that the septum valve is working in a cleaner gas and it is easier to effectively control noise emissions from the valve.

Also in cases where the gas cleaning plant water circulation system has not incorporated a cooling tower, problems have arisen at the stoves as a result of excessive water drop-out with the septum located between the stages. With the septum located after the secondary unit the gas no longer leaves the cleaning plant in a saturated condition.

As stated previously the above systems worked in conjunction with a septum valve which generated a high noise emission. As furnace size and operating top pressures increased this problem became more acute. To achieve acceptable noise limits it was necessary to incorporate a silencer and enclose the valve in an acoustic enclosure.

The latest development resulted in the incorporation of the primary and secondary stages into one vessel and the use of the secondary stage to control the top pressure thus eliminating the septum valve.

Advantages of this system are that the pressure reduction takes place within the scrubber vessel where it is more amenable to noise reduction measures. The design of the scrubbing stages is such as to minimise erosion by the dust laden gases. Also this system leads to a more compact plant arrangement.

The gas cleaning plant arrangement installed at Ahmsa incorporates the latest developments referred to above and is shown in Figure 10.

This scrubber incorporates two adjustable high efficiency scrubbing stages in series and a droplet separator built into one common casing. The gases are cooled by sprays in the upper stages of the tower. The gases then pass to the primary scrubbing stage comprising an inlet cone with an adjustable ring orifice at the base. The adjustment is performed by hydraulic cylinder. The pressure drop across the primary stage is controlled at a pre-set level, sufficient to collect the larger dust particles.

A second stage of cleaning identical with the first is provided. The second stage throat is automatically positioned to control the furnace top pressure.

The gas cleaning plant arrangement installed at Acominas is of the type incorporating a septum valve as shown in Figure 11.

The gas passes from the dustcatcher to the primary scrubbing stage. This consists of an annular fixed throat venturi scrubber mounted above a water separator vessel.

The gas then passes to an automatically adjustable rectangular throat venturi scrubber mounted above a second water separator vessel. The water separator is followed by a septum valve comprising four butterfly regulating valves.

ENVIRONMENTAL CONSIDERATIONS

In earlier days blast furnaces were so small in comparison to their surroundings that their effect was felt only in the immediate vicinity of the furnace.

As furnace size increased, however, it became apparent that the furnace could exert an appreciable influence on the climate and habitability of the area in which it was located.

In many ironmaking districts operations have now been placed under some degree of pollution control. Controls vary from country to country and in some instances from area to area. Whatever the existing conditions, however, controls everywhere are becoming progressively tighter year by year thus compounding the problems associated with pollution.

The main areas of control can be summarised as follows: –

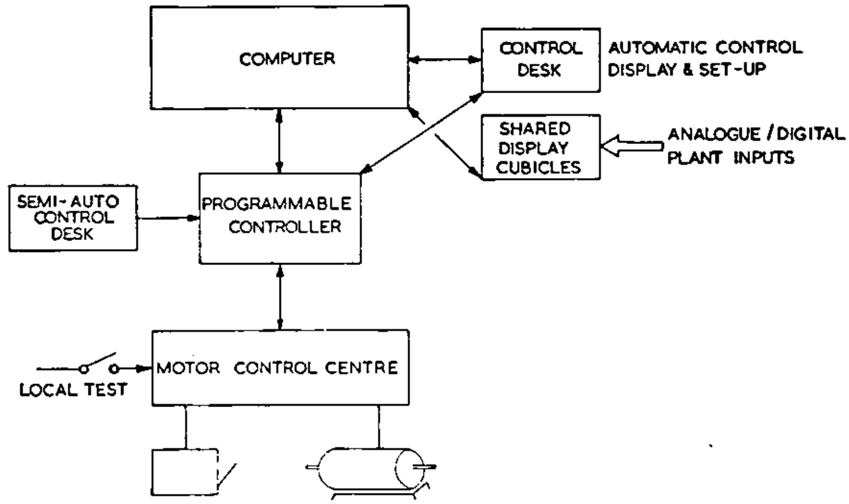
1. Air pollution from stacks and materials handling and casting operations.

   Modern units generally require to be equipped with a means for suppressing or collecting dust arising from materials handling operations. Collecting systems are usually equipped with wet or dry cleaning systems to limit dust concentrations at the stack to less than 0.1 g/Nm^3.

   Modern units also generally require to be equipped with a means for collecting fume arising in the cast house during tapping operations.
2. Contamination of spent water.

   Modern units require to be equipped with efficient clarification systems. Treatment of 'blow down' water is necessary in some instances.
3. Noise.

   The ambient noise level in a given location is increased by any industrial activity and the blast furnace is no exception. Man's tolerance for noise has an upper limit based on intensity and period of exposure.



12. CONTROL HIERARCHY

Modern high pressure units have a high potential for noise generation and silencing equipment is now common for stove blow down and top pressure relief facilities as well as for the snort valve.

Where septum valves are fitted on modern units they must be effectively silenced by the fitting of a silencer suitably lagged and housed in an enclosure.

The Acominas blast furnace includes several features specifically included for pollution control.

A comprehensive system for the collection of arising dust in the stockhouse is included. Cleaning is carried out using bag filters.

Collection hoods collect arising fume at the taphole and tilting runners in the cast house. Again cleaning is by bag filter.

PLANT CONTROLS

On earlier furnaces the instrumentation and control facilities were minimal and were located adjacent to the various ancillaries, namely, stockhouse, skip hoist, stoves, cast house and gas cleaning plant. These control stations incorporated large case indicator/recorders.

Electrical controls for skip charging were provided together with mechanical weighing indication and manual control of scale car movement and hopper gates.

The modern blast furnace requires to be equipped with automatic analytical instruments to determine gas analysis and other devices to monitor operating temperatures, flows and pressures. Modern materials feeding and furnace charging systems need to be controlled automatically to achieve the required production rates.

The overall plant control has evolved in parallel with the blast furnace hardware into hierarchical systems as detailed below. These systems use proprietary modular systems for implementing plant control functions. The use of programmable controllers, shared display systems and an increasing use of medium sized process control computers has developed due to the availability of engineer biased software aids and high level languages.

A typical control hierarchy is shown in Figure 12. The general purpose medium sized digital computer undertakes plant data logging and process model functions outputting dynamic mimic and loop diagrams to visual display units. The computer also initiates control actions to plant via the second level control which comprises a programmable controller for logic action and a shared display system for instrumentation actions. The programmable controllers incorporate all the automatic, semi-automatic and process logic and safety sequences necessary for protection of personnel and safe operation of the plant. The programmable controllers issue individual drive commands to the third level motor control centres. The motor control centres contain no sequence interlocks but maintain essential safety and plant interlocks, such as overloads, trip switches, speed switches and critical plant interlocks for local protection of personnel.

Modern practice requires that all the controls are located together in a central furnace room where functions can be easily supervised. The control room is housed in a control building adjacent to the furnace.

All signals from plant transducers are brought back to the control room.

Located in the control room are the control desk and panel. The desk incorporates the necessary push buttons, digital displays and thumb wheels to order any necessary change to the plant sub-systems. The control panel houses the mimic diagrams for weighing/charging, furnace top, stoves, gas cleaning, and furnace cooling systems. Located below these are the small case instruments, recorders, controllers, indicators and alarm annunciators. Improvements in instrument design and technology with the benefits of instrument miniaturisation has allowed a more compact arrangement to be adopted.

With the introduction of shared display systems and computer generated mimic diagrams the extensive plant mimic panels with individual loop controllers, recorders and indicators have been superseded by the shared display system multi-loop formats. These multi-purpose displays are used to display individual multi-loop details in various preformated screens. Static mimic diagrams are available for display of plant loop connection details and on advanced systems digital computer derived dynamic mimic diagrams are available for display of live loop measurements.

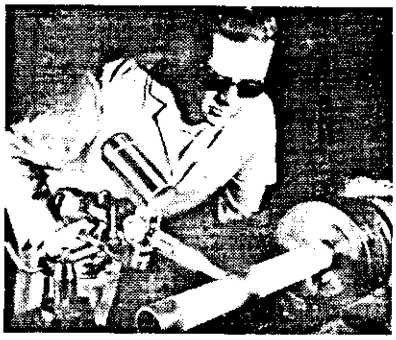
The control building also houses the electrical distribution, weighing, motor control centres, programmable controllers, computer systems, plant offices and amenities.

Blast Furnace

The provision of plant controls on the blast furnace is limited to measurement of in-walls/stave temperature and control of cooling. In addition, modern analysis equipment is used to give continuous analysis of blast furnace top gas.

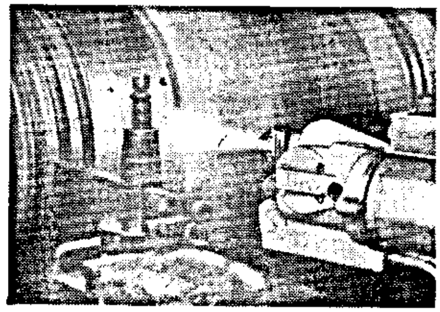
Furnace developments in monitoring the prevailing conditions within the furnace include continuous temperature measurement at the stockline from which to generate gas temperature profiles and the incorporation of infra-red cameras. **PM**

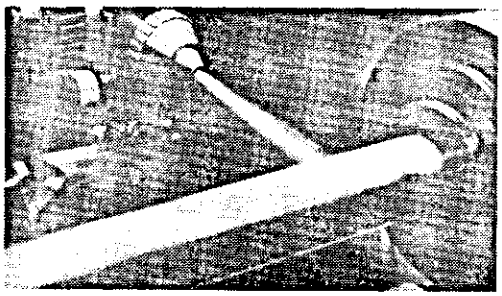
(end of Part I)



CUT MACHINE DOWNTIME

REDUCE MAINTENANCE COST





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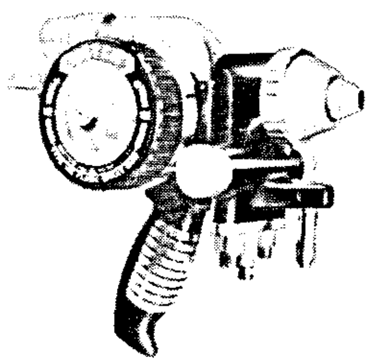

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A NEW MACHINING AREA FOR MODERN TOOL TECHNOLOGY

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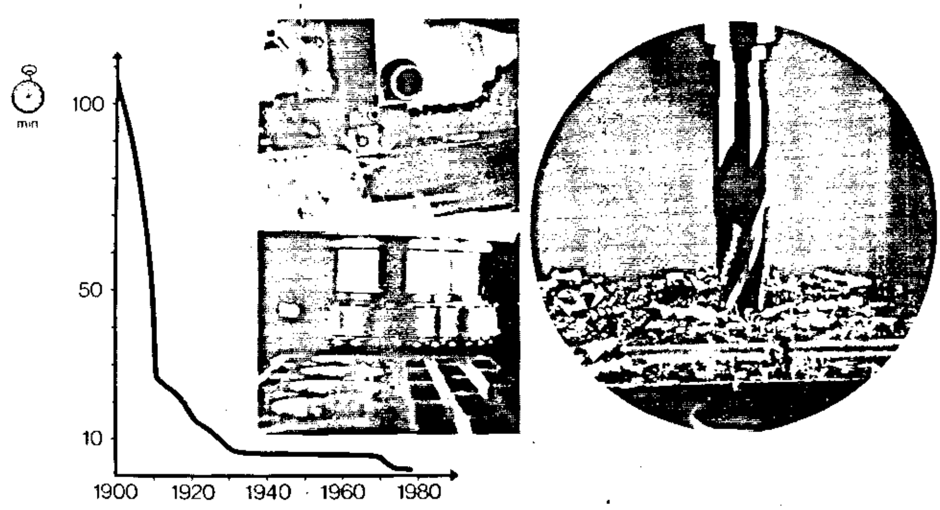
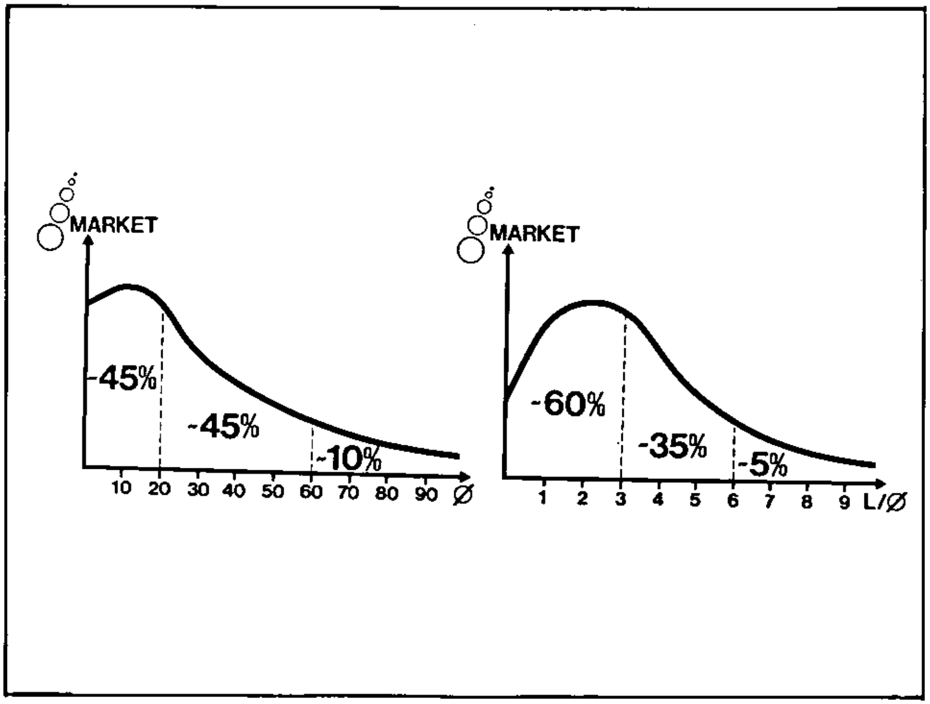
Sandvik AB

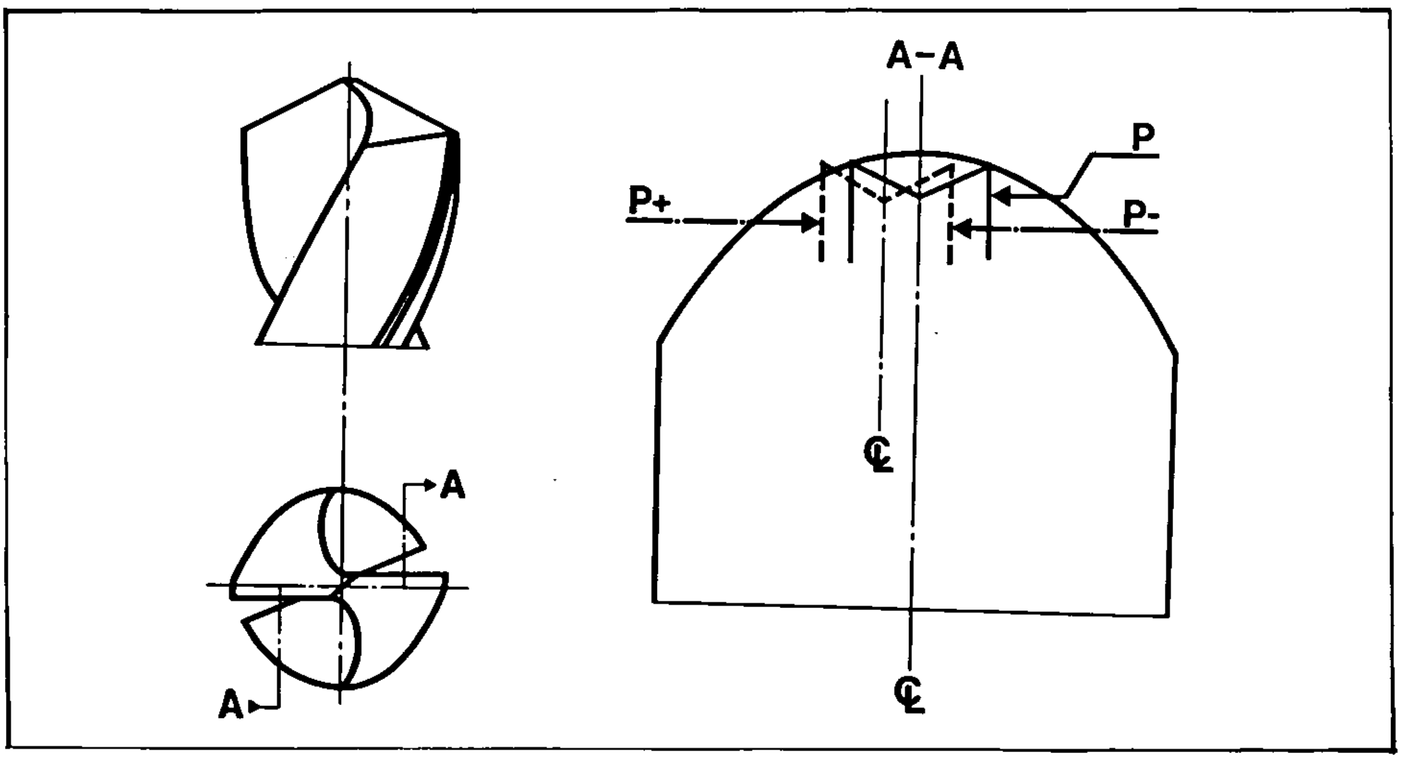
Important progress in metal cutting has been made in this century through the rapid development of new cutting tool materials, better cutting tools and more accurate and powerful machine tools. As a result of this progress during the past 80 years, the time needed in turning to form a certain workpiece decreased from 100 to 1 minute. This rate of improvement is also valid for most milling operations. The third major metal cutting area, drilling, with the exception of some special areas was not subjected to such favourable progress. However, as we shall see, developments during the last few years have also brought drilling up to modern machining standards and provided this field with the revolutionary changes it needed.

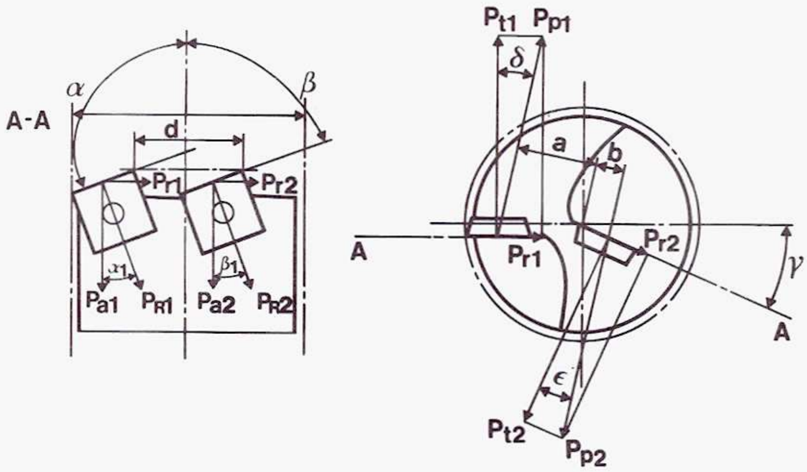


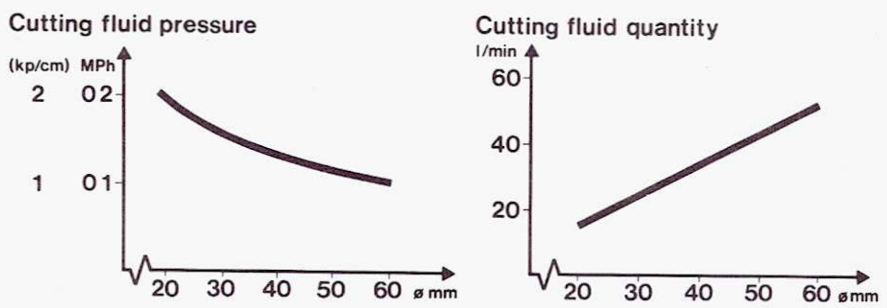
Studies of the market for drilling indicate that approximately half the cost for drilling tools are for the diameter range below 20mm. Less than 10% of the tool costs are for diameters above 60mm. If we note the distribution of drilling depth or length in relation to diameter, we find that the majority of holes have a length smaller than three times the diameter. Only 5% have lengths exceeding six times the diameter.

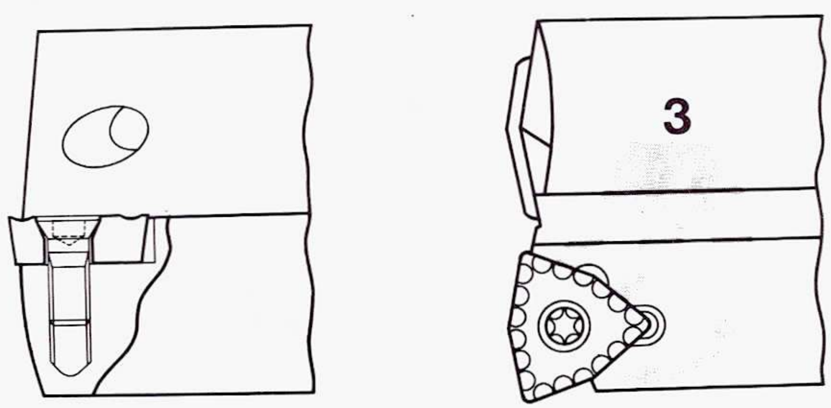
Carbide tipped drills in the form of EJECTOR or BTA types are used mainly for the diameter range above 20mm. and then, for long holes. For diameters below 20mm, carbide tipped gun drills have become a successful application. However, this is only in specially equipped gun-drilling machines with guide bushes, coolant sealings and coolant supply with rather high pressure.











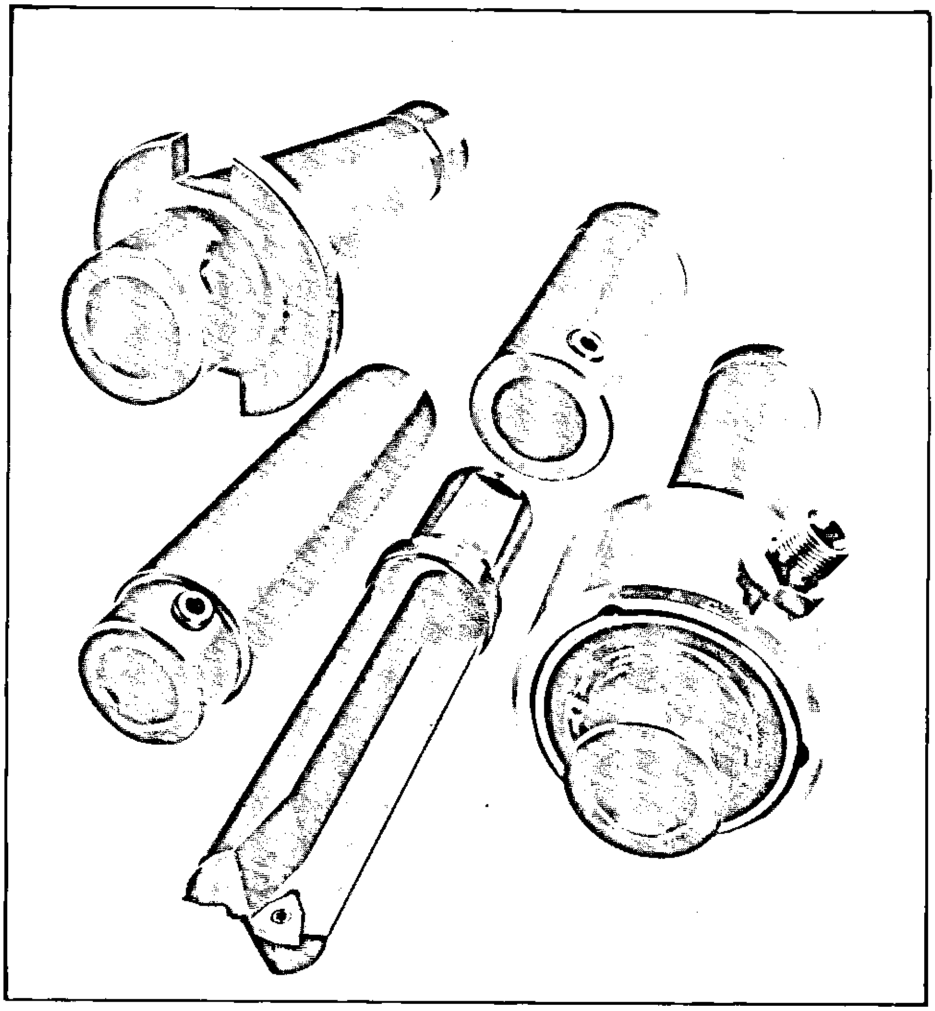
For the dominating range of short holes and diameters below 20mm the high speed steel twist drill is the only tool used to any great extent up to now. Today, these stand for more than 20% of the total costs of all tools within metal cutting and machining. The reason for this situation, to start with, is the way in which the drill is guided through the workpiece and the tool geometry. But, also the suitability, or the unsuitability, of carbide plays a role for the tool design in question. The carbide tipped deep-hole drilling tools are in general guided by two or more support pads, which act at the start in the drill bush and then in the machined hole. The cutting edge or edges are positioned in such a way that the cutting forces are not fully equalized, leaving a resulting side force. This side force is taken up by the support pads giving the drill a certain position in the hole and guiding it on the same direction as of the start.

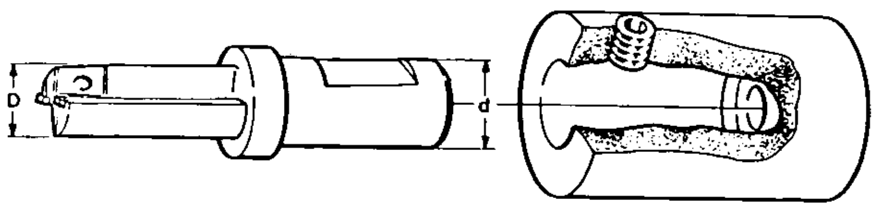
The twist drill on the other hand is a self-adjusting tool. The cutting forces on both sides of the centre line are equal on a correctly ground drill. The main cutting edges are placed above centre, which means a negative radial angle. If the cutting force on the right-hand edge increases, the drill will be brought out of centre and the load on the left-hand cutting edge will automatically increase. When cutting forces on the left-hand side increase to the same value as the forces on the right-hand side, the drill will automatically find a new centre. For this reason, the twist drill always works in a stable position, which would not be the case if the main cutting edges are placed on or under the centre. However with this way of guiding the twist drill in the hole, we cannot expect a very good result with regard to surface finish, straightness and drilling performance as with the tools guided by support pads. The result is in most cases rated as acceptable or the hole quality has to be improved by a following operation. Carbide tipped deep hole drills have in the centre a different design than that of the twist drill. A straight cutting edge passes right through the centre with a falling inclination in relation to the direction of the feed.

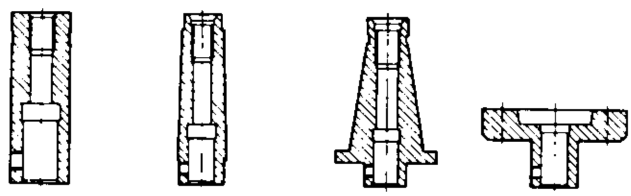
For many years, the industry has been asking for a more efficient way to drill holes with carbide acting as the cutting tool material. A solution is now available in the form of short hole drills with indexable inserts in carbide. The first application is in the diameter range above 18.5 mm, and for depths up to three times the diameter.

The short hole drill operates with two or more cutting edges, each of them cutting a fixed part of the hole diameter. The cutting edges are placed in such a way that the resulting cutting force on the right-hand side of the centre is exactly the same size, but in opposite direction, as the cutting forces on the left-hand side of the centre. Therefore, there are no side-forces or bending moments to be taken up by the tool body during the normal drilling process.

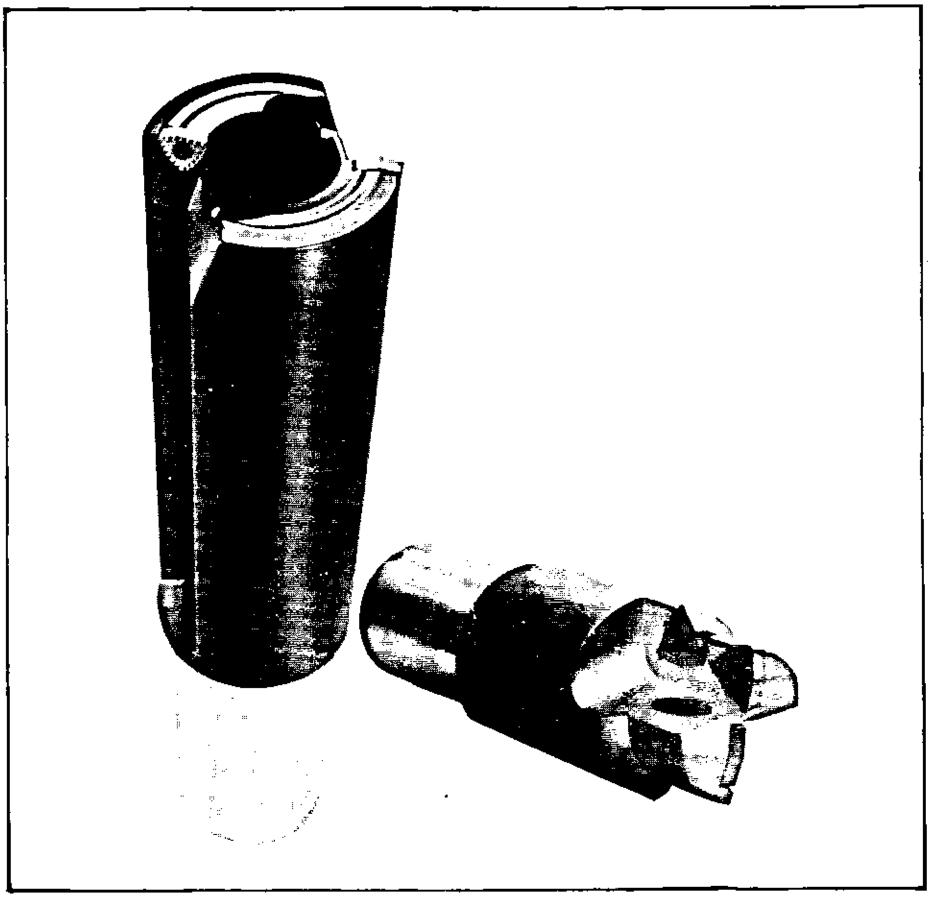
This tool can be used with quite modern carbide cutting data. Cutting speeds of 150-250 m/min-up to ten times the speed used for a good quality twist drill are possible, feed rates of 0.1 -0.3 mm/rev similar to those used with twist drills. This means that the new carbide drill is up to ten times faster than the twist drill. The feed forces and the torque are approximately of the same value as for a twist drill having the same diameter.

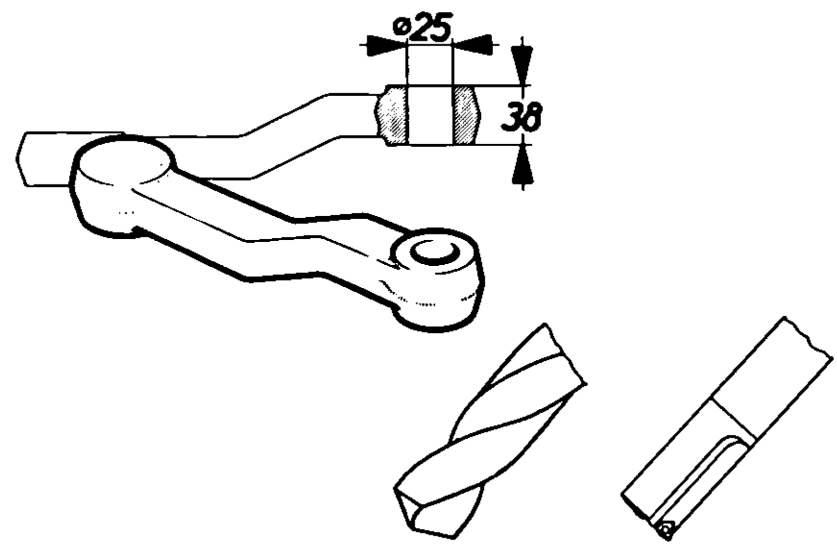






Drill diameter mm D	Holder d	Non-rotating Cylindrical Diameter	Morse taper	ISO taper	Spindle taper
18,5–20,99	20	32	4	40 50	Special
21–30,99	25	40	5	40 50	Special
31–41,99	32	50	6	50	Special
42–56	40	60	6	50	Special





V	m/min	12.3	102
S_n	mm/rev	0.22	0.18
S	mm/min	34	245
T	**min**	**1.42**	**0.17**
/h		40	240

The power consumption is, of course, up to ten times higher and makes corresponding demands on the chip evacuation from the tool. The use of cutting fluid is therefore necessary. The fluid pressure and the amounts required are, however, less than half what is used for a similar EJECTOR drilling operation Cutting edge changing is very rapid through just indexing the inserts—making the optimum economical cutting speed much higher than for drilling tools used up to now.

Trigon shaped inserts with the corner angles 80° and 160° are used in the short holes drill. Some of the advantages of this insert are:

- —The outer part of the peripheral insert as a cutting edge inclined back in the feed direction, which means that the chips are guided away from the surface of the drilled hole.
- —Also the cutting edge going through the centre has got this back inclination towards the centre line which means that optimum cutting conditions can be obtained in the centre of the drill.
- —Wide overlapping parts are used between the peripheral insert and the central insert.
- —In the overlapping zone, the inserts work with angles making the range for the parted chip thickness as small as possible.
- —With stable condition, the clearance of the insert on the periphery allows the drill to also open up the hole just drilled by moving the tool off centre and reversing the feed. A much better surface-finish and a better hole-tolerance is thus achieved.

The inserts have a tapered centre hole and are fixed directly into the tip seat by means of a screw with a tapered head. The inserts are single-sided with a clearance angle of 7° and have form-sintered chipbreakers.

The drill is in two parts: drill and holder, where the holders are available to suit different machines. For instance, the holders can be cylindrical, have a Morse taper, standard ISO—taper, etc... In the case of the rotating drill and if the machine itself does not permit cutting fluid supply through the spindle, there are holders available for supply into the holder.

The drill is clamped in the holder, which means quick tool changes.

The coupling is the well-known Whistle Notch design. Cutting fluid is supplied through two ducts in the drill body and the swarf is evacuated through two external V–shaped grooves

The drills will be available standard diameters in 39 sizes ranging from 18.5 to 56 mm. These sizes are arranged in 4 groups with 4 coupling diameters to fit the 4 holder sizes.

For holes with a diameter above 56 mm special drills are available and in many cases a trepanning tool could be the solution.

Let us study some of the remarkable improvements recorded in practical use of this drill:

This is the drilling of a steering arm. Hole diameter 25 mm, depth is 38 mm. The arm is machined in an NC–machine with the following cutting data;

	HSS	T-MAX-U
v (m/min)	12.3	102
S_n (mm/rev)	0.22	0.188
s' (mm/min)	34	245
T (min/comp)	1.42	0.17
Comp/H	40	240

This is machining of a starter ring. Hole diameter 42 mm, depth is 6 mm. Material: carbon steel (0.45 C)

In this case with a very short hole, we see that the twist drill had to be fed 12+6=18 mm through the hole, while the carbide drill 2+6=8 mm – only half the distance. This makes the drilling time per component 24 times faster. (The feed is approximately 12 times faster).

The cutting data in this case are:

	HSS	T-MAX-U
v (m/Min)	21	264
sn (mm/rev)	0.3	0.25
s' (mm/min)	45	500

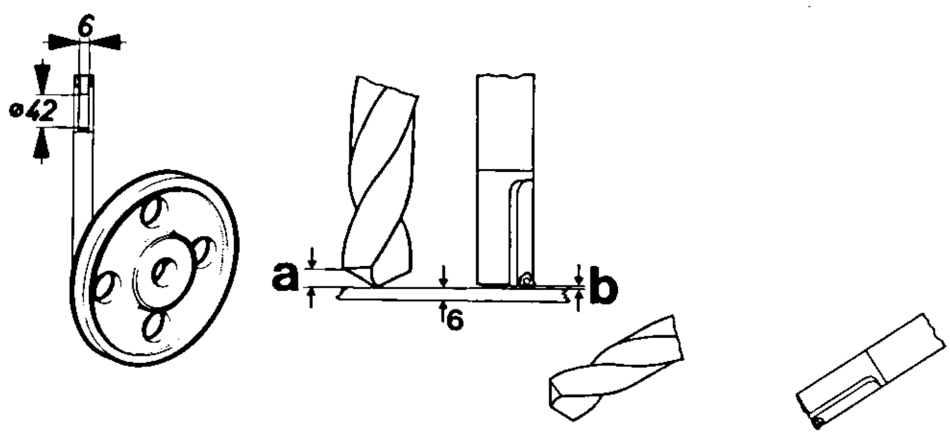
This is the machining of a gear blank. A great advantage of the short drill is that the tool also can be used as a boring bar for immediate machining of the drilled hole in order to obtain a closer tolerance and a better surface finish. This operation can very often be made when the tool is on return stroke.

The gear blank was previously drilled by a conventional twist drill and thereafter machined by internal turning in a separate operation. The machining cost was then 3.33 Sw.Cr. By applying the T–MAX Universal we have an improvement of 82%.

Hole: 31.2 h8
Drilling: 30.8 mm
Boring: Cutting dept 0.2 mm

	1	2			1
N	300 rpm	3000rpm	Cutting time	4 secs	3.3 secs
v	295 m/min	295 m/min	Machine cost	0.39 Sw.Cr.	0.22 Sw.Cr.
s	0.25 nn/rev	0.32 mm/rev	Tool change time cost	–	–
s'	750 mm/min	970 mm/min			

Machining cost/comp. 0.61 Sw.Cr.

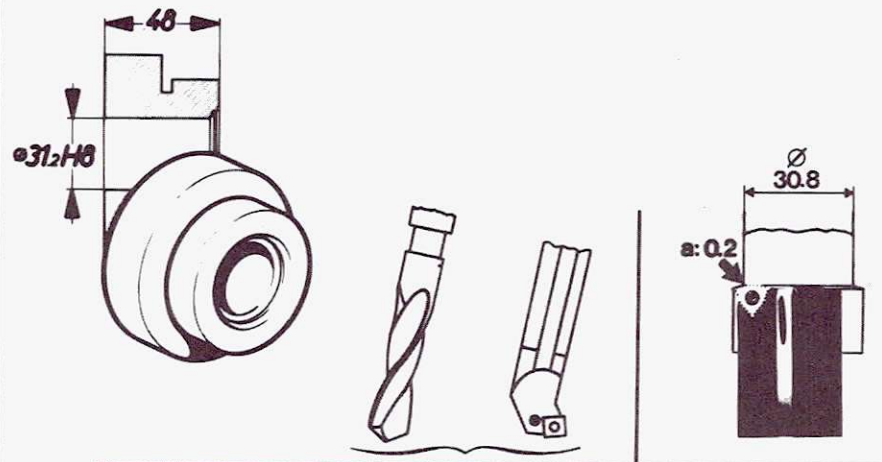


Feed Distance a	12	-
Feed Distance b	-	2
T sec	96	4
Tool Cost/Comp.	0.18	0.08
Machine Cost/Comp.	6.99	1.88
Machining Cost/Comp.	7.17	1.96

73%

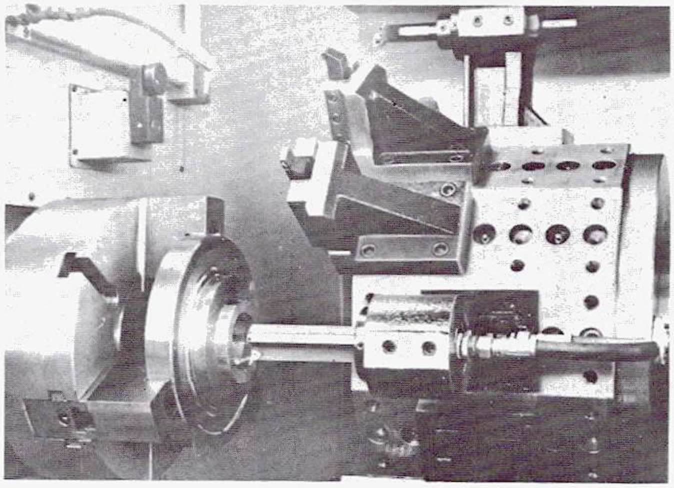
For many holes where twist drills in high speed steel today are used, we have now a modern tooling alternative with ten-fold better productivity with tool cost about the same as for twist drills.

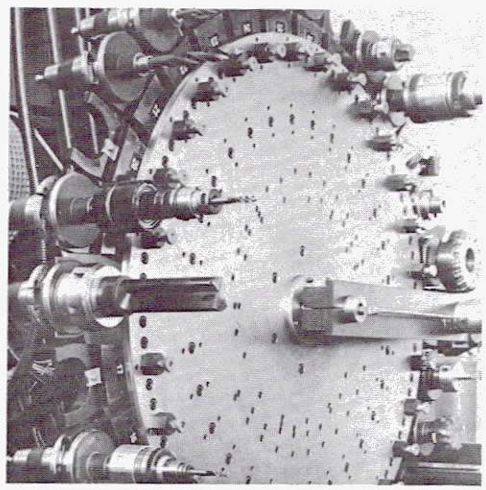
The T–MAX U drill can, without special precaution, be used in many existing machine tools, such as lathes, milling machines and rigid drilling machines. Cost reductions are especially attractive when using modern NC–lathes because of the high productivity of the new drill now making it possible to finish many workpieces in one chucking operation. **PM**

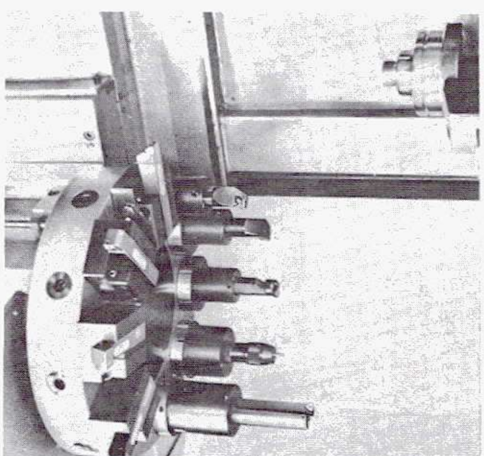


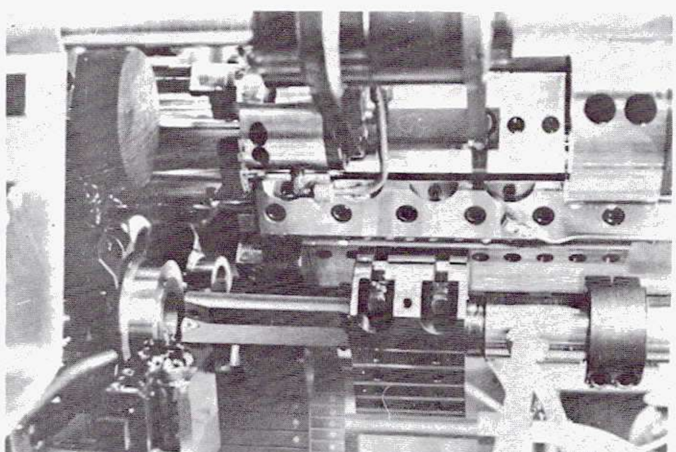
Cutting time sec	**39**	**7.2**
Machining Cost	**3.33**	**0.61**

82%









THE FMC COKE PROCESS & ITS IMPACT ON THE WORLD STEEL INDUSTRY

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SYNOPSIS

Due to the project decline of reserves of suitable coals for coking to metallurgical grades of coke, the concept of producing metallurgical coke from non-coking coals is receiving increasing interest throughout the world.

The FMC coke process is a proven process that can convert non-coking coals to metallurgical coke. An 80,000 ton per year FMC coke process plant has been in operation for over 16 years and the product has been successfully tested in ironmaking blast furnaces. This paper will present the history of the process development, discussion of the process, and the future of the process as related to steelmaking.

Several examples will explore the economic advantages of formcoking over conventional coking for selected geographical areas of the world.

Forecasting the growth and technological paths the world's steel industry will take during the remainder of this century is indeed a difficult task. There are many significant factors that will influence the direction the steel industry will take, including both the political and economic aspects. The purpose of this paper is to present several ideas and concepts that relate to the theme that the form coke process will emerge as a desirable alternate to the conventional coke battery for the manufacture of metallurgical grade coke.

Ignoring the political aspects affecting the world's steel industries, it is proposed that the major driving force behind the steel industry's dynamics to the year 2,000 will be the developing nations' goal to reach 30% of the world's steel production by the year 2,000. This goal was established in the United Nations Organization for Industrial Development (UNIDO) in the "Lima Declaration" of 1975.

Therefore, unlike many of the developed nations, the iron and steel industries of the developing countries have specific objectives that they consider necessary to contribute to the healthy economic growth of their individual nations. There are those who consider the goals established in the Lima Declaration as unrealistic and perhaps even damaging to the welfare of the developing nations. This is a debatable issue; however, the purpose of introducing the Lima Declaration goal is to indicate that the steel industries in the developing nations will be actively striving to meet this goal and, as such, will be the initiators of new plants and users of new technology.

Certainly, major producers of steel in the world have objectives for production; however, the urgency of these objectives are not necessarily viewed in the same manner by the governments of the industrialized nations. As an example, in the United States it would appear that a significant amount of capital available for investment in new steel making facilities is being directed toward pollution control facilities to meet government regulations. Having clean

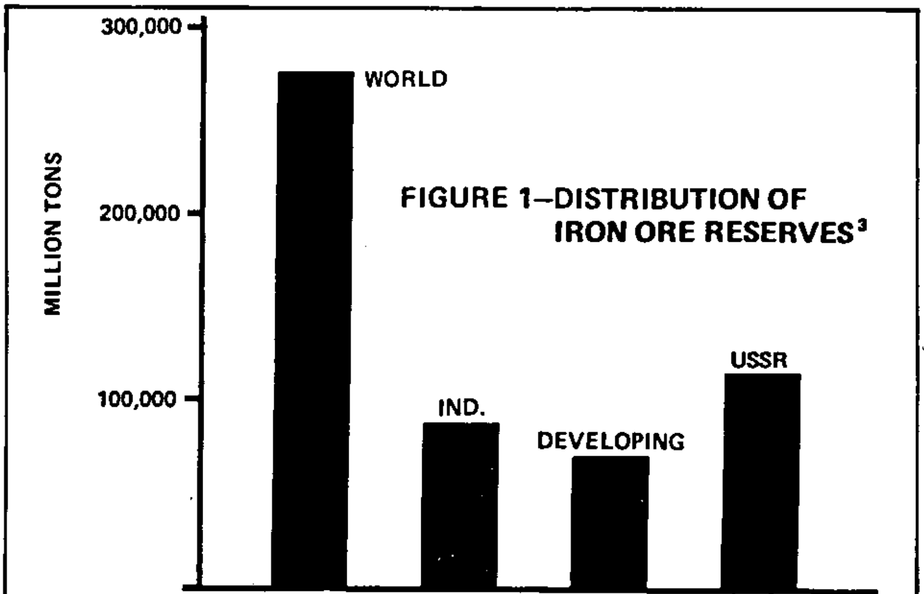


FIGURE 1–DISTRIBUTION OF IRON ORE RESERVES[3]

FIGURE 2—MAJOR IRON ORE IMPORTERS[4]

TO	FROM
JAPAN 128 MM TONS	AUSTRALIA, LATIN AMERICA, INDIA, AFRICA
W. EUROPE 130 MM TONS	AFRICA, LATIN AMERICA, SWEDEN, AUSTRALIA
USA 45 MM TONS	CANADA, LATIN AMERICA, AFRICA

air and water is certainly a worthwhile objective; however, it should be recognized that this course of action can be expected to place the U.S. steel industry at a competitive disadvantage as it is spending much of its available capital for pollution control equipment, while other nations install new and more efficient steel making facilities. The point here is that the developed nations will not have the driving force to install and operate new capacities as well as will developing nations. Whenever steel production goals are established the means to achieve those goals must be reviewed carefully. Before a steel plant can be built, a source of the raw materials must be established and the entire project financed. To finance a project, favorable cash flows are essential which, in turn, reflect the cost of producing the steel and its selling price.

Two major raw materials involved in producing steel in the conventional plant are iron ore and coking coal; and the dynamics of the world's steel industry are very much influenced by the location of these resources.

Figure 1 shows the distribution of the world's iron ore reserves. As can be seen, 28% is contained in the developing nations, whereas 32% is contained in the developed nations, exclusive of the USSR.

Figure 2 indicates the current trading patterns of this ore. It is not surprising to see that in 1975 Japan was the largest importer of iron ore, as Japan has no iron ore reserves and is a major steel producing nation. It should be noted that the development of the Japanese steel industry proceeded very rapidly following the conclusion of World War II, as building the steel industry of the country was a prime objective of the post-war period. Today Japan possesses a modern, highly efficient industry, even though it imports the majority of its raw materials.

This same type of determination is projected to exist in the developing nations for the remainder of this century. However, unlike Japan, many of the developing countries will be rich in the iron required to make steel. Domestic coking coals, on the other hand, will be scarce to non-existent in many of the developing nations.

Figure 3 indicates that some 49% of the coking coal reserves in the world are located in the industrialized nations: 31% in the USSR and Poland, 15% in the PRC and only 5% in the developing nations of Africa, Asia, the Near East and Latin America. Japan, with a favorable cash flow position due to its active efforts in the past several years to export finished products such as autos, electronics, cameras, etc., has been able to make substantial investments in coking coal reserves in areas off its shores. The developing nations do not enjoy this position and, therefore, are required to import a substantial part of their coking coal or finished coke requirements at market prices. Several developed nations are also in this unfavorable position of having to import their coking coal/coke requirements. As an example, due to its geographical orientation, Canada is exporting coking coal from its Western boundary and importing coking coal in the East. Further, all of its foundry coke requirements are imported as coke.

It is projected that the price of coking coals will increase at a greater rate than previously experienced due to the increasing utilization of coal as a source of energy for the generation of electricity and conversion to liquids and gases. Those nations without an abundant supply of coking coals are, therefore, facing a situation which requires suitable alternatives. Two alternatives available to developing nations, if fortunate enough to have adequate reserves of petroleum, natural gas or low rank coal, are direct reduction of iron ore or the production of a metallurgical grade formcoke using noncoking coals. Of these two alternatives, it is projected that the production of formcoke will be the dominant route, due to cost consideration and the existence of conventional iron and steel making facilities in many of the developing countries.

Direct reduction of iron ore relates to the production of iron from ore without melting. Several processes are available to accomplish this conversion including shaft furnaces, static beds and fluid beds. Natural gas is a preferred source of reductant for these processes; and in countries such as Venezuela that have large reserves of natural gas and iron ore, this is a viable alternative to conventional blast furnace iron making. Other sources of reductant are hydrocarbon liquids and gas produced from coal. The capital investment, however, increases exponentially when considering the use of a reductant source other than natural gas or naphta. A developing nation, therefore, with conventional steel making facilities in place and suitable reserves of noncoking coal might choose the manufacture of formcoke from its noncoking reserves as the preferred course of action over the direct reduction route based solely on economic criteria.

Formcoke is the generic name given to a product that is manufactured by combining coal and/or coal chars with binders and forming a product to a certain shape. A prime advantage of a formcoke product is to utilize noncoking coal for all or part of the raw material feed. To my knowledge, the only form coke process that can utilize a 100% noncoking coal feed material is the FMC Coke Process. A. G. Mckee, as of the fourth quarter of 1977, was awarded the role of the worldwide exclusive licensor of this process

FIGURE 3–RECOVERABLE COKING COAL RESERVES[5]

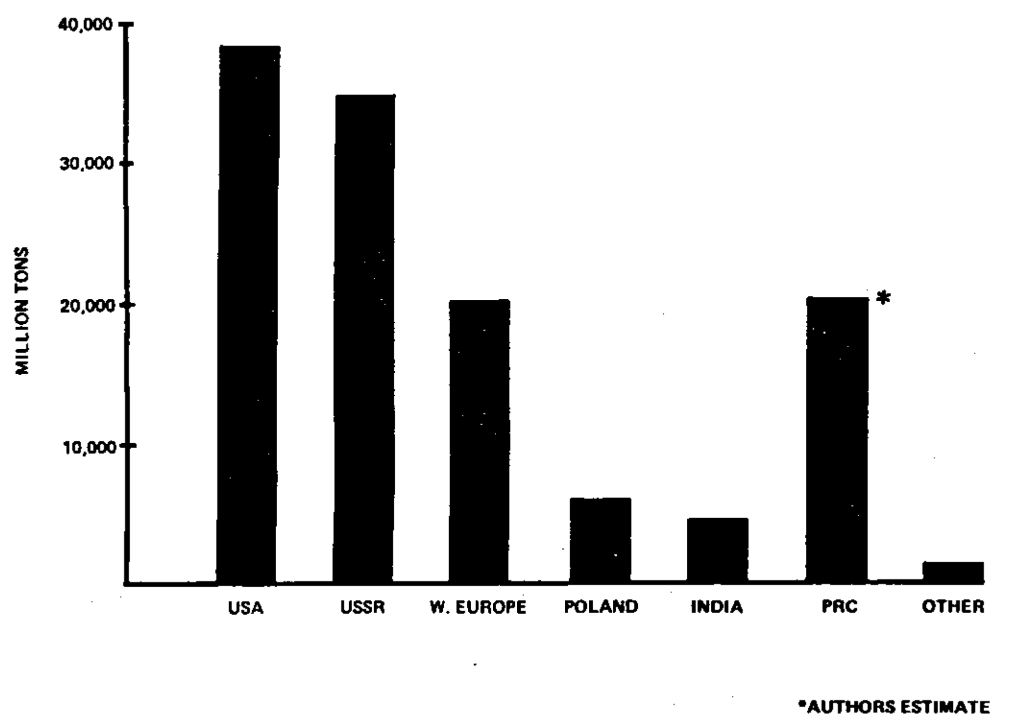
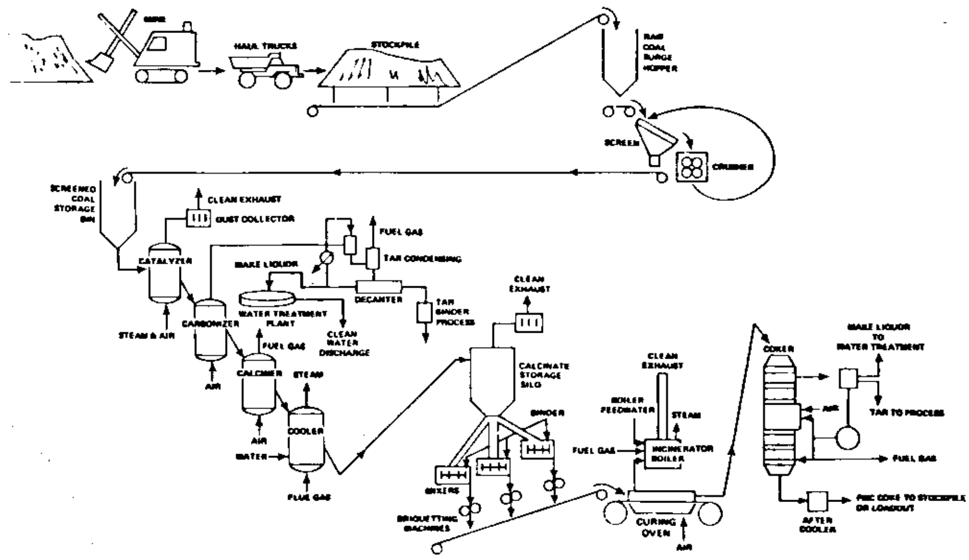


FIGURE 4 – TYPICAL FMC COKE PROCESS PLANT
500,000 METRIC TONS FORMCOKE PER YEAR CAPACITY



for the FMC Corporation. FMC has been operating a commercial FMC Coke Process plant for several years at Kemmerer, Wyoming, to produce formcoke briquettes for feed to a phosphorus furnace operation in Pocatello, Idaho. The Kemmerer, Wyoming plant uses a sub-bituminous noncoking coal which is strip mined. The economic advantages of this operation can quickly be appreciated when it is recognized that a Western sub-bituminous coal has a value of approximately $15 per net ton loaded aboard rail cars, as compared to $60 to $70 per net ton for a typical coking coal.

It is estimated that an FMC Coke plant of 500 000 metric tons per year of capacity, erected in the United States would cost approximately US $100 000 000. Operating costs, exclusive of depreciation, debt service, taxes, etc. are estimated to be about US $10 per metric ton.

The FMC Coke Process, as shown in Figure 4, consists of two primary sections. The first part of the plant is the Pyrolysis section where, through a series of fluidized reactors, a low volatile char and tar-based binder are produced. The remaining section of the plant is the Forming Section where the calcinate and binder are briquetted and the resulting green briquettes are cured, coked and cooled.

In the Pyrolysis Section, crushed coal is dried and catalyzed, carbonized and calcined at successively higher temperatures as it flows in a continuous stream through a three-bed fluidized system. Tar and gases are recovered in this section to be used for binder and appropriate energy requirements respectively.

In the Forming Section, the calcinate and binder are mixed and fed to a dual roll briquetting machine where "green" briquettes are produced. The "green" briquettes are cured on a moving grate in an oxygen containing atmosphere and are then coked in a directly fired shaft kiln to produce a metallurgical grade coke in the form of a briquette.

Successful blast furnace tests have been achieved with FMC coke briquettes at British Steel's Cardiff, Wales works in 1972[1] and Inland Steel's East Chicago Works[2] in 1973. Not only did the briquettes perform well in the blast furnace tests, but they further proved to be extremely resistant to degradation when transported.

The FMC Process is essentially an enclosed system and, as such, can meet strict environmental and safety standards.

So here we have a formcoke process that can produce a metallurgical coke from noncoking coal in a method that is environmentally acceptable and meets safety requirements. What impact will this process have on the world's steel making centers? My crystal ball is no clearer than anyone else's; however, I think there are several trends that will materialize during the remaining years of this century barring any major political/economic upsets.

Considering the dedication of the developing nations to advance their economies and their commitment to steel production, the existing trend to build new steel capacities will continue. Due to the need for these nations to improve their balance of payments, a great effort will be made to add as much value to natural resources as possible while at the same time eliminating imports wherever possible. Developing nations will view very carefully their need to import coking coal. If suitable, domestic sources of noncoking coal are available; formcoke will be substituted for conventional coke.

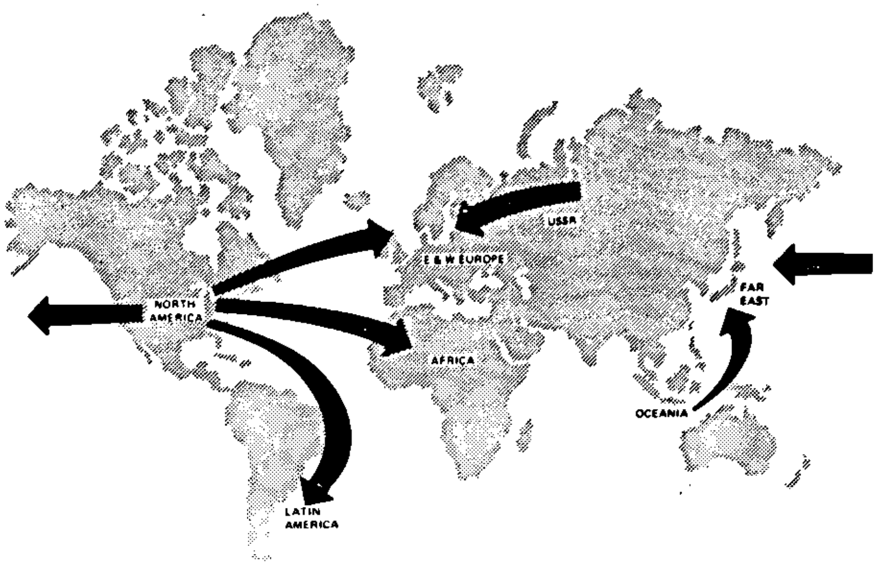


FIGURE 5
POSSIBLE MAJOR COKING COAL TRADE PATTERNS BY THE YEAR 2000

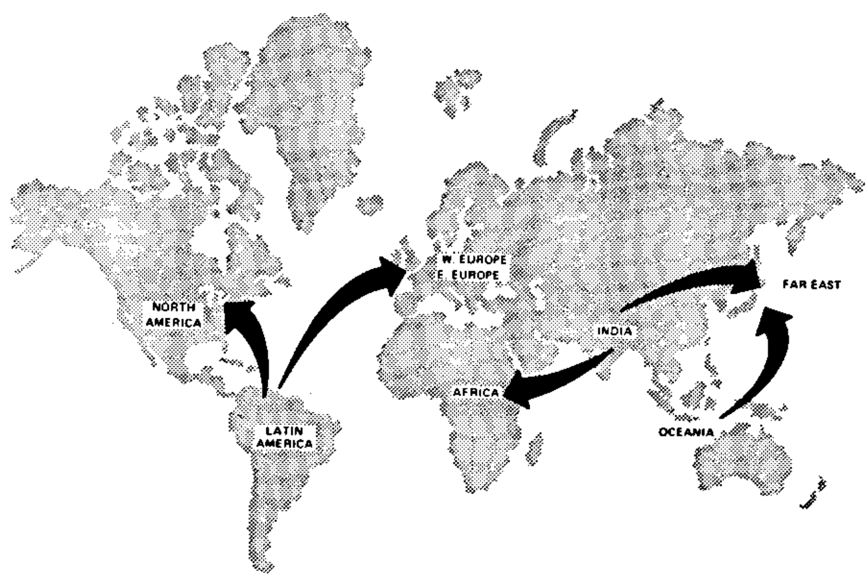


FIGURE 6
POSSIBLE TRADE PATTERNS OF PIG IRON & SPONGE IRON IN PLACE OF IRON-ORE.

As a result, by the year 2,000 the trade pattern for coking coals may resemble the distribution shown in Figure 5. At the same time, substitution of pig iron and direct reduced iron for iron ore may resemble the trade pattern shown in Figure 6.

Therefore, those developing nations blessed with suitable reserves of noncoking coal, iron ore and an orientation to conventional steel making (blast furnaces) could very well become worldwide centers of iron production for the developing nations. Due to the competitive nature of steel production with the industrial nations, the exportation of finished steel from developing nations to other developing nations or developed nations is expected to be small. The scenario described above may not prove entirely accurate; however, it is anticipated that the ability to produce metallurgical coke from a nonmetallurgical coal will impact the world's steel industry in a manner that will alter current raw material trade patterns and establish iron making centers with export capabilities.

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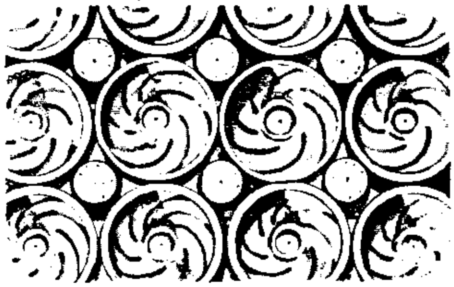
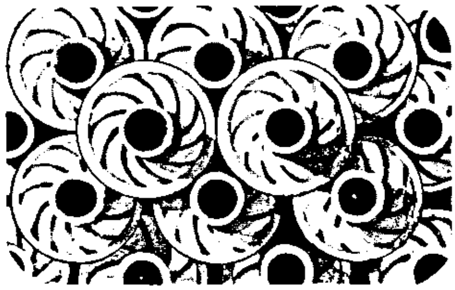
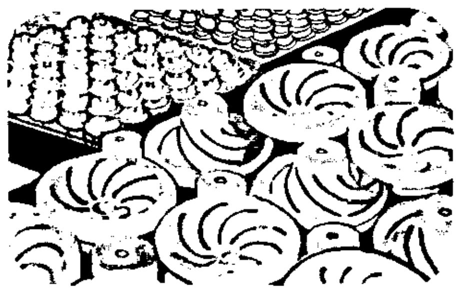
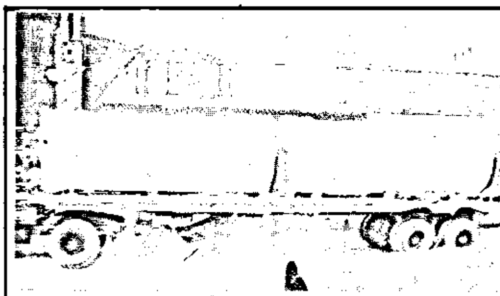
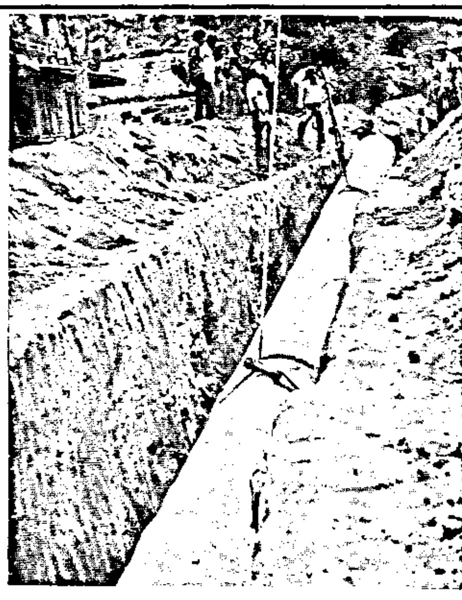
PM











RATIONALIZATION WITH PNEUMATICS (1)

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THREE OPERATIONS DURINGS ONE DOWNWARD STROKE OF A PRESS

This example is not restricted to a certain type of press. In the present case, a hydraulic press is used.

PROBLEM

Four parts, one ball, two spacer pins and one nozzle, must be pressed in three different operations into a premachined workpiece - made of a lightweight alloy.

SOLUTION

A combined tool consisting of a standard column frame was equipped with a pneumatic feed table having two work stations and one workholder as the initial station. The feed table is operated by a pneumatic cylinder. The workpieces are inserted, placed in the other stations and removed all by hand.

SEQUENCE OF OPERATIONS

The workpiece is placed in the 1st station on edge and at a certain angle determined by the workholder. The hole in the edge must point vertically upwards. A starting pulse is now given and the piston rod of the vertical pneumatic cylinder in station 1 is extended. The travel of the piston rod is used to check for the existence of this hole. If the piston rod can be extended completely, the hole is at the proper location, and the work cycle can continue. The piston rod now retracts, thus giving a signal to blow in the steel ball, which had been singled out previously in another pneumatic device. The ball rolls the hole, but since the diameter of the ball is larger than the diameter of the hole, the ball falls to just less than halfway into the hole . The ball is thus ready to be pressed in place.

In the second station the two spacer pins are placed in the workholder (directly after placing the workpiece in the first station), which is spring-mounted. If the workpiece is now placed over the workholder and pressed downwards, the pins stop moving and are pressed downwards together with the workholder; the ram is rigid.

The nozzle is placed on a pin in the third station. The workpiece must be turned from its position in the 2nd station. It is placed over the nozzle onto four locating pins which center the workpiece. The ram bears against place springs.

The workpieces pass through all three stations in succession. Thus, there are always three workpieces in the tool during each downward stroke of the press, each workpiece being one step further along in the process than the workpiece in the preceding station. Once the three workpieces have been put in position after previously having inserted the spacer pins and nozzle, blown in the ball and retracted the piston rod in station 1, the press is ready for operation.

As soon as the actual stroke of the press is initiated, the ball, spacer pins and nozzle are simultaneously pressed into place. It should be especially emphasized that the ball is pressed into place by the piston rod of the pneumatic cylinder in station 1.

This cylinder is mounted in the upper part of the tool and moves downwards with the plunger of the press. In order to withstand the high pressure used to press the ball into place, the piston rod must be in the retracted position.

In this example, the cylinder has two functions, checking for the existence of the hole and pressing the ball into place.

SAFETY MEASURES

The workholding table with stations 2 and 3 is shifted towards the operator and away from the center of the tool while the workpieces are being inserted and repositioned. The operator's hands thus do not come into the danger area of the rams.

A stroke of the press can only be initiated if the piston rod of the cylinder in station 1 and the workholding table are in the specified working positions.

LOCATING AND CLAMPING PNEUMATICALLY

Depending on the cylinder size, direct contact pressures of approx. 30,000 N can be applied with the aid of pneumatic cylinders without mechanical stepup elements. This assumes that a normal air pressure of 6 bar is available. Normally, however, pressure of up to 10 bar can be employed, so that the direct contact pressure may be even higher. Depending on the application, a combination with mechanical transmission and stepup elements may be of advantage for technical reasons or because of the greater force necessary.

For clamping devices pneumatic cylinders are used for positive clamping. Figure 2 shows a few general examples of direct and indirect clamping. The air pressure and piston diameter yield the value of the clamping force, which does not always have to be large.

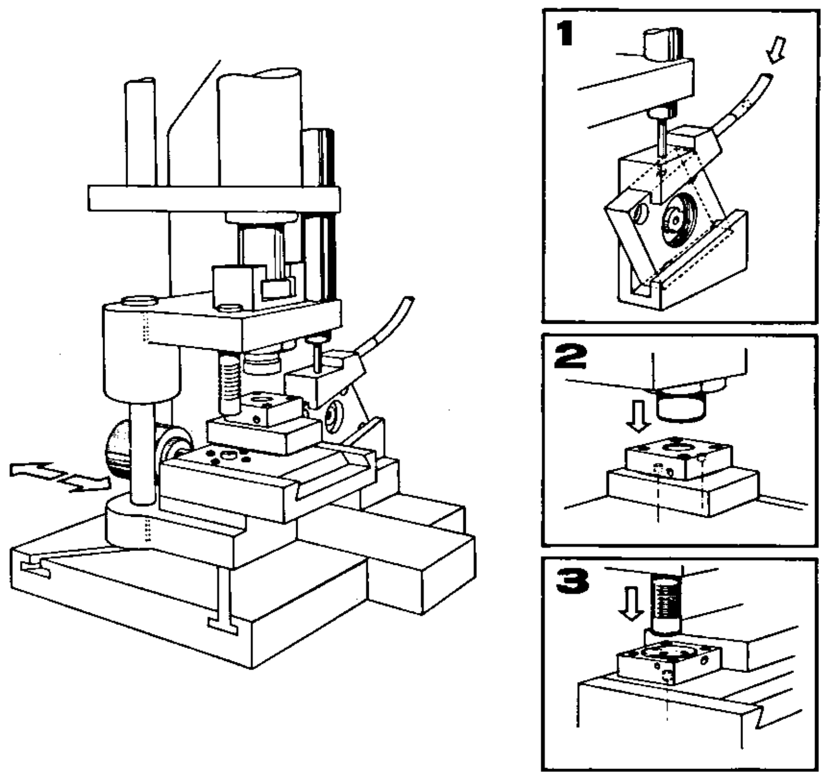


Fig. 1. Three-station tool for a hydraulic press is used to press a ball, two spacer pins and one nozzle into place. With the aid of two pneumatic cylinders, auxillary functions for an efficient work cycle are performed. (Company photo: Dunkers/FESTO)

Efficient clamping equipment that can be used to clamp fragile materials, for example, can be constructed even with pressures of about 1 bar and piston diameters of 6 mm. The average value of the clamping force is specified by the piston diameter; the exact contact pressure can then be infinitely varied by means of the adjustable air pressure. Using cylinders, the clamping force can usually be generated exactly where it is needed.

By incorporating a time delay in the forward strokes of various cylinders the inserted workpiece can be located before clamping takes place.

This is done in the example shown in Fig. 3. Here, the cylinders (1) locate the workpiece, which is pushed into the work-holding fixture and against the locating pins by the forward stroke of the piston rods. The three clamping cylinders which clamp the workpiece in this location by means of wedge and tumbler lever mechanism, are now actuated. **PM**

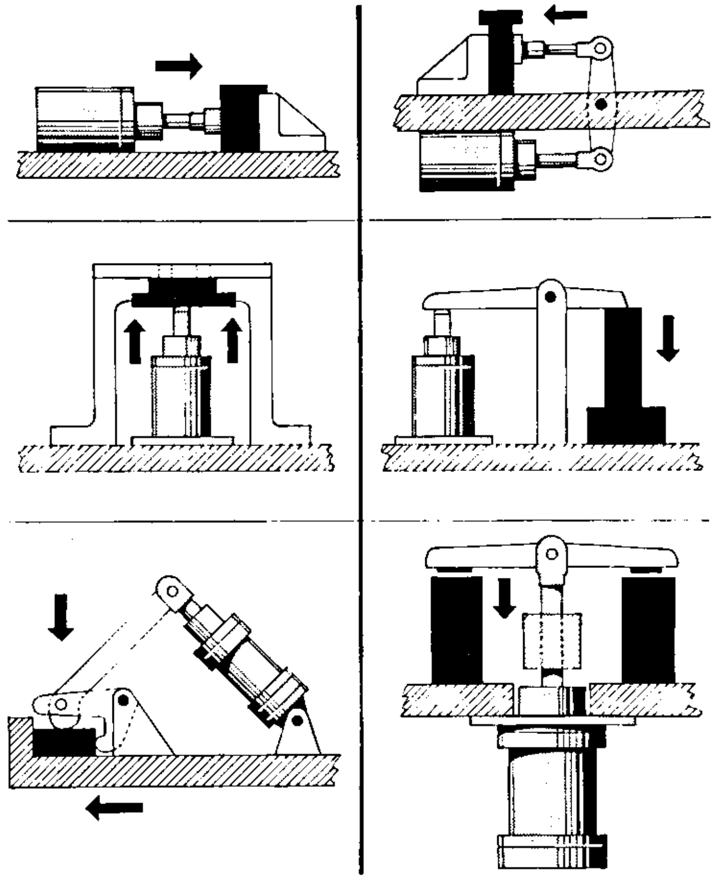


Fig. 2. Clamping by means of pneumatic cylinders. With the aid of mechanical stepup or stepdown elements, the clamping force can be increased or reduced.

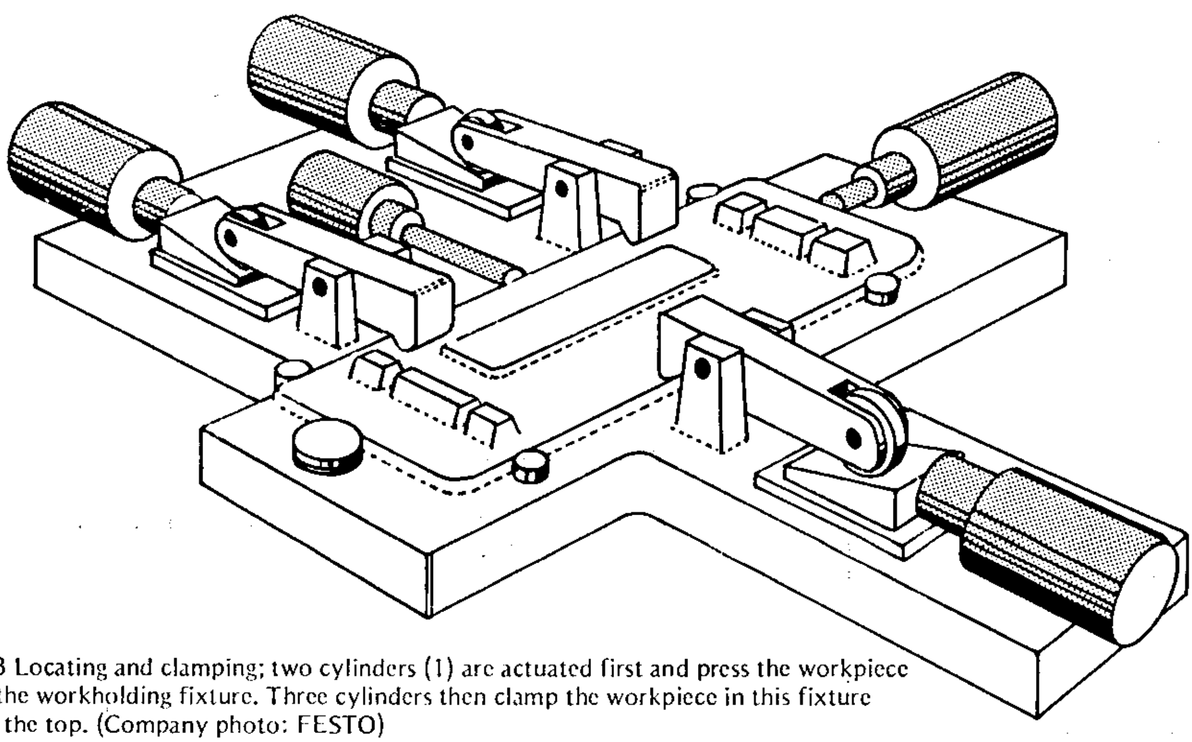
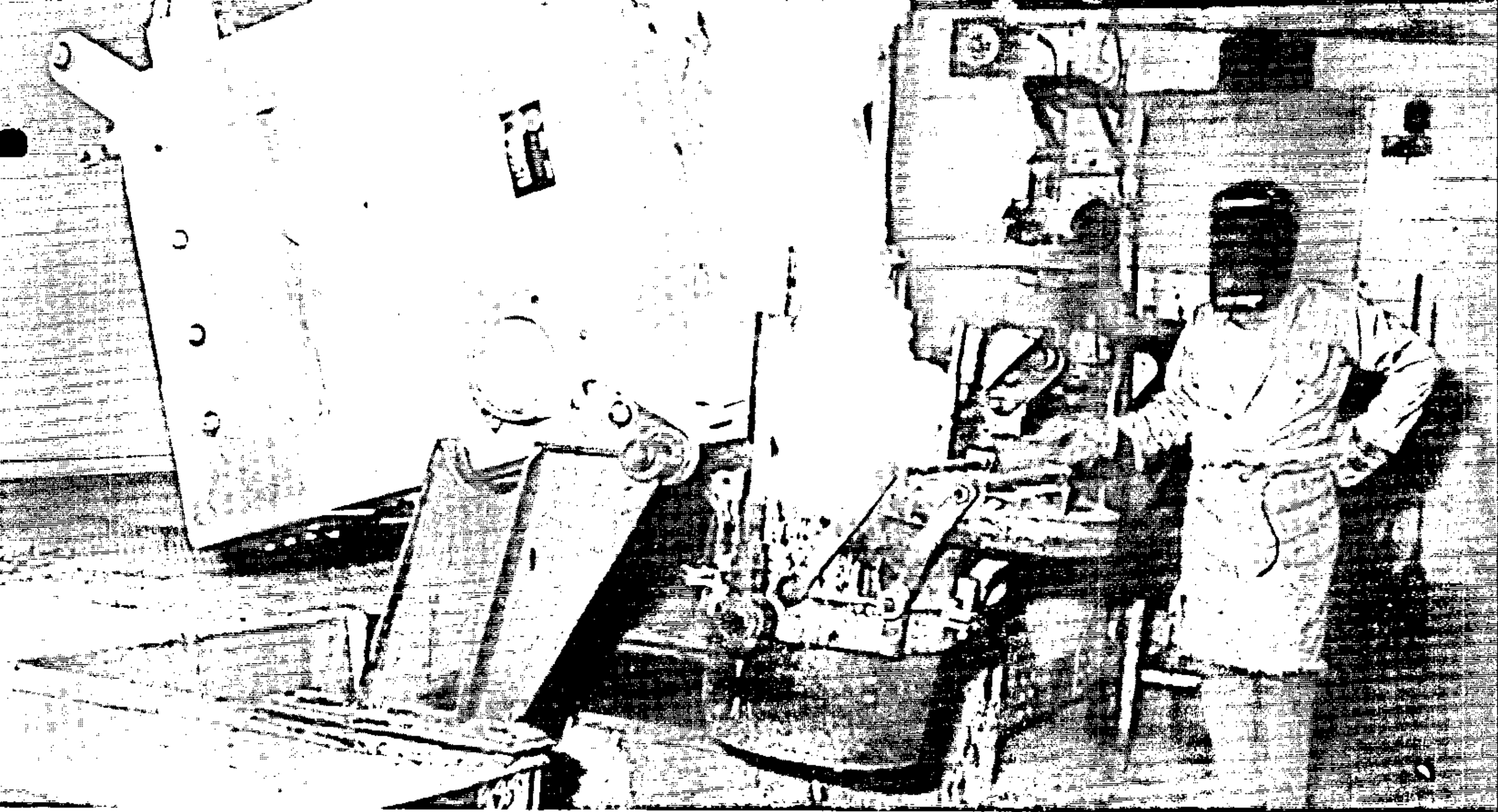


Fig. 3 Locating and clamping; two cylinders (1) are actuated first and press the workpiece into the workholding fixture. Three cylinders then clamp the workpiece in this fixture from the top. (Company photo: FESTO)



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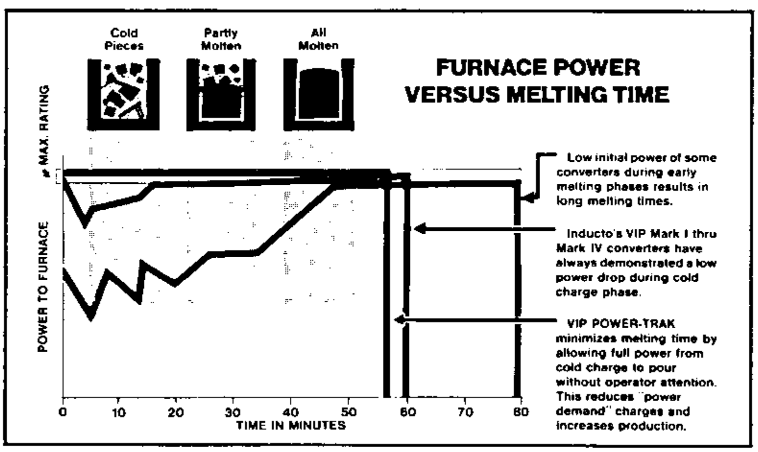

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253 MA – A SPECIAL STAINLESS STEEL

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SUMMARY

The 253 MA is an austenitic 21 Cr:11 Ni high-temperature steel alloyed with silicon, nitrogen and rare earth metals. The rare earth metals combined with silicon give this steel excellent resistance to oxidation and carburisation at temperatures of up to about 1150°C, and nitrogen together with carbon contribute towards a high creep-rupture strength. The steel displays a high degree of structural stability and therefore has little tendency to precipitate embrittling phases during service at elevated temperatures.

Its combination of good corrosion resistance and high creep strength makes 253 MA a very suitable material for purposes where 18Cr/8Ni steels are insufficiently resistant to oxidation and carburisation and where stainless chromium steels lack the necessary creep strength. Because of its good structural stability, 253 MA has successfully replaced steels of the 25Cr/20Ni type. Moreover, in certain applications, 253 MA is a better alternative to the more highly alloyed materials such as Alloys 800H, 600 and 601.

253 MA is now extensively used in the metallurgical, petro-chemical and the power industry. Applications include tubes for waste heat recovery systems in metallurgical industry, tubes and rollers for heat treatment furnaces and radiant tubes for furnaces in petrochemical industry, expansion bellows and recuperators in the metallurgical industry.

INTRODUCTION

Metallurgical and petrochemical industries involve a number of high temperature applications where conventional austenitic 18Cr/8Ni steels lack sufficient oxidation resistance. Oxidation resistance can be improved by alloying an austenitic steel with additional chromium. Silicon is the other alloying element mainly used for raising oxidation resistance, and aluminum is also used for this purpose, though to a lesser extent. Nickel also has a beneficial effect in this respect.

There are on the market a large number of high - temperature steels in which Cr, Si and Ni have been used as alloying elements to give good oxidation properties. High-temperature steels of this kind, listed in order of oxidation resistance include the following: AISI 309 (23Cr/13Ni), 310 (25Cr/20Ni), 310S (25Cr20Ni/Si) and 330 (19Cr/35Ni). These steels are also superior to 18Cr/8Ni steels in terms of carburisation resistance but they are often found wanting in particularly adverse carburisation conditions. Increased nickel increases the resistance to carburisation, and nickel base alloys with nickel contents exceeding about 50 per cent offer superior properties in cases where extremely high carburisation resistance is called for. One of the commonest nickel base alloys used for carburisation furnaces and suchlike is Alloy 601, which has about 60 per cent Ni.

The abovementioned high-temperature steels and nickel base alloys suffer from one disadvantage compared with 18Cr/8Ni steels, namely their appreciably higher cost, which is due to their extra contents of chromium and nickel. In terms of mechanical properties too, they suffer from a number of disadvantages which limit the range of service temperatures and environments in which they can be used.

In AISI 309, 310 and 310S type steels, relatively short service times in the 650-950°C temperature range are sufficient to cause precipitation of embrittling phases, such as sigma, which drastically impair the ductility and toughness of the steel. The alloying elements chromium and silicon are particularly active in accelerating embrittlement, while nickel on the other hand counteracts this tendency. AISI 330 and Alloy 601 have a high enough nickel content to avert sigma phase embrittlement. On the other hand alloys with high nickel content have their limitations in certain surroundings. More specifically, they are unsuitable for use in sulphurous surroundings, in atmospheres where carburisation and oxidation occur simultaneously, and in atmospheres which are alternately reducing and oxidising.

Closely controlled additions of rare earth metals (REM) have been found to enhance the resistance of austenitic steels to high temperature oxidation. Even the addition of a few hundredths of a per cent brings a radical improvement in this respect. A number of advantages, both economically speaking and property-wise, are to be derived from using REM together with the conventional alloying elements chromium, silicon and nickel in the development of steels with high oxidation resistance. For one thing, a smaller proportion of alloying elements helps to cheapen the material, and at the same time it means less danger of embrittlement when the metal is in service. The high-temperature steel 253 MA is an austenitic 21Cr /11Ni steel in which rare earth metals are used to give resistance, primarily, to oxidation. The present report describes the manufacture of this steel, its microstructure, mechanical properties and corrosion resistance, and presents various examples of its applications.

ALLOY DESIGN

The principal aim in developing 253 MA was to evolve an austenitic silicon-alloy high temperature steel with rare earth metals added in closely controlled quantities to secure resistance to oxidation in the 600-1150°C temperature range. Another aim was to make the steel highly resistant to carburisation and to give it a high level of creep strength within the same temperature range, together with less proneness to sigma phase embrittlement compared with steels of the 25Cr/20Ni type. A judiciously balanced combination of oxidation resistance, carburisation resistance, creep strength and structural stability was obtained with the chemical composition shown in Table 1.

The addition of 21% Cr and 11% Ni gives 253 MA a fully austenitic structure in the solution-annealed state. As far as physical properties are concerned, this steel resembles the 18Cr/8Ni steels. The following alloying elements were added in order to obtain a stable structure and the desired properties.

Carbon reacts with chromium to form carbides of the $M_{23}C_6$ type, which serve to enhance strength. Carbon, like nickel, counteracts proneness to sigma phase embrittlement and stabilises the austenitic structure.

Nitrogen combines with chromium to form a nitride, Cr_2N which-like $M_{23}C_6$- contributes towards creep strength by means of precipitation hardening. Nitrogen stabilises the austenitic structure and reduces the tendency to sigma phase formation.

Silicon reacts with oxygen to form SiO_2, which is included together with other oxides in the oxide layer. SiO_2 gives good oxidation resistance because of its low permeability to metallic ions and its good adhesion to the metal. In conventional austenitic steels, however, SiO_2 forms very slowly and thus its growth can be inhibited by other rapid-growing oxides with inferior properties.

Rare earth metals promote the growth of SiO_2, thereby improving oxidation resistance. The superior oxidation resistance resulting from the addition of REM also helps to improve carburisation resistance and high temperature sulphidation.

STEEL MAKING

253 Ma is normally manufactured in arc and A.O.D. furnaces. It is converted by conventional methods into tube, bar, strip, sheet and plate. Its workability is very much the same as that of the 18Cr/8Ni steels, except for its slightly higher deformation resistance during both hot and cold working, which is due to the addition of nitrogen.

Solution annealing at 1050-1150°C is usually the final operation in the manufacture of the above-mentioned products. Components of which high creep strength is required should be solution annealed at 1080-1150°C. Strip can also be supplied cold rolled to the required mechanical properties. Most of the following data concerning properties refer to material solution annealed at 1080-1100°C.

FABRICATION

The material can be bent both in the hot and cold state. The temperature range recommended for hot bending is 850-1100°C. If the operation is performed at about 1100°C and the material is then cooled rapidly, no further solution annealing is required. Otherwise the bending operation should be followed by renewed solution annealing to restore the properties.

Like other austenitic steels, 253 MA work hardens during cold bending. Moderate degrees of reduction, however, do not have any appreciable effect on its properties, and no subsequent heat treatment

Table 1. Chemical Composition (nominal) of 253 MA

C	Si	Mn	P max.	S max.	Cr	Ni	N	REM[a]
0.08	1.7	0.8	0.040	0.030	21	11	0.17	0.04

[a]REM = rare earth metals

is therefore required. On the other hand, if cold working has exceeded 10-20 per cent, renewed solution annealing is advisable if the material is to be used at temperatures exceeding 800°C and if the highest possible creep strength is desired.

WELDING

The weldability of 253 MA is comparable with that of the 18Cr/8Ni steels, and the same fusion welding methods can be practised, i. e. primarily MMA welding using matching coated electrodes or gas-shielded arc welding by the TIG and MIG methods.

Since 253 MA has a low thermal conductivity and a high thermal expansion coefficient, welding must be carried out - as in the case of conventional 18Cr/8Ni steels - with a low heat input so as to keep the weld deformation under control. If, in spite of all precautions, the residual stresses are judged liable to impair the function of the structure, stress relieving must be carried out at 850-950°C.

As filler materials for MMA welding we recommend 253 MA coated electrodes and 253 MA welding wire. TIG is preferable as a filler material for gas-shield arc welding TIG and MIG. These filler materials have the same chemical composition as the parent material, and a weld metal is thus obtained having the same creep strength and oxidation resistance as the parent metal.

MICROSTRUCTURE

Its judiciously balanced chromium and nickel additions give 253 MA fully austenitic structure after solution anealing; see Figure 1. This austenitic structure is further stabilised by the nitrogen addition.

A systematic metallographic study has been made of specimens aged at 700 to 1000°C with holding times of up 4000 h in order to ascertain what phases are precipitated in the steel during service. Grades AISI 310S were also studied for purposes of comparison.

After only brief ageing, 253 MA precipitates type $M_{23}C_6$ carbides and, to a lesser extent, type Cr_2N nitrides, both of which contribute towards the creep strength of the steel. Figure 2 shows the structural appearance of the steel after 1000 h ageing at 800°C. After longer ageing sigma phase, σ, is precipitated in the grain boundaries, together with a phase whose morphology resembles that of the sigma phase. This latter phase is made up of pi phase, , which is a nitride with the chemical formula $Cr_{12}Si_2Fe_4Ni_2N_4$. The pi phase appears to occur in nitrogen-alloyed steels only and has not been reported as occurring in 18Cr/8Ni or 25Cr/20Ni steels. A special etching technique makes it possible to distinguish pi from sigma, as is shown in Figure 3.

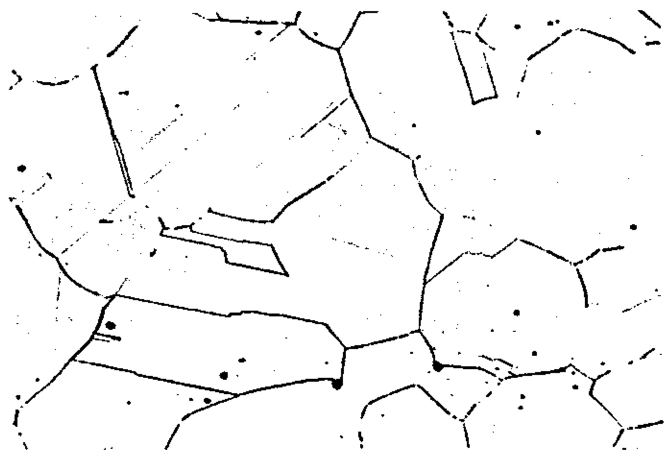


Fig. 1. Microstructure of 253 MA in the solution heat-treated condition X500

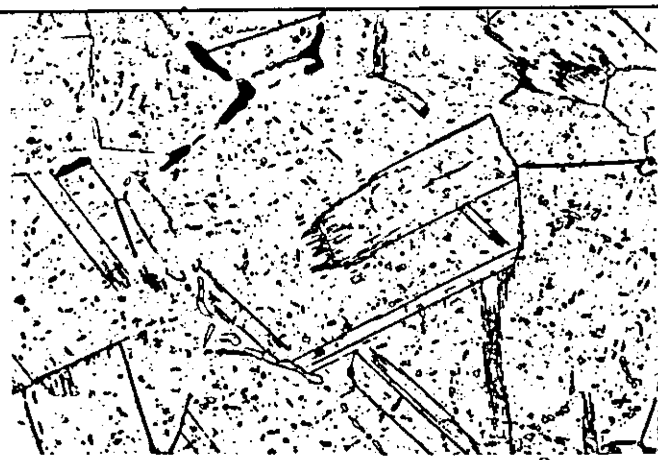


Fig. 2. Microstructure of 253MA after ageing at 800°C for 1000 h. Precipitates of $M_{23}C_6$ and, to some extent, Cr_2N. X500

Fig. 3. Microstructure of 253 MA after ageing at 800°C for 2400 h. Coarse precipitates of sigma (dark) and pi (bright). X500

The pi phase appears to be embrittling, like the sigma phase, and it reduces the toughness and ductility of the material. Compared with AISI 310 and 310S, however, 253 MA requires much longer ageing for these embrittling phases to be precipitated, as witnesses Figure 4, which gives TTT graps for the precipitation of 1 per cent by volume of sigma in 25Cr/20Ni steels and 1 per cent by volume of sigma + pi in 253 MA. The slighter tendency of 253MA to form embrittling phases is due to its high carbon content and its nitrogen addition. These elements bind chromium in the form of carbides and nitrides, whereupon the chromium content of the matrix declines, thus delaying the formation of sigma and pi. The favourable influence of nitrogen is clearly demonstrated by Figure 5.

In addition to delaying the nucleation of sigma and pi, carbon and nitrogen also inhibit the growth of these phases. Consequently, the amounts of embrittling phases occuring in 253 MA are far less than those occuring in 25Cr/20Ni steels after long service periods. For example, after 2000 h ageing at 800°C about 1 per cent by volume of sigma + pi was measured in 253 MA as against some 15 per cent by volume of sigma in AISI 310S. Figure 6 illustrates the abundant precipitation of sigma phase in AISI 310S after 2000 h.

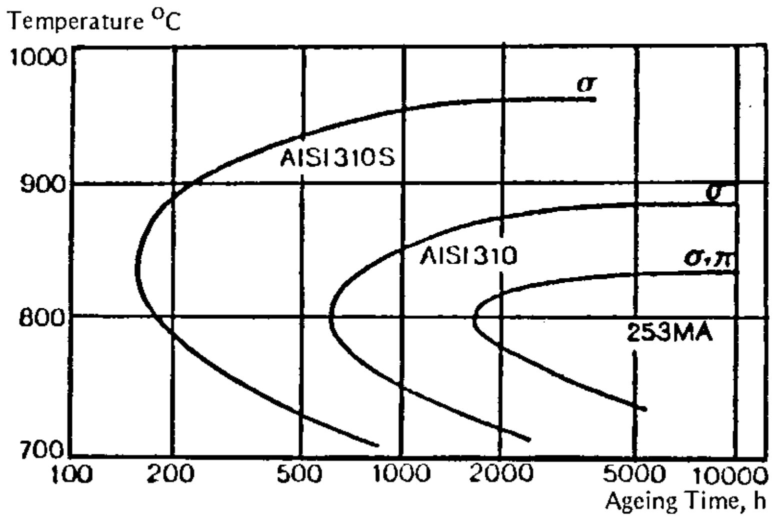


Fig. 4. TTT-diagram for precipitation of sigma +pi in 253 MA and sigma in AISI 310S and 310. The curves represent one per cent by volume.

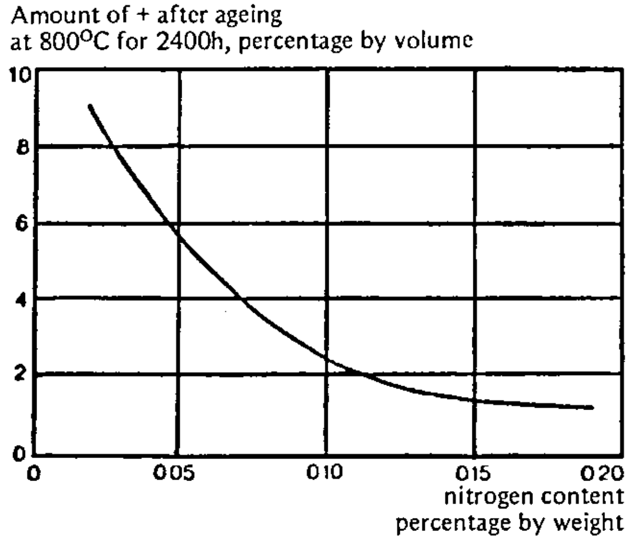


Fig. 5. Effect of nitrogen on the amount of sigma + pi in austenitic 19-21 Cr/10-13 Ni steels after ageing at 8000°C for 2400 h.

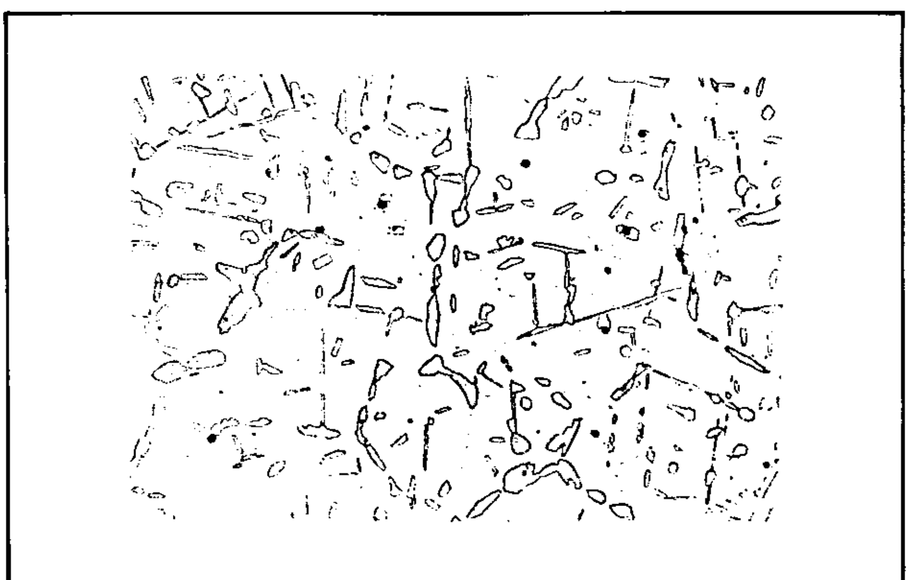


Fig. 6. Microstructure of AISI 310S after ageing at 800°C for 2000 h. Coarse precipitates of sigma.

MECHANICAL PROPERTIES

Table 2 shows the tensile properties of 253 MA in its solution-annealed state at room temperature. Owing to the nitrogen addition, this grade has higher yield strength and tensile strength than the conventional 18Cr/8Ni steels, while its elongation is on the same level. Thus 253 MA combines high strength with good ductility. Expressed in terms of the product of yield strength and elongation, the tensile properties of 253 MA are superior to those of all the high-temperature alloys listed in Table 3.

Table 2. Tensile properties of 253 MA at room temperature

Yield strength 0.2% offset N/mm^2 min.	Yield strength 1.0% offset N/mm^2 min.	Tensile strength N/mm^2	Elongation A5[a] % min.	Hardness Vickers about
310	340	600-800	40	190

[a]A5 corresponds to $5.65\sqrt{S_O}$

Table 3. Tensile properties at room temperature of some high-temperature materials

Grade	Yield strength 0.2% offset N/mm^2 min	Elongation A5 % min.	Product of yield strength and elong. N/mm^2 % x 10^{-3}
253 MA	310	40	12.4
AISI 304	210	45	9.5
W – Nr 1.4828	230	30	6.9
AISI 310	240	25	6.0
Alloy 800h	170	30	5.1
Alloy 800H	200	58	11.6
Alloy 601[a]	295	10	3.0
AISI 446			

Nitrogen-alloyed austenitic steels are characterised by relatively low ductility and toughness after ageing at temperatures in the region of 800°C. Ageing also reduces the impact strength of 253 MA. Table 4 shows the impact strength, after 1000 h ageing at 750°C, of 253 MA and W – Nr 1.4828, which is a silicon-alloyed 20Cr/12Ni steel with no nitrogen and REM added. In spite of its nitrogen addition, 253 MA has an impact strength which is negligibly inferior to that of W – Nr 1.4828. This is explained by its lesser tendency to precipitate embrittling phases. Whereas W-Nr 1.4828 precipitates about 5 per cent by volume of sigma phase 1000 h ageing, the only precipitates in 253 MA are of the $M_{23}C_6$ and Cr_2N types. It should be pointed out in this connection that the impact strength of 25Cr/20Ni steels after similar ageing treatment is in the region of 10 J/cm^2.

Creep-rupture strength in the solution-annealed state is summarised in Table 5, where the average strength for rupture in 10,000, 50,000 and 100,000 h at 600 to 1100°C is given. The number of individual specimens tested at 600, 750 and 900°C and the rupture lives are shown in Figure 7

As has already been mentioned, precipitated particles of $M_{23}C_6$ and Cr_2N, contribute to the creep strength of 253 MA. The precipitation hardening effect of these particles gives the steel a creep-rupture strength exceeding that of both 18Cr/8Ni and 25Cr/20Ni steels, as can be seen from Figure 8.

Table 4. Impact strength at 20°C (Charpy V-notch tests) of 253 MA and W – Nr 1.4828 after ageing at 750°C for 1000 h.

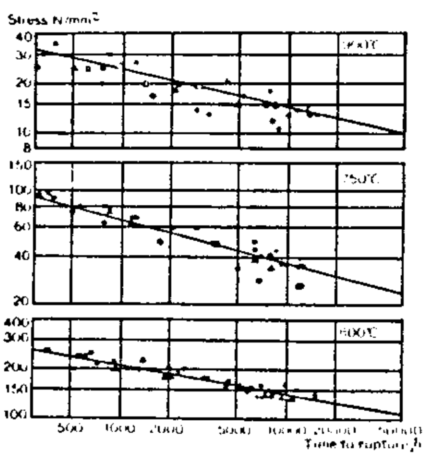
Grade	No. of tests	Impact strength, J/cm^2 min.	max.	average
253 MA	8	30	34	32
W – Nr 1.4828	8	38	41	40

Table 5. Average creep-strength in the solution heat-treated condition.

Temperature °C	Stress, N/mm^2, to cause rupture in 10,000 h	50,000 h	100,000 h
600	145	110	(98)
650	96	68	(57)
700	60	42	(35)
750	38	25	(21)
800	25	17	(14)
850	19	13	(11)
900	14	10	(8.4)
950	10.5	(7.2)	
1000	7.8	(5.6)	
1050	5.7	(4.0)	
1100	4.2	(3.1)	

The figures in brackets indicate that the extrapolation has been made to times exceeding 5 times the true testing time.

Fig. 7. Creep-rupture strength of 253 MA at 600, 750 and 900°C.



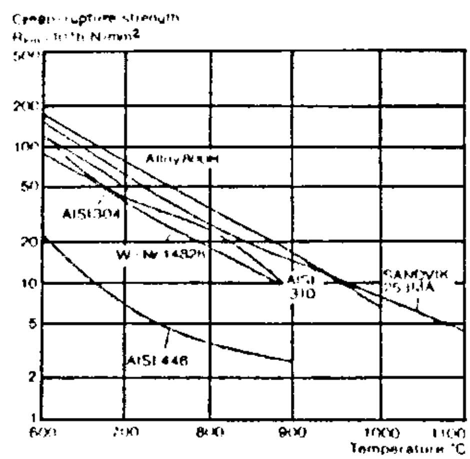


Fig. 8. Creep-rupture strength (10,000 h) as a function of temperature for some austenitic steels and the ferritic chromium steel AISI TP 446.

It is interesting to note that the creep-rupture strength of 253 MA is lower below about 950°C but higher above this temperature than the creep-rupture strength of Alloy 800H. In the case of Alloy 800H, it is the precipitated particles of $M_{23}C_6$ and carbides, that contribute towards good high-temperature strength. In both alloys, the precipitation-hardening effect declines with rising temperature, due to the growth of the particles. The strength of 253 MA declines less rapidly with rising temperature than that of Alloy 800H because nitrogen also contributes to strength through solution hardening. Unlike precipitation hardening, solution hardening greatly enhances strength at temperatures in excess of 950°C.

CORROSION PROPERTIES

Oxidation Resistance

The oxidation resistance of 253 MA in air has been determined in both isothermal and cyclical conditions. Experience from these tests has shown that the steel can be used in air up to about 1150°C. Table 6 shows the results of isothermal tests in which253 MA was compared with various other high-temperature alloys having austenitic and ferritic structure respectively. The oxide layer was removed by sand blasting.

At 1000°C the oxidation resistance of 253 MA is comparable to that of 25Cr/20Ni steels and Alloy 800H. At 1100°C 253 MA displays a weight loss which is smaller than that sustained by Alloy 601. The weight loss figures shown in Figure 9 were obtained following cyclic oxidation 5 x 24 h with cooling to room temperature every 24 hours. One characteristic feature is that weight loss is relatively constant in the 1000–1150°C temperature range.

In the cyclic tests as with isothermal oxidation, 253 MA was compared with various other high-temperature alloys. The results are summarised in Figures 10 and 11, in which graphs of the mean values obtained have been plotted as a function of the testing temperature. Up to about 1150°C the oxidation rate is the same as for AISI 310S and lower than that of other alloys.

Table 6. Descaled weight loss after isothermal oxidation in air during 1000 h.

	Weight loss, g/ (m^2 h) 800°C	900°C	1000°C	1100°C
253MA	–	0.03	0.11	0.11
AISI 304	0.03	0.19	0.41	–
W – Nr 1.4828	–	0.03	0.07	0.23
AISI 310	0.02	0.06	0.14	0.20
AISI 310S	0.02	0.04	0.08	0.13
Alloy 800H	0.02	0.05	0.10	0.18
Alloy 601	–	–	0.03	0.16
AISI 446	0.02	0.06	0.18	0.26

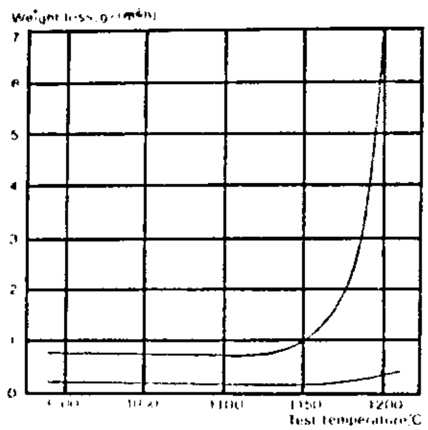


Fig. 9. Oxidation in air of 253 MA resulting from cyclic exposure for 5 x 24 h.

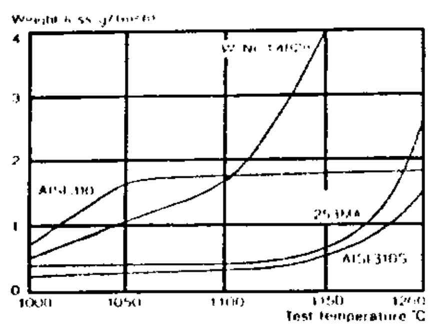


Fig. 10. Oxidation in air (average values) of 253 MA, W – Nr 1.4828, AISI 310 and 310S resulting from cyclic exposure for 5 x 24 h.

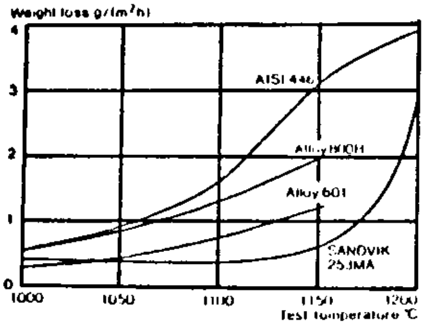


Fig. 11. Oxidation in air (average values) of 253 MA, Alloy 800H, Alloy 601 and AISI 446 resulting from cyclic exposure for 5 x 24 h.

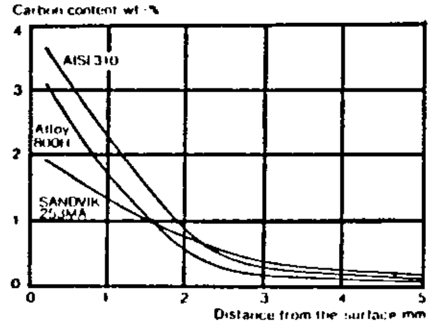


Fig. 12. Carbon profile for 253 MA after carburisation in 10% CH_4+ 90% Ar for 500 h at 1000°C.

As was mentioned in the section on alloy design, the REM and silicon additions account for the very high oxidation resistance of 253 MA. The favourable effect of REM is most clearly apparent from a comparison with the 2Si/20Cr/12Ni steel W – Nr 1.4828, which according to Figure 10 displays more than four times the weight loss at temperatures exceeding about 1100°C. This shows that silicon alone is not sufficient to achieve a drastic reduction of the oxidation rate of steels with 19-21 chromium and 10-13 per cent nickel. This is because silicon has a low diffusion rate in austenite, which means that silicon oxide is formed much more slowly than other, faster growing oxides included in the oxide layer. The oxidation rate is not substantially reduced until rare earth metals are added together with silicon. The reason is that REM atoms dissolved in the austenite enhance the diffusion rate of silicon to the metal-oxide interface, thereby promoting the formation of SiO_2. The increased proportion of SiO_2 in the oxide layer makes the latter more impervious to metallic ions of chromium and iron, and when sufficient transport-inhibiting SiO_2 has been formed, oxide growth comes almost to a standstill.

Apart from inhibiting oxide growth, rare earth metals also help to improve the adhesion of the layer and to increase its elasticity. This is evident because rare earth metals increase the number of oxide nucleation sites, thus giving a more fine-grained oxide than would be obtained without any REM additions. The good adhesion and great elasticity of the oxide of 253 MA gives high resistance to scaling even during rapid temperature fluctuations, hence the good oxidation resistance observed in cyclic tests.

Carburisation Resistance

The protecting oxide layer in 253 MA makes it highly resistant to carburisation in constantly carburising atmospheres with a greater or lesser oxygen content. Figure 12 shows carburisation in a mixture of about 10 per cent methane and about 90 per cent argon containing 1 per cent oxygen. The superior carburisation resistance of 253 MA, compared with AISI 310 and Alloy 800H, is due to the silicon and REM additions giving a more protecting oxide layer which makes it more difficult for carbon to penetrate into the metal.

Austenitic steels acquire an oxide layer in atmospheres which are alternately oxidising and carburising. At first this layer protects the steel against carburisation in the normal manner, but prolonged exposure makes it progressively thicker, and carburisation will then progress rapidly in the event of oxide breakthrough. An experiment was conducted in a production gas carburisation furnace to ascertain the proneness of 253 MA to carburisation in an alternately oxidising and carburising atmosphere as compared with the sensitivity of various other high-temperature materials. In this experiment, ground and preoxidised (1070°C, 6 h, air) specimens were tested as follows:

Furnace atmosphere: LPG + air
Temperature: 925°C
Procedure: The specimens were exposed in the furnace for 42.5 h altogether, the first 25 h (approximately) in about 0.17% CO_2 and then in about 0.20-0.25% CO_2. Forced cooling in the air was then followed by annealing at 650°C for 5 h in N_2 gas. This procedure was repeated 10 times.

The results, summarised in Table 7, show that ground specimens were moderately carburised while the pre-oxidised specimens were heavily carburised. There is little difference in proneness to carburisation where the ground specimens are concerned. Air cooling gives all alloys a thin oxide layer which prevents carbon penetration in the carburising atmosphere. The pre-oxidised specimens on the other hand, have a thick oxide layer from the very beginning, with a greater or lesser incidence of cracks in which carbon diffusion can proceed rapidly. In this state 253 MA displays lower carbon absorption than 25Cr/20Ni steels and W – Nr 1.4828. This can be mainly attributed to the improved elasticity of the oxide obtained with REM additions and to the correspondingly lesser likelihood of crack formation and penetration of the layer.

Table 7. Carburisation testing of 253 MA and some other high-temperature grades in a production furnace for 10 x 42.5 h at 925°C.

	Ground surface Carbon pick-up wt – %	Pre-oxidised surface Carbon pick-up wt – %
253 MA	0.010	0.100
AISI 310	0.010	0.840
AISI 310S	0	0.366
W – Nr 1.4828	0.008	0.258
Alloy 800H	0.065	0.085
Alloy 601	0.053	0

In addition to its good resistance to oxidation in air and to carburisation, 253 MA is also highly resistant in other atmospheres. It can be used in oxidising, sulphurous atmospheres up to about 1025°C, reducing, sulphurous atmospheres up to about 650°C, synthetic gas (ammonia synthesis) at high processing temperatures, because it is more resistant than the conventional 18Cr/8Ni steels to nitrogen absorption.

Compared with ordinary stainless steels, 253 MA is highly resistant in cyanide melts and neutral salt melts and also to metal melts, e.g. lead, at high temperatures. Its resistance to metal melts is to a great extent determined by their oxygen content. As with other alloyed steels, corrosion is greatest at the surface of the metal bath.

APPLICATIONS

Because of its very good oxidation resistance in air and other atmospheres, its good carburisation resistance and its high creep strength, 253 MA is a very suitable material for purposes where 18Cr/8Ni steels have insufficient resistance to oxidation and carburisation and where stainless chromium steels lack the required creep strength. Moreover, thanks to its high structural stability, 253 MA can be recommended as a substitute for embrittlement-prone steels such as AISI 309, 310 and 310S. AISI 330 is also surpassed by 253 MA in terms of both creep and oxidation properties. For certain purposes, 253 MA is also a suitable alternative to such materials as Alloy 800H and Alloy 601.

The following examples indicate the versatility of 253 MA in heat resisting applications. The list is not complete but serves to show that the steel can be used in many different high temperature environments.

Recuperators in Metallurgical Industry

253MA is used as recuperators for blast furnace gas by a number of steel mills. The operating temperatures vary from ambient for the inlet combustion air to about 1150°C for the inlet hot gas. The grade has replaced the commonly used grades AISI 310 and 310S. All experience gained so far shows that the service life of 253 MA exceeds that of AISI 310 and 310S. In the zinc production industry 253 MA is being used in a recuperator, where previously AISI 310S was used.

Gas Preheaters and Other Heat Exchangers in the Direct-Reduction Process

253 MA has come to be used as gas preheater tubing in the direct-reduction process. It has replaced Alloy 800H, with satisfactory result.

Heat Treatment Furnaces

253 MA is being used in numerous furnaces of various types including both bell type and muffle furnaces, as well as for furnace hardware, baskets etc.

In muffle furnaces for the annealing of drawn wire, muffle tubes of 253 MA are being used. For this application 253 MA has replaced AISI 310S and Alloy 800H.

Radiant tubes of 253 MA are being successfully used in different types of process furnaces in steel plants and in the copper and aluminum industry. In many applications tube temperatures have been up to about 1050°C. The steel has replaced such grades as AISI 309, 310 and 310S and in one case Alloy 601.

Thermocouple Protection Tubes

253 MA is widely used for high temperature thermocouple protection tubes in different types of heat treatment furnaces. For this application the steel has replaced the commonly used grades AISI 310S and Alloy 800H. Thermocouple protection tubes in 253 MA are also used in the petrochemical and fertiliser industries. At a fertiliser plant 253 MA has replaced Alloy 800H, which suffered creep and sulphur attack in the SO_2 containing atmosphere at 1050°C. The higher creep strength of 253 MA and its better resistance to sulphur attacks have solved these problems.

Burners

253 MA is used for burners and burner components in different types of furnaces in the metallurgical, cement and chemical industries. One example showing that 253 MA is superior to AISI 310S in sulphur-containing atmospheres is oil burners used to produce drying air to dry calcium phosphate at a chemical plant. With AISI 310S a service life of four weeks was obtained. 253 MA has been found to be still in perfectly good condition after more than three years in service.

Cement Industry

253 MA has replaced AISI 310 and 310S in the 800-1300°C temperature range as firing tubes and burner tubes in cement kilns. Such tubes have been in service for more than three years, with very good results.

Other Applications

furnace rollers
radiant tubes in glass and enamelling furnaces
soot-blower tubes
superheater tubes for refuse incineration plants
tubes for EDC-cracking furnaces in vinyl chloride plants
heat-exchanger tubes for ammonia and gas containing SO_2/SO_3
satellite coolers for calcination kilns in alumina production

In strip form, 253 MA can be applied to the following purposes, among others:

plate heat exchangers
catalyst carriers in exhaust purifiers for cars
conveyor belts in nickel production
belts for continuous casting of metal bars
protection tubes for electric heater coils

PM

JUVENTINO S. PERFECTO

Who says first impressions last?

My first impression of Juventino S. Perfecto, Vice President, Engineering of Benguet Consolidated, Incorporated was that he is strict and tough. But as you learn to know more about him, you will discover that he is an easy-to-deal-with person; strict, but justifiably so. And tough, but resilient. I was able to get more facts about "the man" when I got an invitation to go to the site, "in order for you to get the feel of my work," he said. And so off I went.

Aboard a twin-engine plane, I had an excellent view of a once virgin forest metamorphosing into one of the largest and most modern operating mines in the Philippines. The site is San Marcelino, Zambales, a 30-minute flight from Manila where the man responsible for the Benguet – Dizon Copper Gold Project shuttles four times a week to personally monitor the progress of the job being undertaken.

What can you say about a deeply-tanned man who stands 6'2",weighs 204 lbs, talks with ease while looking at you straight in the eyes and seldom laughs?

An early riser, J.S. Perfecto wakes up at 5 in the morning, has a heavy breakfast with his staff of engineers, then hies off to the working site at 6:30.

In his usual boots, khaki pants, long sleeves shirt, hard hat and a very reliable watch, he drives around the mine site aboard a light blue Land Cruiser, equipped with a two-way radio, checking whether everything is being done as planned. He is purely an action man who wants things done in the shortest possible time . . .

"You cannot do the work by just sitting down, " he reasons out.

A well-built man who looks younger and more distinguished with grey hair, he does not particularly choose his company, "as long as the person does his job properly, he remarked. He also believes that one should really work while working and play only when it is called for.

While making his rounds at the site, his "good mornings or afternoons" and "how do you do's? " accompanied by a pat on the shoulder keep him in close rapport with his workers. Hectic as the mines project is, Mr. Perfecto looks at the job with a lot of satisfaction. Organizing the work in the mine is "like conducting a symphony orchestra, where you have control over the whole setup," he pointed out.

Because he manages the project systematically, problems are easily solved. With much experience, hard work and dedication, everything becomes second nature to him.

This dedication towards his chosen field greatly contributed to his steady rise from the ranks. Born in Manila on May 24, 1919, Juventino S. Perfecto, or "Big Pec" as his colleagues call him, is the tallest in the family and the recognized eldest after an older brother died. He attended Ateneo de Manila for his elementary and secondary education.

In his early years, young Juventino chose to spend his spare time camping in the forest. This consequently led him to pursue a vocation that has always been very close to his heart.

Supporting himself through an athletic scholarship, he was able to obtain a degree in Bachelor of Science in Mining Engineering at the Mapua Institute of Technology in 1940, then passed the Professional Mining Engineering Board.

The outbreak of World War II slowed down the career of the fresh graduate who was all set to face the challenge mining had in store for him.

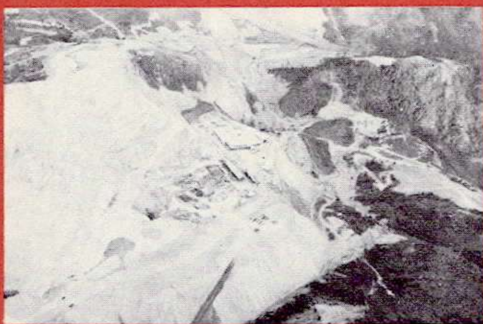
After the war till 1947, Perfecto worked as a Principal Engineer at the Philippine Consolidated Shipyards and then as Assistant Sales Manager for Philippine Consolidated Steel Corporation at the U. S. Naval Base at Manicani Island, Samar, Subic Bay, Zambales and at the Cavite Navy Yard. These years were also significant for him because it was then when he met the former Angelita Molina whom he consequently married. In their 32 years of marrage, they have been able to raise seven children.

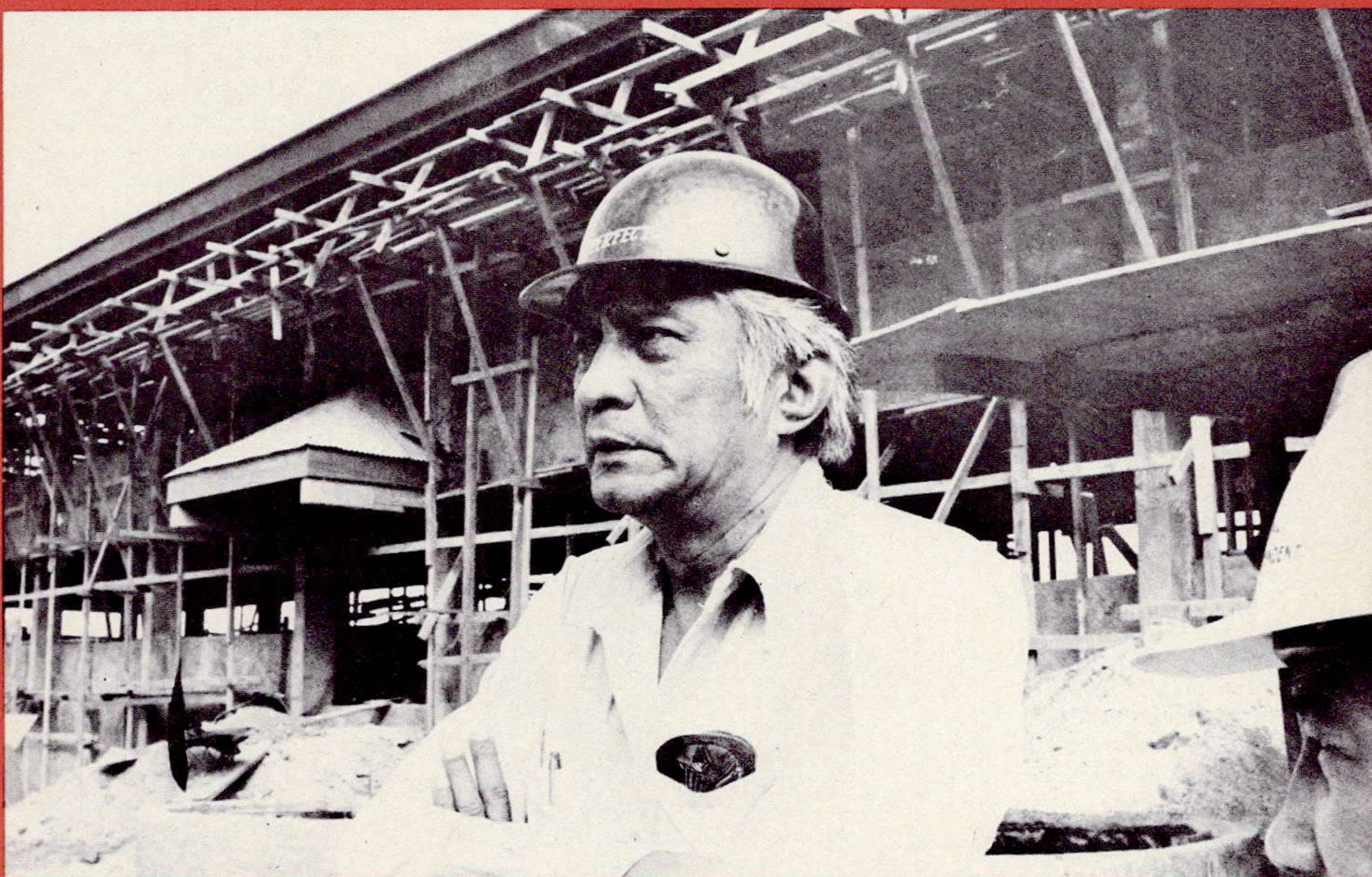
In 1947, he became the General Superintendent at Amalgamated Minerals, Incorporated for the Manganese Mine at Coron, Palawan. He transferred to Romblon Marble Corporation in 1950 and worked as General Superintendent in a marble quarry in Lio, Romblon.

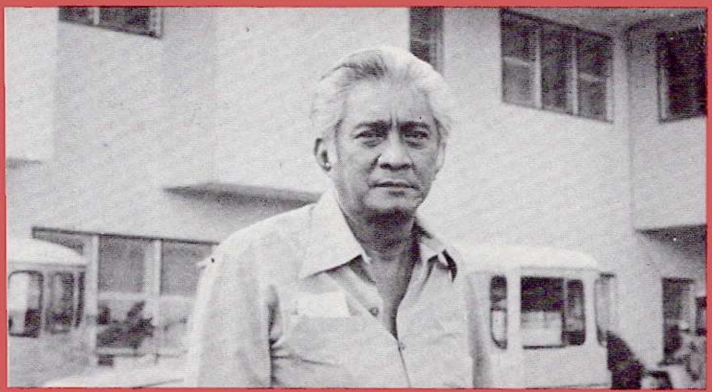
One company's loss is the other's gain. After his short stint with RMC, Perfecto went to work with Benguet Consolidated, Incorporated where he started as a Contract Engineer, rose in rank steadily, becoming Mine Engineer, Production Foreman, Chief Engineer, Project Engineer, and finally, Assistant Vice President for Engineering.

While working at Benguet, he received a scholarship from 1962 to1963 granted by the Federal Republic of Germany for Traineeship in Iron and Steel Production and Copper Smelting. As a result of his one-year stay in Germany, he can speak Deutsch quite well.

men in the metals industry







Perfecto also participates in activities outside his work. He is a member of the Philippine Society of Mining, Metallurgical and Geological Engineers. He served as an adviser of the Philippine Delegation to the 48th Session of the International Labor Organization, held at Geneva, Switzerland in 1964. He was also a member of the Philippine delegation in 1968 to the Second Session of the I.L.O. Committee on Mines Other Than Coal Mines also held in Geneva. With these accomplishments, added to the fact that he actively participates in the steady growth of the mining industry in the Philippines, he was selected one of the 15 most Oustanding Filipino Mining Engineers in 1968.

Heavy work load notwithstanding, Mr. Juventino S. Perfecto favored the PM with an interview in his apple-green wall-to-wall carpeted room filled with books and intaglio prints. Below are his candid answers to some questions.

PM : How would you describe your job as Vice President for Engineering?

JSP : Presently and for the last three years, my whole time has been dedicated to the Benguet-Dizon Project, a $95 million Copper-Gold Operation in San Marcelino, Zambales which the company has scheduled for completion late this year. We are presently constructing a 17,000 tons per day concentrator, building a 100-meter high rock and earth dam, and a 250-meter long concentrate pier.

PM : What problems do you normally encounter in this job?

JSP : There are the normal operational problems such as lack of supervisory and skilled personnel, unexpected changes in shipping schedules that delay arrival of critical machinery and supplies, the seemingly numerous construction projects going on simultaneously in the Philippines that hinder us from securing much needed heavy equipment, and of course, the weather, which we hope shall remain fair and clear at least till July of this year.

PM : What factor/s made you stay with Benguet Consolidated?

JSP : A number of reasons, but foremost was the challenge to succeed in a prestigious and internationally renowned mining company.

PM : How do you assess the country's mining industy?

JSP : Definitely, the mining industry is in its upswing, and the solid establisned mining firms cannot help but generate more income for their companies and the country. But the smaller upcoming mining companies should not be overconfident, and expect to join the giants too soon, for mining is a difficult and complex venture. Unless properly managed, financed and operated, it is very easy to lose not only one's shirts but one's reputation and standing in the community.

PM : Considering today's trend towards industrialization, how would you rate engineering as a profession?

JSP : Engineering is certainly very vital towards the successful industrialization of our country. And certainly, there is a lack of competent, honest and upright engineers. I, for one, would not want to encourage young men and women to pursue engineering as a career, unless he or she is prepared to undergo a lot of hardships, strenous exposure and a long uphill climb to success without much financial recompense. As there is not much financial reward for dedicated and idealistic engineers (unless one resorts to illegal and unethical practices), an engineer can content himself or herself with just a comfortable living minus all the extravagant luxuries so flagrantly displayed by the noveau-riche.

PM : How would you assess the average Filipino worker?

JSP : The average Filipino worker, specially of the skilled category in the mining industry, can compare, if not exceed, his counterpart in other parts of the world as far as productivity, dedication, loyalty and endurance are concerned. For example. in underground mining, our miners, muckers, timbermen, trammers, etc. can, aside from producing more tons per manshift, also withstand prolonged exposure to extremes in temperature and humidity.

Our Filipino welders are among the best in the world: our mechanics and electricians are very thorough and competent; and heavy equipment operators are definitely outstanding. I speak from actual experience, for records in the project I have worked on are exceptional.

PM : How would you describe yourself?

JSP : It would be better if you were to ask others to describe me. Physically, I am in very good shape, and intend to stay that way for the next twenty years. I shall brobably outlast a lot of younger men in all kinds of activities.

PM : What kind of people do you like to have around you?

JSP : Honest, hardworking and sensible. I cannot stand non-producers, or braggarts. I appreciate people who do their jobs well and contribute to the successful culmination of an objective. Naturally on the lighter side, one feels flattered to have beautiful people around him, catering to his whims.

PM : How do you spend your spare time, if you have any?

JSP : My definition of spare time is time away from my job, my family and friends. There is so little left of it, and I believe that if I told you what I did with my minimal spare time, you would not believe it, and this might even shock your very puritan readers.

PM : How does your family react to your tight schedule?

JSP : My family has been exposed to my tight schedule for the last 32 years, and by now has learned to accept it. I do not deny them any love or affection, concern and responsibility, and I am proud that I have a beautiful and well-balanced family. We maintain an open and meaningful relationship, so much so that my future sons-in-law and daughters-in-law share in all our family happenings.

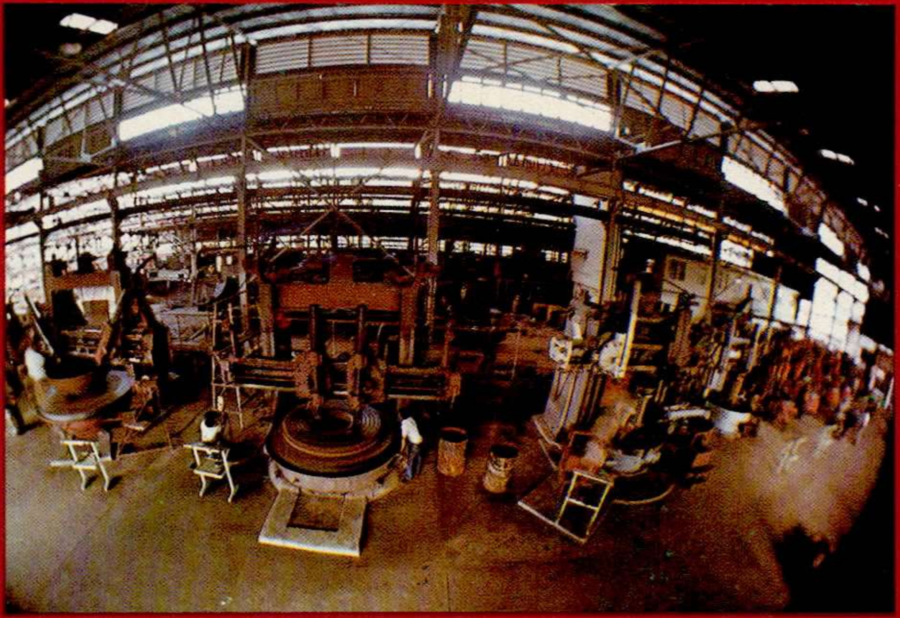
PM : Do you find your work tiring?

JSP : My work is only as tiring as I wish it to be. After work, would you like to join me in a game of basketball, or softball or tennis, or would you like to box with me? I am sure that I can give a good account of myself in any of these sports. (After all, the man is only 60.—Ed.)

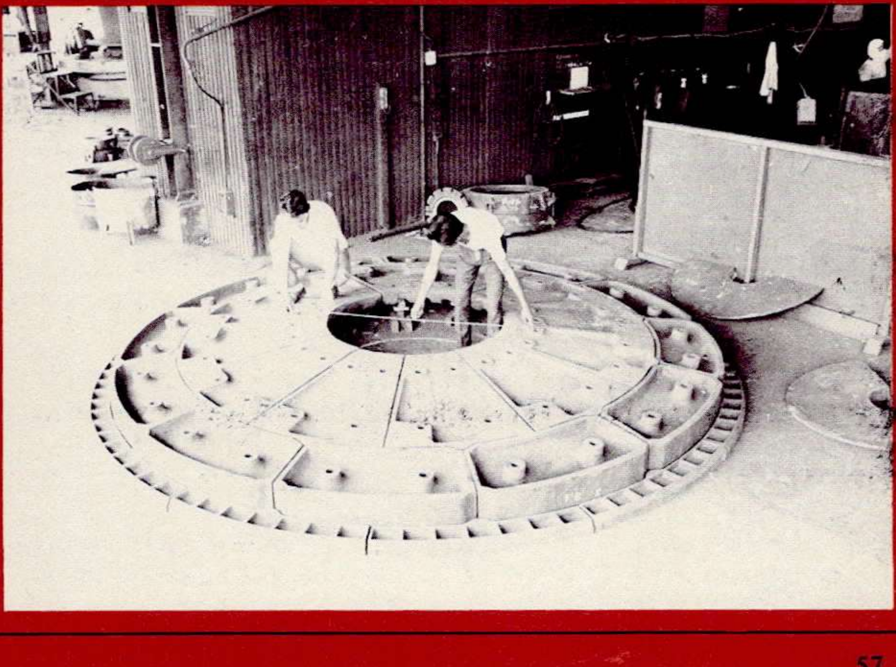
Perfecto ends his day at the mining site at around 5:30 in the afternoon, and from then on : plays basketball - to unwind; drinks a couple of beer after a quick shower — for relaxation; has his dinner; chats with his staff in the sala — for a roundup of work; then goes off to bed.

To the challenge he hurled back at us, here are my answers. I am too short to play basketball; I have been hit by a softball bat on the forehead before so I'd better not take another chance; I would love to play tennis but I tire easily. And to box? Well, that will be the day! But then again, Juventino S. Perfecto, in whatever aspect, has a hard act to follow. **PM** cover story

ENGINEERING EQUIPMENT, INC. FOUNDRY DIVISION



Top: Expanded Machine Shop with 12 vertical boring mills is among the largest in the country.
Middle: One of the company's two 750-kw Triline Induction Melting units with twin furnaces.
Bottom: A complete set of end liners composed of filler rings, center liners and throat liners ordered by Allis Chalmers.



Since its establishment in 1960, the Foundry Division of Engineering Equipment, Inc. (EEI) has weathered price fluctuations, market overcrowding, decline in traditional domestic markets, and rising labor costs to emerge as the country's top producer of quality castings.

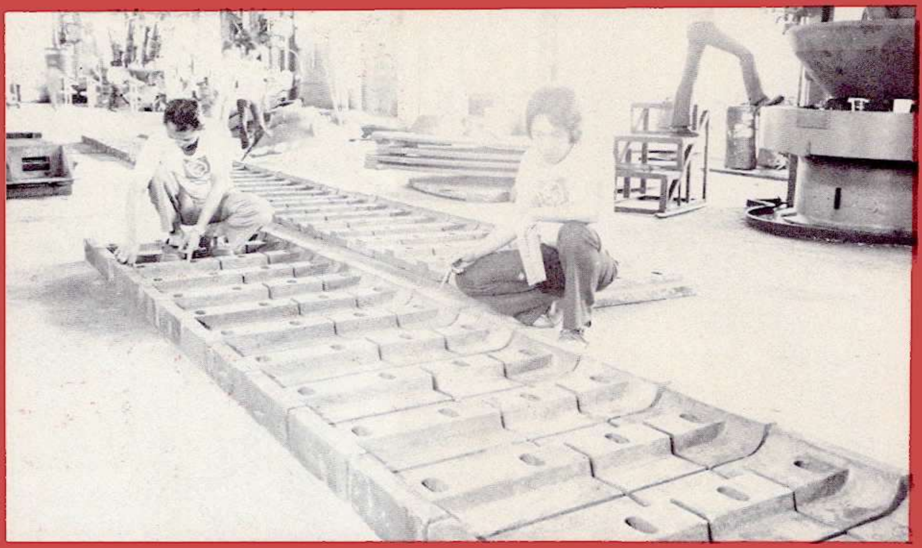
The Division operates the largest and most modern commercial foundry in the Philippines. And for more than 15 years, it has successfully upheld a reputation as a dependable supplier of wearing parts for the mining, cement, sugar, and allied industries in the domestic market. Its skills and factor advantages were internationally recognized in 1972, when EEI became a manufacturing licensee of ESCO International (USA) and WARMAN International (Australia).

EEI began to export its castings in 1971. In preparation for a bigger campaign in this area, the company carried out a ₱7.5 M foundry expansion program in 1974 involving its castings plant. It was in the same year that it finally penetrated the Japanese market despite formidable and sophisticated competition, marking a "first" in the Philippine export scene. EEI scored another first when it was contracted by two Australian mining firms to deliver more than ₱.5 M worth of castings.

From that time on the Foundry Division, through its highly skilled manpower, has continued its outstanding record of being the first local foundry to export castings to highly industrialized markets. In line with this is its reputation of being the Philippines' largest supplier of manganese steel castings and a variety of carbon steel, stainless steel, wear resistant and cast iron castings.

EEI's Foundry Division classifies itself mainly as a jobbing foundry. In the overall total of 3,849,000 kg output in 1978, the mining industry consumed the majority with 41% (1,575,753 kg) going to domestic users and 39% (1,503,479 kg) to exports. Next in line were the cement and aggregate industries with 7% (269,433 kg) for domestic and 2% (76,981 kg) going to exports. The export markets covered were Australia, Papua New Guinea, Fiji, Nauru, Hong Kong, Thailand, Malaysia, Indonesia, the United States, Canada and New Zealand.

This tremendous tonnage output is done with a manpower force of 700, all working at the EEI plant in Bo. Namayan, Mandaluyong, Metro Manila. The plant operates at a rated capacity of 700 MT/month.



Ball Mill Shell liners made from ESCO alloy material for Thailand cement company.

PRODUCT LINES AND SERVICES

Mining Industry: grizzly bar units and parts, pan/hydrostroke feeder units and parts, jaw/gyratory/cone roll and impact crusher parts, rod/ball mill wearing parts, cyclone/classifiers/ flotation cell parts, pump units and parts

Cement/Aggregates Industry: raw mill/finish mill wearing parts, kiln parts and accessories, clinker cooler parts, clinker breaker hammers, slurry pump units and parts, jaw/impact/ gyratory/cone and roll crusher parts, grizzly/feeder units and parts, calcinator filling bodies, classifiers

Sugar Milling: cane knives, shredder hammers, mill roll pinions, couplings and bearing liners, scrapers and scraper toes, returner bars and toes, trash plates, pillow block, bearings, mill chains

Ma Material Handling: cane/mine cars, locomotive parts, wheels and tires, axles, couplers, journal bases, pedestals, bronze bearings, bull wheels, dump station parts, bull rails, side rollers, overhead crane wheels, clamshell buckets, conveyor parts, links sprockets, chains, drums, rock grapples, sprockets segments, dozer undercarriage parts

ESCO Earthmoving, Rigging and Dredging: shackles, ferrules, choker hooks, sockets, cutting edges, end bits, points, adapters and accessories, dippers, hoes, router bits, grouser tips, track pads, chains, rippers, dredge points and adapters.

Specialty Products: dredge pump units and parts, refiner plates, grinding segments, feedscrew, plates, cooling coils, flanges/elbows/ tees, diptubes and tuyeres, bottle molds, glass runners, grate bars and supports.

The EEI Foundry Division has employed a more sophisticated method which has developed Esco kiln chains of stainless steel for greatly increased profits. Produced by the continuous casting method, these improved Esco chains come out already linked, doing away with the traditional, more time-consuming "link-up methods" of cutting and welding. The chains have an exclusive round link design that permits freer rotation for continuous self-cleaning, reduced snarling and hang-ups. The cross section in every link prevents material build-up as there are no flat spots.

In multi-million land reclamation projects, Esco 34D dredge cutterhead teeth are used extensively to dredge further into the rocky, mud-trapped waterbeds. These cutterheads can be kept on the bottom for a longer period of time, with less tooth breakage under the toughest digging conditions.

The Division developed, in 1977, a new series of Esco points and adapters for power shovels. Known as Esco Series 77, these are designed to absorb severe impact and abrasion common to open pit mining operations. Further improvements feature a shield, which is added to the pin to protect it from wearing during operation, and to make it available for reuse.

Despite a slump in the sugar industry in 1977, the Division posted a 200% sales increase in mill roll pinions during the first two quarters of the year. A major factor in this boom was the use of better alloys in the making of pinions. The alloy SAE 4140, specially heat-treated, has the same strength and durability as the carburized SAE 1045.

Mine car wheel and axle assemblies. EEI introduced the use of tapered roller

EEI was one of the first to manufacture cane cars locally. Special features include a lever braking system which acts on all wheels with equal pressure, a specially designed dust-free collar for journal boxes, an axle box cover and grease fittings for easy maintenance. Brakes have specially designed self-balancing linkages for maximum breaking force with least lever effort. Capacities range from 5 to 25 tons with 50% to 100% overload.

The Foundry Division has a continuing research program for the manufacture of castings with better alloys to help realize maximum efficiency in any sugar milling equipment.

For materials handling transport, EEI casts parts and fabricates assemblies for cane cars, Granby mine cars, side dump, bottom dump and specially designed mine cars that are the first of their kind in the country. The company also introduced the use of tapered roller bearings in cane cars – an improvement over bronze bearings – giving more haulage plus longer life.

EEI also makes rock grapples and different kinds of Esco buckets. Clamshell and dragline buckets are triple-tapered for faster loading, cleaner dumping and longer bucket life, while orange peel buckets have powerful three-point grip.

Through continuous research and development, with technical assistance from Warman International (Australia), EEI has maintained the high quality standard of the Warman slurry pump. This is locally manufactured, and has the same patented scalloped impellers that eliminate possible clogging. Without sacrificing hydraulic efficiency, the special shape of the impellers and the casing liners filter abrasive solids from the running clearances, thus obtaining long life of wearing parts. The rubber or metal liners can be detached and replaced as needed. The metallurgical properties of the liners, which can be Ni-hard, chrome or stainless steel, and the patented design configuration of either rubber or metal liners increase the pump's capacity to handle abrasive materials. To facilitate simple maintenance, the pump is easy to dismantle and assemble. In case of space limitation in the work area, the pump discharge can be oriented in eight positions at increments of 45°.

To make sure that each pump produced meets international standards, the same quality control procedures observed by Warman are rigidly enforced by EEI.

MARKETING

The mining industry has been the Foundry Division's traditional and major market for more than a decade now. The Division has provided, under an annual supply agreement, the castings requirements of Marinduque Mining & Industrial Corporation, Marcopper and Benguet Consolidated, Inc.

In 1968 the Division penetrated the cement and other related industries. In 1975, it made a breakthrough in the aggregate industry by tapping an annual casting supply contract for Luzon Aggregates and Supreme Aggregates. The supply consists of castings for the company's gyratory and jaw crushers. In the cement sector, the first annual contract was inked with Bacnotan Cements, followed by Filipinas Cement Corporation for the supply of castings requirements for crushers, kilns and coolers.

Also in 1975, the first unit of locally manufactured Warman pumps was ordered by Canlubang Sugar Central, while 240 pump impellers were cast for Inco mining.

With its objective of getting a bigger share of the world market for castings, the Foundry Division concluded agency agreements with more foreign dealers in 1976. It also sent representatives on foreign trips to look into the feasibility of putting up liaison offices and maximizing sales activities in areas where EEI castings are now exported.

To the Division's growing list of export markets have been added the states of Iowa, Arizona and New Mexico in the USA with the help of Universal Engineering Corporation (for Iowa) and Process Equipment Company (an EEI agent). Sales in the Southern American countries of Bolivia and Brazil were made possible through coordinated sales efforts with Consolidated Purchasing and Designing, Inc. and Allis-Chalmers Corporation of USA.

Foundry Division's export sales network widened further with the establishment of additional export agents based in strategic parts of the world's industrial community. Aside from Process Equipment Company, the new agents are P. T. Yasa Sefia of Indonesia; Kelly Engineering Associates of Hong Kong; Kaiser International Services Corp. for the USA; Noyes Pty Ltd. of Australia; United Motor Works, Malaysia; Emperor Industries, Ltd., Pacific Island; and MSI International, New Zealand.

The EEI Export Group oversees all these export programs, with permanent area managers assigned to the Pacific Region and ASEAN market. They are Louis B. Santiago for Papua New Guinea, Ricardo A. Villo for Indonesia, and Romeo V. Baron for Malaysia.

For 1979, EEI Foundry Division hopes to establish, in the marketing aspects, a target product mix of 50% export and 50% domestic sales in tonnage, a concentration on critical and intricate castings to boost domestic sales, opening up of new export markets, and going for straight line production. With a 60% share of the mining market and 20% of the sugar market, the Foundry Division hopes to establish a greater marketing arm in 1980 and beyond.

PRODUCTION PROCESS

The foundry process starts with the selection of the most economical material for the pattern and corebox. The choice of wood, plastic or metal depends on producttion quality, degree of dimensional accuracy, molding technique, size, shape of casting and volume of requirement. For earthmoving products, the foundry uses plastic patterns due to their smooth surface and the complex core slug of the products. Wooden patterns are used for cement and mining products because of their lightness compared to plastic or metal.

A pattern or corebox is usually made according to drawings, unless old patterns which can readily be revised or repaired are still serviceable. Afterwards, pattern dimensions and allowances undergo dimensional check and adjustment prior to coremaking.

Core sand preparation involves mixing of either chromite or silicon sand with resin binders (self-set process) or with silicate binders (CO_2-silicate process). Checking is done for shear, tensile and compressive strength using the sand strength machine. Coremaking then proceeds using pattern and corebox.

For greensand molding, fresh sand is mixed with bentonite and flour in a sand muller. For chemical molding, sand is mixed with sodium silicate and ester catalyst in a continuous mixer directly discharging into the molding blanks.

Coremolds done with the CO_2-silicate process are generally used for earthmoving products like cutting edges, while for mining and cement products, greensand molding is utilized.

Molds assembly involves setting of cores in molds and closing of cope and drag for floor molds. Core molds are usually stacked in the chemical-bonded process where sand to metal ratio is possible due to its high strength. Visual inspection is done in this area for eroded/damaged portions using inspection mirrors through sprues/risers. Repair of eroded/damaged portions is immediately done.

All in all, the molding process involves one continuous mixer with a capacity of 4 tons/hour of chemically bonded sand, two 30" x 30" twin-shell molding machines (flash size), one 15" x 15" molding machine, and one 20" x 30" twin-shell molding machine (for metal patterns).

With the increase of the Foundry's sand drying requirements, the need for a more efficient drying system led to the installation of a rotary sand drier. The oil-fired sand drier features an oil combustion equipment and fully automatic charging system, which consists of three storage bins, a conveyor, and a bucket elevator. Measuring 4 ft in diameter and 12 ft long, the rotary drum makes possible uniform sand drying. Its 48-ton daily capacity is more than sufficient to meet daily sand drying requirements.

Another recent facility is the Fordath Mark IV Continuous Mixer. This directly fills coreboxes and molding flasks with a controlled stream of automatically mixed and accurately proportioned sand, binders and catalyst.

Traditionally, core sand mixtures are prepared by batch mixing; binders and catalyst are measured, added to the sand manually and then mixed mechanically. The prepared batch is later transferred to the work place and into the coreboxes manually.

With the use of "no-bake" binders, curing or hardening time was shortened.

ESCO dredge cutter teeth used by Construction and Development Corp. of the Philippines.

The problem was getting the mixed sand into the coreboxes before hardening takes place.

The operation of the continuous mixer has not only eliminated this problem; it has also increased production as well as prolonged the bench life of the cores.

Based on the targeted product mix selection of scrap and weighing of ferro-alloys is done prior to charging the desired materials into the furnace. Chemical analysis is done prior to furnace tapping through the use of a vacuum-emission spectrometer.

Melting is done in four electric induction furnaces (2 tri-lines; 2 high-frequency) having a combined rated capacity of 50 tons/day. These utilize three power sources: 750, 250, and 175 kw. The small high-frequency furnaces are used in melting and refining of small high-alloy and precision castings. The big tri-line furnaces, with rated capacity of 1 ton per hour each, are used for larger casting jobs.

The refined molten metal is poured into lip pour type ladles, having capacities ranging from 10 kg to 250 kg for the small castings and 500 kg to 5 tons for the bigger castings.

After a specified time in the molds, the mold and casting are brought to the shakeout area to remove mold sand and cores. There are three shakeout machines for this purpose, including a 50-ton capacity shakeout machine equipped with a 60,000-CFM capacity dust collector.

Visual inspection is done at this stage to check for casting defects, e.g., blowholes, pinholes and cracks. Castings with defects beyond tolerable limits are automatically rejected and sent back to the scrap yard.

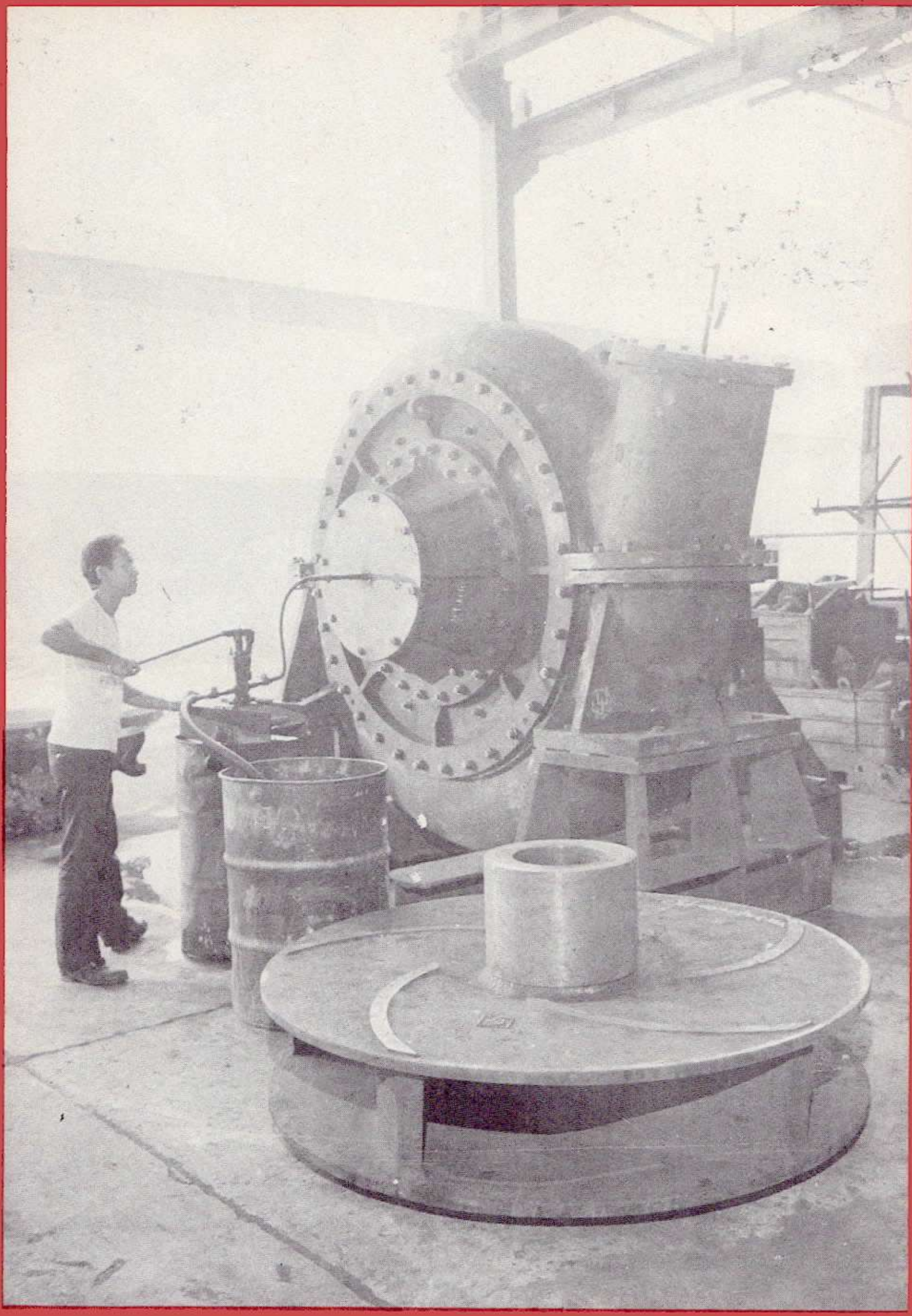
A shotblasting machine is employed for the cleaning of castings. This machine, a Sintokogio Core-Knockout type, is a distinct innovation over conventional types. It combines in one preparation the usually separated process of sand removal and surface cleaning of cast iron or cast steel products. Its table diameter of 2.8 meters has a 5-ton loading capacity. For small castings, a new 1-ton capacity Sintokogio shotblasting machine with a table diameter of 1.8 meters is used.

Gates and risers are either removed by cutting torches, electric arc or by abrasive cut-off wheel.

Heat treatment of castings, when required, are done in any of the six production heat-treating furnaces depending on the size of the casting and process required.

Small castings are loaded in trays and heat treated inside any of the three 5-ton capacity batch ovens, gas-fired and equipped with fully automatic combustion and temperature control systems. Bigger castings go to the 15-ton, single-end furnace. This diesel-fired Johnston type furnace measures 8' x 8' x 17' and is the biggest in the Philippines.

7-foot bowl and mantle liners for export to Bougainville copper mine.



A 20-ton dredge pump for C & A Construction

The car type furnace is used in normalizing, tempering, hardening and annealing treatment of castings. Through its automatic temperature and burners control, it ensures constant oven temperature and thus uniform heat treatment of castings.

Finishing and machining are done using swing grinder for risers and sprues. Electric angle and pneumatic straight grinders are used to smoothen outside and inside surfaces. For accurate dimensions, the shop utilizes vertical boring mills, turret lathes, planers and shapers. The shop is equipped with 12 giant boring mills, lathes, and planers having machining capacities ranging from 3 ft to 16 ft generating an annual output of 1,000 to 2.400 tons.

Increasing quality control requirements for the radiographic examination of castings led to the construction of a new and larger non-destructive testing building. The egg-shaped cubicle, measuring 19ft high and 30 ft in diameter, includes a jib boom and a monorail to facilitate transport and arrangement of castings for simultaneous gramma-ray exposure. The gramma-ray machine is equipped with an 8-curie cobalt 60 source.

QUALITY CONTROL

Quality control actually begins with project engineering, where castings, drawings and specifications are studied, and service or operational requirements are determined. Afterwards, the most exacting standards of inspection are applied to the castings, from patternmaking to finishing and machining, right up to the moment they are ready to be shipped.

What the castings undergo as they take shape at the foundry may serve to explain why EEI has maintained a solid reputation among its local and foreign customers as a producer of the most dependable castings.

Foundry's Quality Control became a department in 1970. It consists of three groups, each under a supervisor: Chemical Control, Metallurgical Control and Mechanical Inspection. Each group has quality control engineers and several quality control assistants (QCA) as well as technicians and helpers. QCAs perform a crucial role in the entire process of casting. It is only with their approval that castings can go on to the next stage of production.

Castings pass through several stages, and in each one, minute and careful inspection is done to ensure that only the soundest castings finally make their way to the customer.

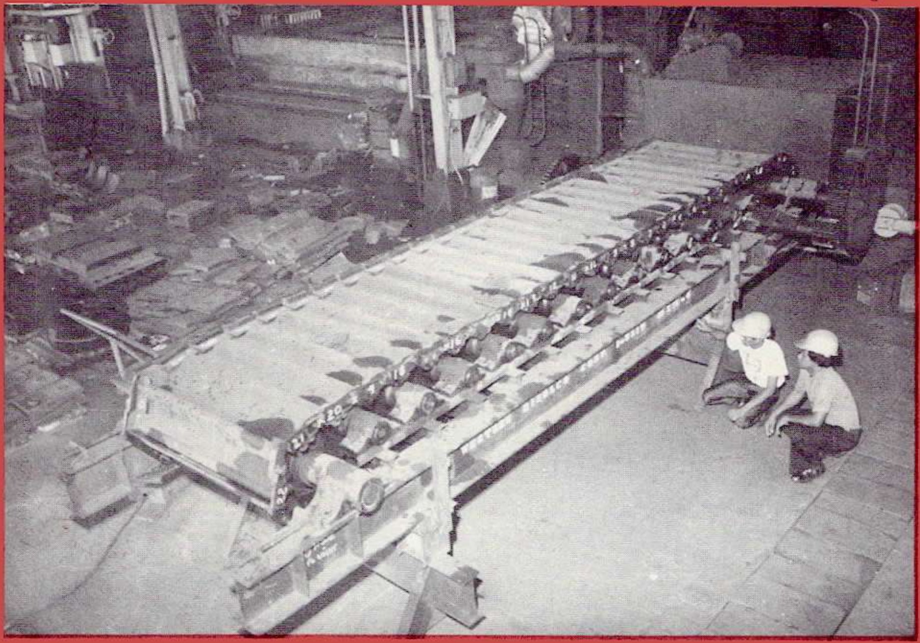
Patternmaking. Since castings undergo changes in the latter stages, tolerances, shrinkage, drafts, risering and machining allowances are incorporated into the patterns. The QCA checks patterns against specifications, and inspects as well the coreboxes made for the castings' internal passages and contours. Mechanical inspection always requires a very personal touch. Successful casting depends a great deal on how carefully quality control is applied on patterns.

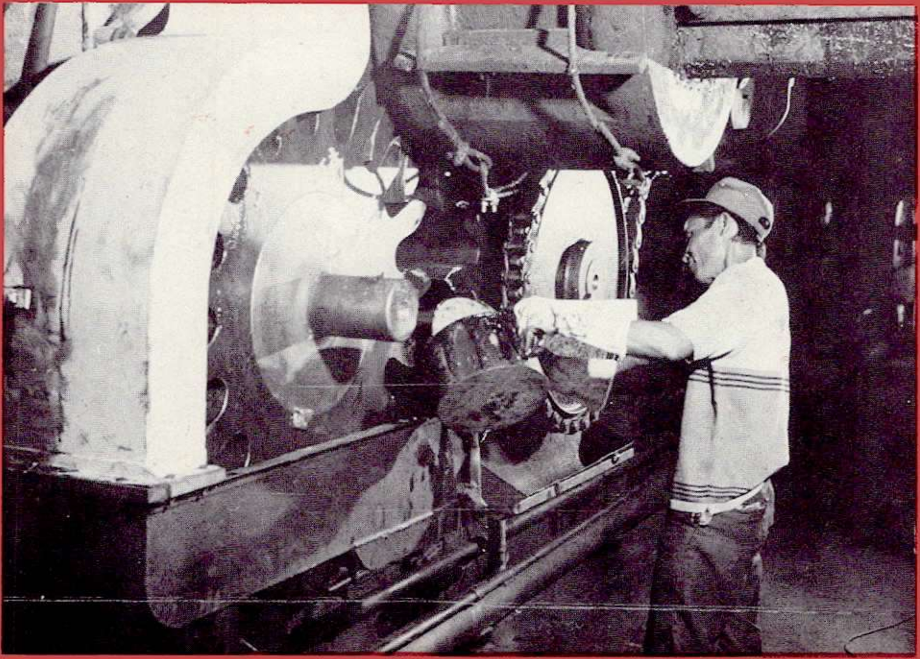
Molding. Metallurgical control takes over. The QCA tests the physical characteristic of incoming sand. A series of screens are used to determine grain size. If the sand is too coarse or too fine, adustments are made in the molding process. The QCA determines the properties of the sand mixed with binders. An improper mixture results in defective castings. He also tests the compressive strength, green hardness, moisture content and permeability of the molding sand. Finally, the QCA oversees the production of the mold. The closing of the mold is crucial since the least error in alignment would ruin it.

Melting. The QCA's main function is to check the chemistry of the metal. Before melting, a chemical analysis of raw materials is made to ascertain chemical composition. This information aids QC personnel to determine the amount of materials needed for a specific heat. Quality is provided with a sample of the molten metal for preliminary analysis. This is an in-process check to detect elements requiring necessary adjustments. The most modern laboratory equipment, such as the Labtest Spectrometer, Varian Techtron Spectro-photometer and Leco Carbon Determinator, are used in chemical analysis, as well as equipment required in conventional methods. A final heat sample is analyzed to determine the actual chemical composition of the metal.

Pouring. When melting is complete and the desired composition is attained, the metal is superheated. The QCA certifies the tapping and pouring temperatures using the latest digital display immersion thermocouples, and only then is the molten metal poured into the prepared molds.

Heat Treatment. After castings have been allowed to solidify, they are freed from their molding boxes. The sand, gates and risers are removed. Heat treatment follows. This is necessary if the castings are to achieve the desired internal structure. The heat treatment QCA sees to it that only clean and non-defective castings are loaded into the furnace. He checks their soundness and makes rejection





Top: Pan feeder assembly exclusively manufactured locally by EEI with integral link design and up to 1,800 ton per hour capacity.
Bottom: Mill roll pinion using longer lasting, more economical alloy SAE 4140 eliminates need for carburizing without any loss in strength and durability.

Top: Power shovel track pads for export.
Bottom: Special alloy steel ball mill end liners for export.

reports on unwanted castings which are then remelted. The effectiveness of heat treatment is checked with the aid of sophisticated equipment. For hardness testing, a portable Brinnel Hardness Tester is used. Grinder, polisher and metallurgical microscope are used for metallography. The Transpol/Transcopy equipment facilitates micro-structure examination without the usual destructive technique.

Finally, the QCA advises going on to the next process or repeating the whole heat treatment cycle.

Finishing & Machining. After heat treatment, castings are generally ground and given a final cleaning. The QCA conducts an in-process dimensional and machine-finish inspection. A final dimensional inspection is conducted after completion of either grinding or machining.

Non-Destructive Tests. Radiography, magnetic particle and dye penetrant tests constitute the non-destructive system used by Quality Control. All trial castings have to pass X-ray inspection before mass production to check the internal condition of the material. Further magnetic particle or dye penetrant test are carried out at the end of the casting process to detect hairline cracks and other surface imperfections. It is only after castings have passed any of these tests that they are allowed to be turned over to the shipping area.

Shipping. A QCA oversees the final inspection of all crated items before these can leave the plant.

In addition to the in-process inspections of the Quality Control Assistants, they also analyze complaints, if any, of Foundry's customers. But the most important part of their task is over: they have carefully "nursed" the castings through every step of production — the best guarantee for quality a foundry can offer.

ORGANIZATION & MANPOWER BENEFITS

At the helm of EEI is its Board of Directors, composed of: Jaime V. Ongpin, Chairman & Chief Executive; Ven O. Ducut, President; Felicito C. Payumo, Executive Vice President; Cesar C. Zalamea, Bernard E. Berkenkotter, Alvin J. Farretta, Jovencio F. Cinco, Makoto Hattori, and Mario D. Camacho, Directors.

The Foundry Division is ably managed by: Vicente R. Prieto, group vice president; Vicente N. Muñoz, Vice President & general manager; Jose B. Maroma, assistant general manager for marketing; Eduardo S. Perez, assistant general manager for operations; Romarico J. Platon, assistant group manager for quality control; Emmanuel O. del Rosario, manager, products and systems departments; and Rene J. Crisologo, group manager, domestic sales.

For 1977, EEI held a total of 85 in-plant training programs with 1,803 employees participating. On the other hand, individuals from various levels of management were sponsored for 15 ex-plant technical and specialization courses. More important, EEI has implemented the tie-up training agreement with the Department of Education and Culture for the establishment of pilot skills centers in La Union, Marikina and Cagayan de Oro.

EEI holds company-wide safety contests which have kept consciousness at high levels, and rewarded deserving workers for their sustained efforts. Well organized teams on fire prevention, first aid, disaster and flood control at the various offices have successfully prevented the occurrence of fatal and disabling accidents.

To provide employees some respite from the rigors of work and to allow them to enjoy healthy and friendly athletic competition, the company sponsors year-round activities in sports like bowling, tennis, pelota, golf, chess and basketball.

On the community scene, the Company erected a school canteen for the Namayan community last year, and has continued to supply the three barrio clinics with family planning aids since then.

OUTLOOK

The Foundry Division expects greater success in the future, by continuing its aggressive thrust in the export markets and upgrading its products mix in favor of more profitable product lines.

In line with this export drive, the Division's ₱11.2 M expansion program was started this year. This involves foundry modernization and mechanization and has been divided into 3 phases. To oversee this project, several management personnel were sent on extensive training in Japan last January 1979.

This expansion program, expected to be finished by 1981, may be considered as the Foundry Division's additional stepping stone to greater success in the exports market, as well as in the domestic market for intricate precision castings. **PM**

Top: One of 25 units of specially designed mine cars for Benguet exploration.
Bottom: EEI is the exclusive manufacturing licensee for ESCO earthmoving and rugging equipment, and Warman pumps and parts.

technical abstracts

ADVANTAGES OF COLD SAWING

Against flame cutting, cold sawing of plate on a volume basis offers distinct advantages of speed and finish. In terms of speed, a 50 mm thick plate can be sawn with a carbide saw at around 800 to 850 mm/min compared with flame cutting at 225 mm/min. Steel 125 mm thick can be sawn at 275 to 375 mm/min compared with flame cutting at 150 mm/min.

As regards finish, pieces can be cut off within tolerances of around 0.03 mm per 30 mm and finish is generally within 63 to 80 RMS without any carbides or hot spots in the surface. In cold sawing there is no physical change in the steel. Heat goes straight into the chip while the workpiece and saw blade stay cool.

Many of these arguments also apply in comparison against abrasive cutting. There is no temperature differential, no noise problems, no hard skin effects, nor does the engineer have to specify an amount of material to be machined or ground off to reach final dimentions. *Metalworking Production, June 1978.*

REDUCE HANDLING TIME FOR FASTER CUT–OFF

High capital outlay on up-to-date fast cutting-off machines can be completely wasted if valuable production time is lost through manhandling material, waiting for the crane and manual off-loading of work. Up to the present there is still the tendency to regard the saw as a low output item stashed away out of sight in the steel stores.

Customer demand for improved handling systems has led to the development of various systems to handle solid bars, bundles of bars and beam sections for feeding to the sawing machine. These include: powered roller feed-in/take off; bundling with bar reservoir; hydraulic load/unload for heavy bar; hydraulic magazine for heavy bar.

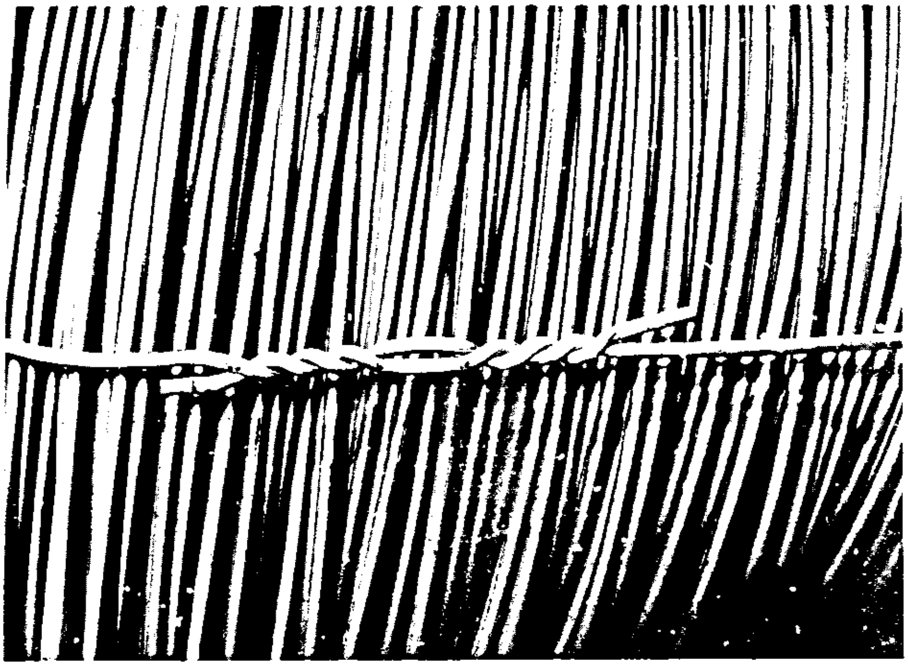
The report focuses on Kasto/Rivers bandsaws, which are gaining in popularity in the steel, forging and high volume production industries. These are made in capacities of 450, 650, 800 and 1050mm and can be semi-or fully-automatic in operation. They have electromechanical vertical and horizontal clamping systems suitable for small solid or tubular material in bundles or large solids. Feed vice and carriage are mounted on a pivoting system to assist feeding bent bars or sections into the machine. A useful feature is the automatic positioning of carbide-faced blade guides which cuts down changeover time from one job to another. *Metalworking Production, June 1978.*

PICKING THE RIGHT CUTTING FLUID

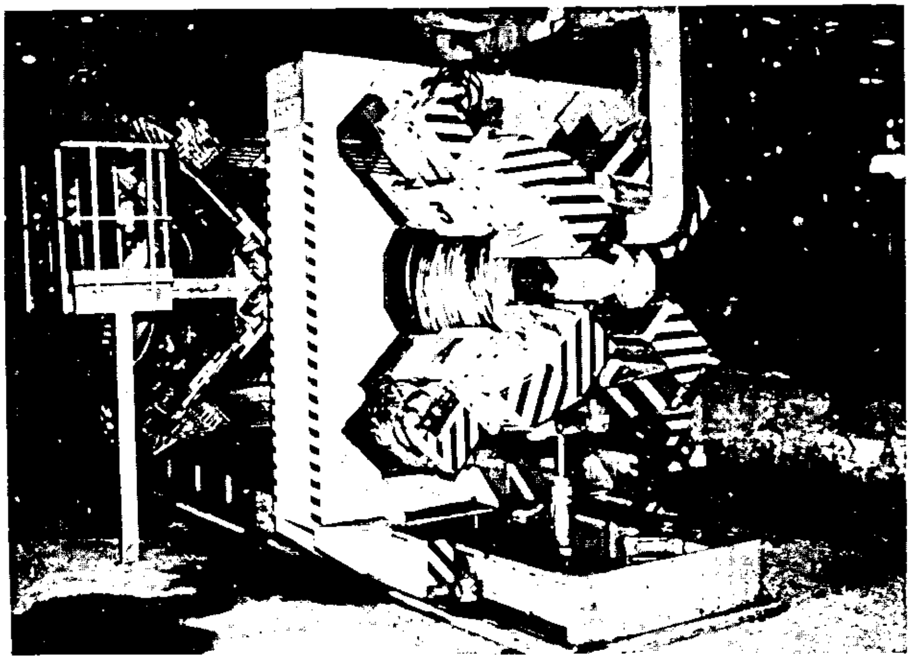
The proper choice of cutting fluid means many benefits: higher cutting rates, longer tool life, lower power consumption, better product quality, reduced scrap, and more safety for the operator. But when the wrong fluid is used, risks are just as many: fumes, corrosion, sticking of slides, and damage to the machine tool.

Cutting fluids have two basic jobs—to disperse heat and lubricate between cutting tool and workpiece.

Four types are now in use: 1) aqueous fluids consisting of water or non-oily solutions of chemicals in water, which have excellent rust-inhibiting properties and pro-



The automatic machine used for compressing and binding wire wound into coils (photos from Sunds AB, Sweden).



vide a clean flushing action; 2) neat oils consisting of mixtures of different types of oils and additives, the blending of which is determined by the application and users should confirm with manufacturers prior to use; 3) soluble-oil emulsions that are oils added to water, now used for machining the toughest of steels; and 4) synthetic coolants that are soluble oil emulsions with additives, which give stable emulsions with a wide range of waters, and scum formation does not occur.
Industrial World, May 1978.

COMPACTOR/BINDER FOR LARGE WIRE–ROD COILS

A new automatic machine developed by Sunds AB of Sundsvall, Sweden, is capable of compressing and binding wire rod wound into coils up to 3.5 m long unpressed and 1.5 m diameter in just 50 seconds. The loops of wire are tied with in-line knots that leave no projecting ends and are at least 90% as strong as the wire itself.

The compactor station can be installed in different kinds of hook conveyor systems as well as work in combination with a capstan, normally without modification. Its main frame is fixed on a movable carriage guided along the inner side of two sections and supporting four press arms (each with a binding unit, a central mandrel and two lifting arms. Two hydraulic cylinders move the carriage horizontally. A movable press plate is supported on a separate carriage resting on steel rollers guided by the outer edge of the rails.

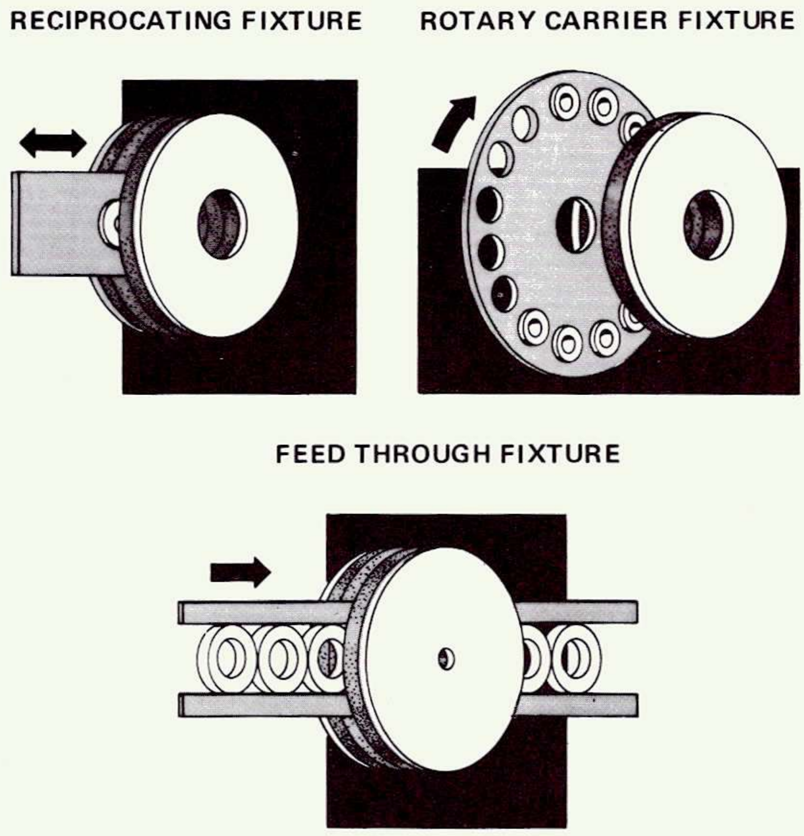
When a coil is positioned in front of a compactor, the main carriage is moved forward so that the mandrel enters the coil which is lifted from its hook and centered by the two lifting arms. The four hydraulically-operated press arms, each at an angle of 45° from vertical, close around the coil. *EIBIS.*

HAVE YOU EVER MELTED A THREE–TON BLOCK?

At some date prior to 1885, the Pratt & Whitney Co. of Hartford, Connecticut employed a Mackenzie cupola of oval cross-section to dispose of a three-ton block of iron. The furnace had one interesting feature in that an inner sleeve within the cupola shell provided the means of funnelling the refractory lining inwards to 40 by 30 in. just above the wall, compared with 50 by 40 in. at the charging door. This design allowed the insertion of a continuous non-clogging tuyere slot around the periphery of the cupola. It also provided room for the wind-belt to be located inside the outer shell of the cupola.

The founder was said to have built a bed containing 2,000 lb. of coal and then lowered the iron down the shaft by means of a jib crane, the charging opening having been especially enlarged for the purpose. Some 400 lb. of coal was then placed around the lump of scrap and the fire started. After it was burning bright, four successive charges, each containing 500 lb. of coal and 4,000 lb. of scrap and pig, were tipped into the furnace and the blower started. The shallow well furnace suggests that the cupola ran on an open taphole. While claiming success for the operation, the writer of the report was suitably vague in his assessment of the metal's temperature.

Perhaps this century-old description of an epic melt might spur those ironfounders who possess an odd scrap casting, which has defeated the breaking ball, to recoup their losses. *Foundry Trade Journal, April 13, 1978.*



WORKPIECE HOLDING and feeding for double disc grinding can be done with reciprocating or oscillating, rotary carrier, or feed through fixtures.

INCREASED USE OF GEAR GRINDING

Grinding of gears to the required accuracies after heat treatment offers several advantages over shaving. And the demand for improved gear finishing methods is stimulating the substitution of grinding after heat treatment for shaving before heat treatment.

There are two general methods for grinding gears after heat treatment. The first is an intermittent grinding method in which the workpiece is indexed after each tooth or tooth space is ground. The grinding wheel is generally dressed, with automatic compensation, several times for each workpiece.

A second method for grinding accurate gears, introduced in the early 1950's, is continuous grinding. A grinding wheel having a worm contour is precisely synchronized with the workpiece drive, resulting in continuous rotation of the workpiece. Machine kinematics are essentially the same as for a hobbing machine, but with a grinding wheel (worm) taking the place of the hob. *Manufacturing Engineering, June 1978.*

DESIGNING FOR PRICE AND PERFORMANCE

In many ways the task of designing and manufacturing conventional forming machines, which are competitively priced and at the same time embody quality standards ensuring maximum use both in terms of life and application, are often more difficult than developing the more sophisticated models. In most cases, the final choice of this type of machine will rest on the general quality incorporated into the production system by the manufacturer and by the company's ability to keep abreast with market requirements.

The article deals primarily with guillotine and press brakes, whose design and construction are direct results of continuous development programs, allied with careful monitoring of operating performance under different types of shop floor applications. The manufacturing policy ensures that both types of machines follow a pattern of up-dating which keeps them in line with modern sheet metal shop practice.

A number of machines recently installed in the UK demonstrate the practical use of KB press brakes (manufactured by Donewell A/S), whose open back design used for the main frames offers advantages in terms of easier material handling and movement. This has proved of considerable value where the guillotines have been coupled to conveyor and stacking systems. *Sheet Metal Industries, April 1978.*

TABLE I. COMPOSITION AND OPERATIONAL CHARACTERISTICS OF VARIOUS AUSTENITIC STAINLESS STEEL ALLOYS

Type 301.	17 percent chromium and 7 percent nickel. Used when high strength and ductility are required. Slightly less corrosion resistant than 302.
Type 302.	Basic 18 percent chromium and 8 percent nickel. Resistant to most organic and inorganic acids at normal temperatures. Also resistant to heat corrosion, but will exhibit carbide precipitation in welds. Fabrication methods are similar to those used with carbon steel.
Type 303.	Basic 18 percent chromium and 8 percent nickel alloy with phosphorus and sulfur added for improved machinability and minimum galling or seizing. Corrosion resistance is similar to that of 304.
Type 304.	Similar chemical composition to that of 302 but maximum carbon content is 0.8 percent. Lower carbon content decreases the likelihood of carbide precipitation, making this alloy more versatile than 302.
Type 304L.	Extra-low-carbon grade of 304 with maximum carbon content of 0.3 percent. Corrosion resistance does not break down with welding.
Type 305.	Modified 304 with more nickel and less chromium to improve cold-working capabilities.
Type 308.	20 percent chromium and 10 percent nickel. Slightly better corrosion resistance than that of the basic 18-8 grades. Less susceptible to carbide precipitation than 304.
Type 309.	24 percent chromium and 12 percent nickel. Maintains high yield and tensile strengths at elevated temperatures.
Type 310.	25 percent chromium and 20 percent nickel. Higher creep strength and lower coefficient of expansion reduce warpage and scaling at fluctuating temperatures.
Type 316.	Modified 18-8 composition with 2.5 percent molybdenum. Superior resistance to acid or fume attack. Maintains high tensile and creep strengths at elevated temperatures, but will exhibit carbide precipitation in welds.
Type 316L.	Extra-low-carbon grade of 316 with a maximum carbon content of 0.3 percent. Corrosion resistance comparable to that of 316; it does not break down with welding.
Type 317.	Modified 18-8 composition with 3.5 percent molybdenum. Better corrosion resistance and less susceptibility to carbide precipitation than those of 316.
Type 321.	Modified 18-8 composition with titanium added to eliminate carbide precipitation. Corrosion resistance similar to that of 304.
Type 347.	Modified 18-8 composition with columbium added to combat intergranular corrosion. Corrosion resistance similar to that of 304.

TABLE II. ALLOY SPECIFICATIONS FOR FAN COMPONENTS WITHIN THREE BASIC STAINLESS STEEL GROUPS

Fan parts			Stainless steel alloy 304	316	347
Housings, flanges, collars			304L, 316L	316L	NA
Shaft			304, 316, 303	316	4140
Wheels	Spiders	Cast	316L	316L	316L
		Fabricated	316L	316L	347
	Blades, rim, and back plates		304L, 316L	316L	347
	Front plates		304L, 316L	316L	347
Nuts, bolts, keys, set screws			316	316	316

NA—Not Available

HEAT TREATMENT OF MEDIUM CARBON STEELS

In industrial practice there are occasions when the specifications of the steel, its method of manufacture, other parameters, etc. are determined by the plant characteristics and the process schedule mandatory in the particular plant. In this particular instance, oil hardening from austenitising temperature of about 850°C was the fixed parameter and, therefore, the steel had to be such that it responded to heat treatment under these conditions, and satisfied the required mechanical properties.

Deoxidation with aluminum gives inherently fine grained steel with lower hardenability. A higher austenitising temperature of over 150° C is necessary to cause grain coarsening and hardenability in oil. At 850°C and soaking of 20 minutes or more gives rise to a grain size which allows hardening only in water, whereas at 950° C for 20 minutes the degree of grain coarsening allows partial hardening in oil. To attain the hardenability required in obtaining the specified properties by the oil quench/temper process, an overheat of a few hundred degrees is necessary. *Practical Metallography, May 1978.*

CHOOSING STAINLESS STEEL FANS

Economics often play an important role in the selection of corrosion-resistant fan materials. The most economical choice is usually specialty paints and coatings, followed by stainless steel alloys and fiberglass-reinforced-plastic (FRP). However, stainless steel and FRP are superior to specialty paints or coatings for corrosion resistance.

Although FRP fans usually exhibit the best corrosion resistance and can handle certain corrosive agents or reagents, stainless steel fans can operate with higher temperatures, and they stand up better than FRP fans to impact of nonabrasive materials. There are more than 100 registered grades of stainless steel. Not all alloys can match the many different sizes, types and performance requirements of industrial fans.The tables on this page show the characteristics of various stainless steel alloys, and also alloy specifications within three basic steel groups.

There are many special stainless steel alloys available—some have better corrosion resistance, some have better abrasion resistance, and some are nonsparking. Special alloys require careful consideration of costs, availability, design suitability, and fabrication methods. Hence, their selection should be limited to special applications. *Plant Engineering, June 22, 1978.*

THE FOUNDRY INDUSTRY IN HUNGARY

Industrial development in Hungary, which began in the twenties, was not only disrupted by the over-production crisis of 1929 but also restricted to such an extent that foundry production was only able to reach, in 1935, the level achieved six years previously. In 1938, casting production stood at 68,000 tons, produced by 130 foundries, 55 of which were casting aluminum.

The introduction in Hungarian foundries of newer molding techniques as a means of eliminating time-consuming drying has been the main factor in the rapid increase in castings production. By 1975, the country produced 295,000 tons of iron castings, 57,000 tons of steel castings, 21,000 tons of light-alloy castings and 12,000 tons of copper alloy castings, making a grand total of 385,000 tons. Planned changes in the technological aspect of castings use have also demanded an increase in casting production levels.

Engineering remains, in the medium- and long-term, a dynamically developing branch of Hungary's economy. The solution of the development tasks of the engineering industry demands, above all else, an improvement in castings quality, an increase in the proportion of castings produced by modern methods, a wider selection of processes, a reduction in the dimensional differences between the mold, the measurements of the finished parts and the prototype casting. *Foundry Trade Journal, April 13, 1978.*

AUTOMATING BOTH ENDS OF A PRESS

The first automatically loaded and unloaded turret-type punch press has been manufactured by the Strippit Div. of Houdaille Industries, Inc. Equipped with load/unload automation of workpieces, the press spends only nine seconds per part loading and unloading. Manual handling takes an average of 30 seconds.

The NC system calls all the signal governing the action of the press and its handling mechanisms. After a supply of blanks is delivered to the loading magazine and after the tape for the desired part is inserted in the console's tape reader, the machine is started.

With the new press, the operator sets the controls, inserts and removes the NC tape, makes sure that there are enough blanks in the loading station, and occasionally helps with the removal of stacked pieces at the unload end. Besides increase in productivity, the load/unload automation greatly reduces the need for handling the sharp-edged blanks, and also leaves the operator less fatigued at the end of the day. Mechanizing the transfer of blanks to and from the press saves the operator considerable effort.
American Machinist, June 1978.

USING RADIO CONTROL FOR MATERIAL HANDLING

Remote radio control has been a recognized industrial tool only since the early 1960's. To date, most industrial applications have involved control of material handling equipment, particularly electric traveling bridge cranes.

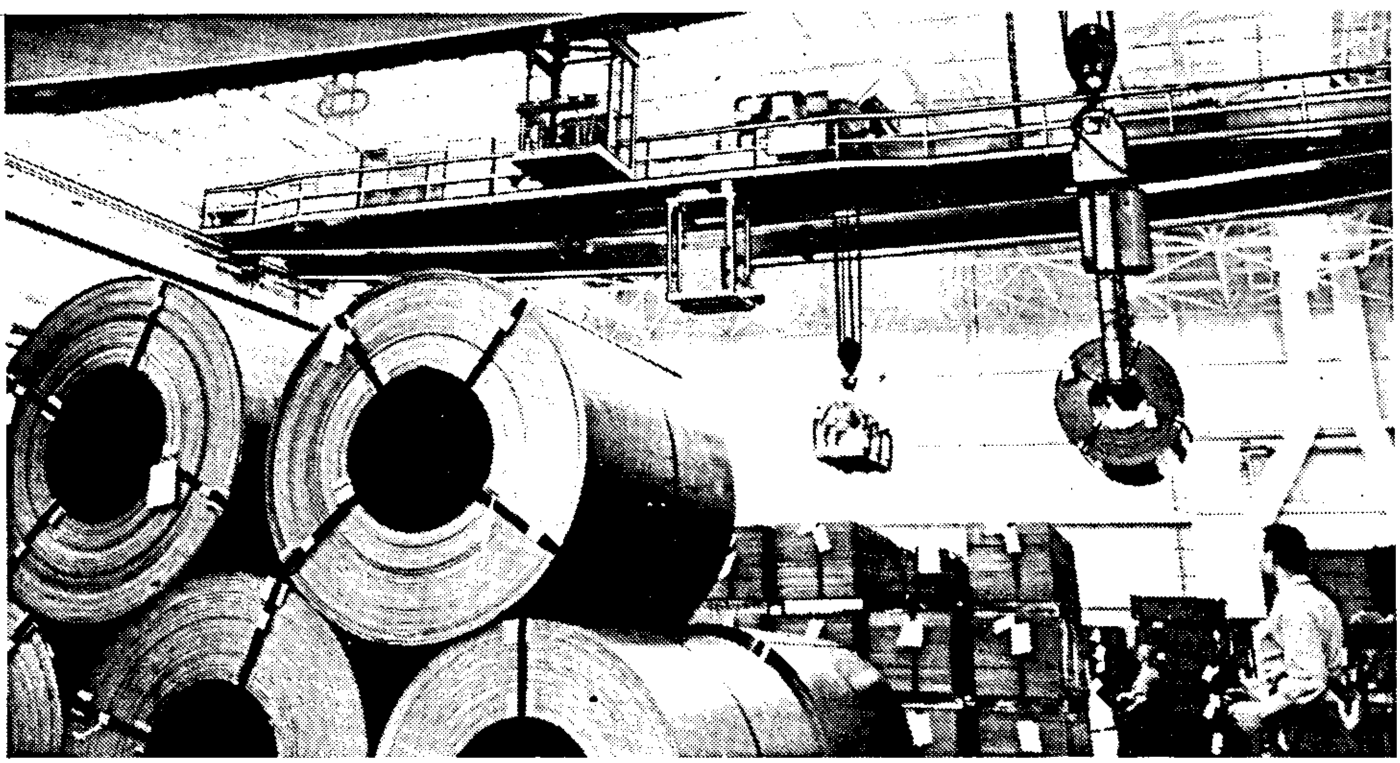
Among the major advantages of radio-controlled handling equipment is improved labor productivity. Using a one-man radio-control system instead of a two-man crew can save $24,800 per crane in a two-shift operation over a 1-year period. Safety can be another advantage. Because only one operator located on the plant floor is used, a radio-control setup eliminates the need for hand signals—which are subject to misinterpretation—between the cab operator and the floor man at the hook. And, an operator located on the floor is usually well removed from hazards—such as high humidity, chemical fumes, smoke and radiation—that may exist at cab level (see photo).

And, with radio controls, two operators can control a single crane on a first-come, first-served basis. In many large facilities, one operator loads a crane at one end of the plant, and then sends it to a second operator for further handling some distance away. This arrangement is known as a two-box, pitch-and-catch operation. *Plant Engineering, June 22, 1978.*

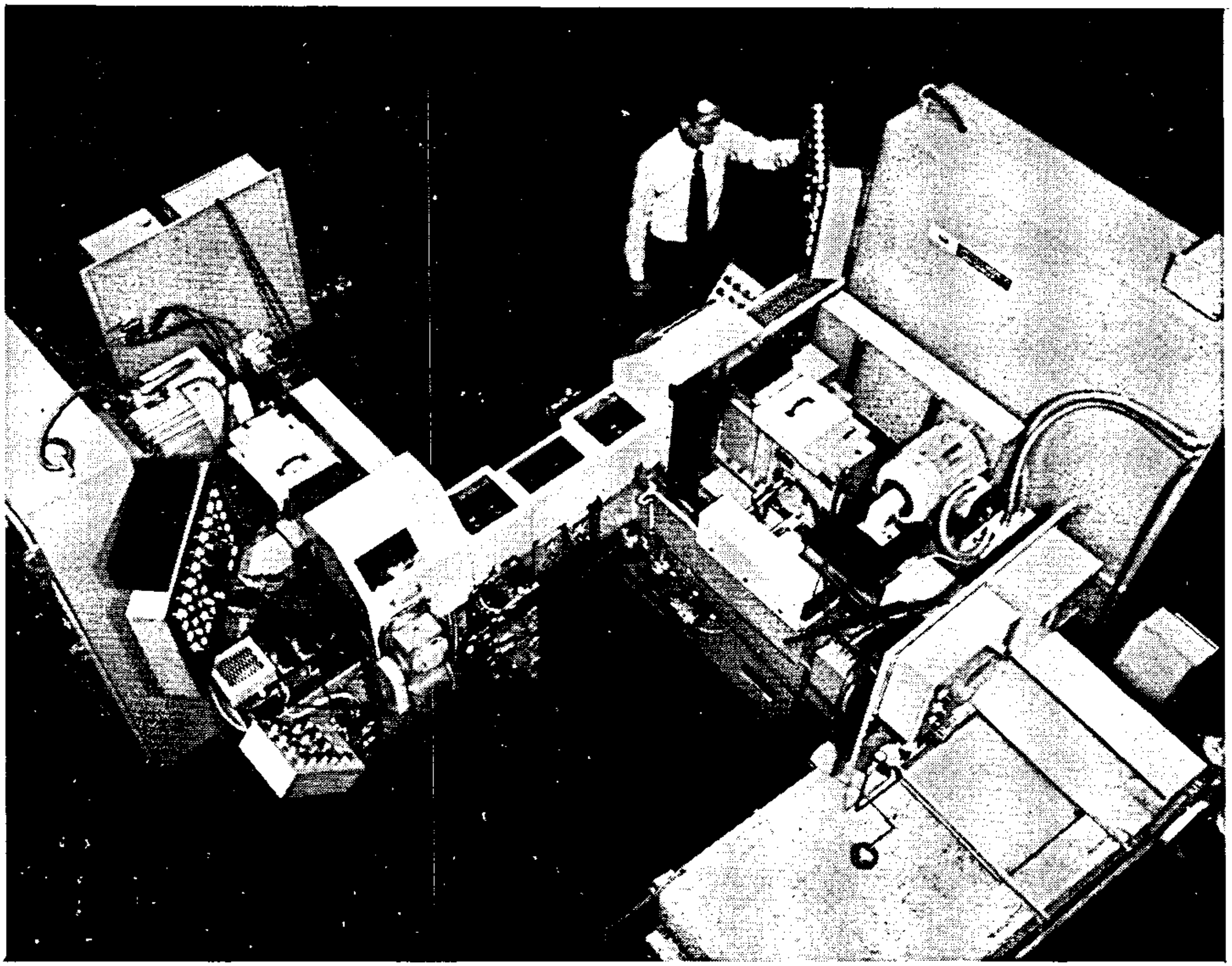
NEW SLITTING LINE IMPROVES PRODUCTIVITY AND SAFETY

The newly introduced automatic 60 in. slitting and banding line designed and manufactured by Ductile Engineering Ltd. is capable of processing mild steel material 1500 mm wide (59.05 in.), in thicknesses up to 3.2 mm (1/8 in.). This enables customers to be supplied with slit coil in any width from 30 mm (1 1/4 in.) up to the side trimmed width of a wide coil.

Two main factors involved in the design of the new line were the need for higher levels of productivity and safety. To achieve improvements in the slitting section, extra equipment can be installed between the main units as part of an efficient system for threading new coils through the line. Push and pull drive systems are also available. In addition to this, the increased slitting capacity emphasizes the need for a new approach to the follow-on banding operation, with its attendant safety hazards. *Sheet Metal Industries, April 1978.*



Crane lifting ladle of hot metal is operated by man (at right) using remote radio control.



Automatic line has two form grinding machines located on opposite sides of a work transfer unit.

HIGHER PRODUCTIVITY IN DIECASTING

Diecasting has always been a pacemaker in the field of metalcasting with its promise of increased productivity, improved quality and more economic use of metals and alloys. This was evident during the Eighth International Diecasting Exhibition held in London, where computer controlled diecasting, high speed diecasting machines and the latest in handling equipment were displayed.

Theme of the exhibition was automation—not only in the diecasting operation itself, but also in the whole shop operation, which is now a practical operation. Manufacturers, suppliers and producers came together to demonstrate the most practical use of labor and material in their particular area of diecasting.

Strong growth is expected in aluminum pressure diecasting, according to a report from the conference, with world production already above the peak output of 1973-74. It was reported that although zinc diecasting is recovering well from the recession in Europe, the US and Japan are still somewhat depressed in terms of tonnage produced. However, the development of lighter and thinner zinc castings have enabled diecasters to keep production levels high. *Metalworking Production, June 1978.*

TRANSFER GRINDING SPEEDS PRODUCTION

The automatic transfer line system shown in photo consists of two high-speed, plunge-type form grinding machines located 64" (1626 mm) apart and on opposite sides of an automatic work transfer unit. Both ends of two rods at a time are automatically ground, with a production rate of 1000 rods per hour. Only one operator is required, and his primary function is keeping the leading magazines filled.

Each machine is equipped with two grinding wheels to finish the ends of two pushrods at a time. Rotary form dressing of the grinding wheels is done with powered spindle, diamond impregnated rolls. Automatic dressing, done during the loading/unloading portion of the cycle, is performed after grinding a preset number of rods.

Automatic transfer of pushrods to the first machine, between the machines, and from the second machine is accomplished with a lift and carry system, with rotating transfer bars. This is a split system, with a transfer bar and individual drive motor for each machine and a crossover station between machines. *Manufacturing Engineering, June 1978.*

MULTI-FUNCTION BURNER

The KS burner, recently introduced by Kawasaki Steel Corp. for use in soaking pit furnaces, is capable of uniformly heating ingots, saving on fuel consumption, ensuring yield improvement at the succeeding initial rolling stage through reduced scale losses, and lowering the level of nitrogen oxide emissions for environmental control purposes.

A major feature of the burner lies in the design of a port in the pit wall which functions as the air and gas injection vent. Three concentric spouts make up the port. Gas flows in through the space between the innermost and middle tubes. The innermost nozzle and the space between the outer and middle spouts are used for the intake of air. The nozzle tips are so designed as to obtain a swirling motion of air, so that the hollow cylindrical stream of gas may be sandwiched between eddy currents of air.

The design, which was adopted to attain a better mixing of air and gas for efficient combustion of fuel, makes it possible to properly regulate flame characteristics. With the flame so controlled, it can be stretched to any length to reach the desired place inside the pit-furnace to heat the ingots to an even temperature. This is done by equalizing the temperature between ingots as well as between the surface and interior of individual ingots, or providing localised temperature adjustments when necessary. *News Release, Kawasaki Steel Corporation.*

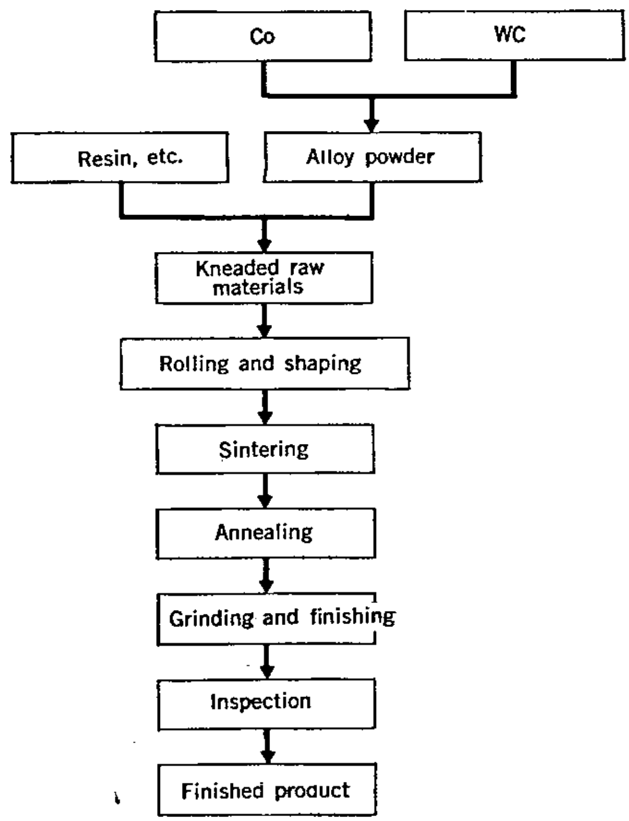
FULLY CONTINUOUS CASTING MACHINE

Kawasaki Steel Corp. has ushered in an innovation in continuous casting technology that can make the CC machine really work nonstop, despite frequent changes in output size or chemistry. This process is said to boost productivity by an additional 30% with cost savings estimated at $ 1.8 million annually per machine.

The new casting techniques help the CC machine get rid of its vulnerability to changes by the use of specially-designed mold, auxiliary equipment and coolants, which are all adaptable to any type of machine, whether it produces slabs or blooms.

The mold is made up of the usual four plates, but is so designed that two of these are movable by auxiliary equipment attached to it. When the width has to be changed, the two movable plates are automatically pushed either inward or outward according to the required change, at a speed synchronized with the CC machine's casting speed. This makes mold replacement unnecessary, thereby permitting the machine to continue its casting operation while the width change takes place. *Kawasaki Steel Corporation, November 1978.*

Carbide Alloy Thin Sheet Manufacturing Process



MANUFACTURE OF EXTRA THIN CARBIDE ALLOY SHEETS

Carbide alloys, known for their exceptional hardness and resistivity to heat and wear, are used preferentially as the material for making tools. However, since the alloy is very brittle, easily deformed by contraction in the sintering process and very expensive as a large number of processes are involved in its existing manufacturing methods, it has been considered virtually impossible to produce a practical commodity having a thickness of 1 mm or less from the alloy.

Accepting this challenge, the Society of Non-Traditional Technology developed a new kind of material having stabilized density and thickness by mixing alloy powder and resin, for use in the manufacture of carbide alloy sheets. The process consists essentially of four steps (see schematic diagram). It has been confirmed that, under optimum sintering conditions, very thin carbide alloy sheets having a thickness of less than 0.8 mm and at least 0.07 mm can be produced in any desirable hardness and shape in a short period of time.

The newly developed carbide alloy sheet is expected to meet large demands for use in sliding parts of machines, on surfaces of metal dies, and many other applications requiring extra-hard and wear-resistant metals. *The Japan Industrial and Technological Bulletin, July 1978.*

TABLE 1—*Coal properties.*

Rank Classification Group	Bituminous Low Volatile	Bituminous High A	Bituminous Volatile C	Subbituminous A	Subbituminous C	Lignite A
Agglomerating Character	Agg.	Agg.	Sl. Agg.	Nonagg.	Nonagg.	Nonagg.
Proximate						
Moisture (seam)	2.0	4.0	10.0	14.0	25.0	40.0
Volatile Matter	21.1	36.4	36.3	35.3	25.8	25.9
Fixed Carbon	68.6	48.9	43.7	41.2	40.9	27.4
Ash	8.3	10.7	10.0	9.5	8.3	6.7
High Heating Value, Btu/lb						
As Fired	13 180	12 370	10 700	9 480	7 500	5 940
Moisture & Ash Free	15 130	14 920	13 380	12 860	11 240	11 150
Ultimate: (Mois.-Ash Free)						
Hydrogen	5.0	5.6	5.5	5.4	5.6	4.3
Carbon	88.5	82.5	74.3	74.2	66.4	67.0
Sulfur	0.4	2.5	4.0	0.5	0.6	0.9
Nitrogen	1.3	1.5	1.4	1.2	1.3	1.2
Oxygen	4.8	7.9	14.8	18.7	26.1	26.6
Grindability (Hi):						
Typical Range	80–110	45–65	45–65	40–60	40–60	35–70

HIGH PERFORMANCE SCREW RECESS IMPROVES PRODUCTIVITY

An improved screw known as Supadriv has been launched by GKN Fasteners Ltd., which claims considerable benefits to manufacturing industries with no increased costs. The improved performance of Supadriv is due to its ability to resist cam out even when the driver and screw are misaligned.

To make the Supadriv recess more suitable for everyday conditions, the sides were made steeper by reducing the included angle of the recess from 52° to 40°. This reduced the wedging effect of the forging punch, which in turn brought an improvement in recess definition, thus providing a better driving edge. These improvements gave excellent resistance to cam out. Furthermore, the width of the recessed wings has been increased so that the driver can be inserted at an angle.

Supadriv's resistance to cam out also means driver wear is reduced, leading to less production downtime and lower operating costs. Also, operator fatigue is reduced because of the resistance to cam out under low end load conditions. *Sheet Metal Industries, April 1978.*

ASTM STANDARDS AND THE EQUIPMENT MANUFACTURER

The need for standardized measurement procedures also apply to boiler and other combustion equipment manufacturers. There is an interrelationship between and among coal properties as they concern combustion, furnace slagging and fouling, and emission control.

The table on this page shows the analysis of typical coals as ranked by ASTM D 388, Specification for Classification of Coals by Rank. Coals are separated into rank according to specific values of volatile matter content, heating value, and agglomerating properties. The increase of coal reactivity with decreasing rank is directly related to the combination of nonagglomerating property and the increased "inherent" oxygen in the lower rank coals.

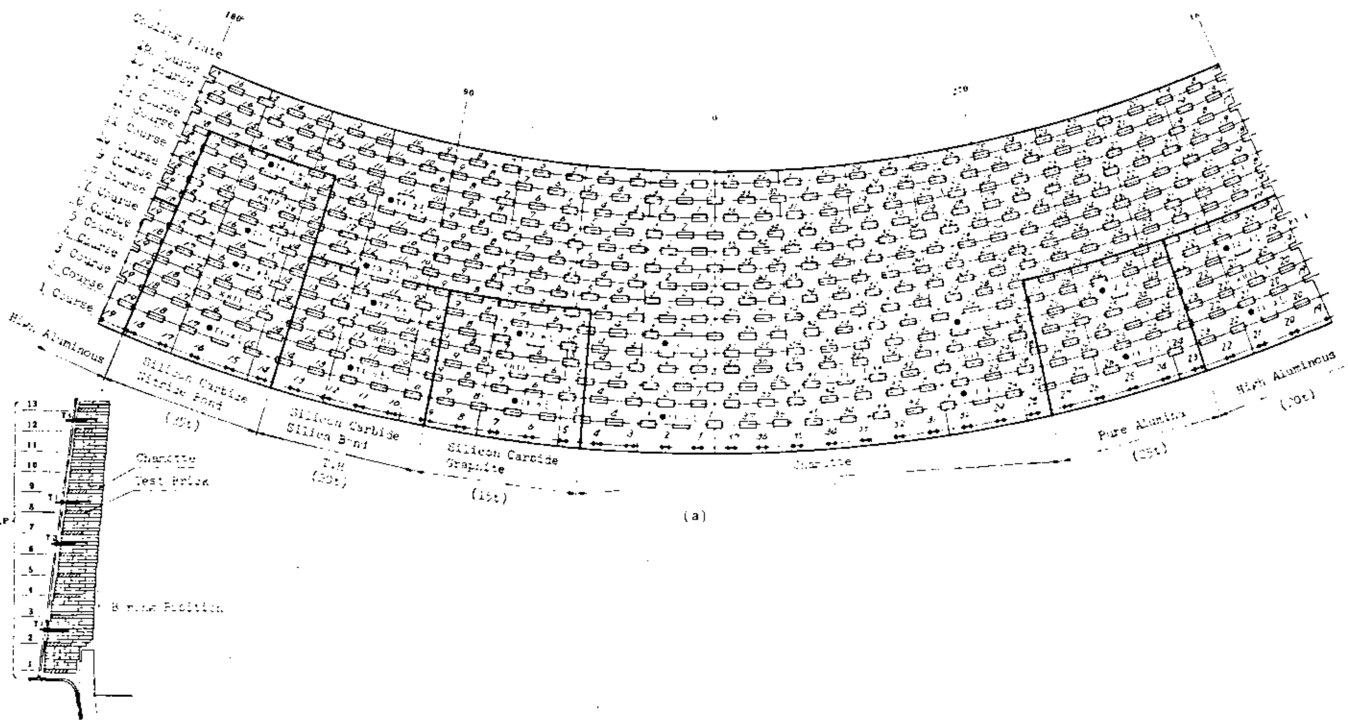
Designers of combustion equipment must also concern themselves with ash properties and their influence on slagging and fouling. Ash behavior from one coal to another varies over a wide range depending on the composition. This is critical to furnace performance, particularly if the design is not matched to ash properties. Behavior in the furnace is primarily responses to the sintering phenomena that occur at temperature ranges between 1400 and 2000° F, slag and clinker formation at ranges between 1800 and 3000°F, and the volatilization of alkalies in the 2000 to 3000°F range. Since the alkalies, sodium and potassium, are subject to vaporization at flame temperatures, the vapors are primarily responsible for the buildup of sintered deposits as they condense at cooler gas temperatures in the convection sections. *ASTM Standardization News, March 1978.*

AUTOMATION IN DIECASTING: AN OVERVIEW

Mechanization of the diecasting process has made steady progress over the years. Techniques to mechanize many aspects of the process now can be brought together to provide true automation in the not too distant future. However, automation may not be for every diecasting, since the cost today of quality labor, skilled maintenance labor, and capital equipment are exerting significant pressures in the direction of more widely utilized automatic diecasting production.

To achieve effective automation, a systems approach is usually required. All aspects of the process and its auxiliary services require careful planning. For example, material flow, including parts removal, scrap removal, and return metal feed, must be considered. Conveyor systems sometimes have been planned, only to have it develop later that they isolated the casting machine so effectively as to make it dangerous or difficult to get dies and materials in and out of the casting area. *Foundry Management and Technology, April 1978.*

Layout of test panel in lower stack linings: a—location of test panels, b—vertical section, •—thermocouple and ⊗—RI.



NEW APPROACH TO BLAST FURNACE STACK LININGS

Blast furnace walls are subjected to temperature, pressure and atmosphere gradients from the hearth to the top and are exposed to different wearing conditions.

Areas which are particularly susceptible to wear are the lower stack, belly and upper bosh. To improve refractories, it is necessary to first clarify the mechanism of wear.

Results of tests carried out on blown-out blast furnaces are as follows:

1. Wall refractories are embrittled by penetration of foreign components of which there are three types: alkalies, zinc and carbon.

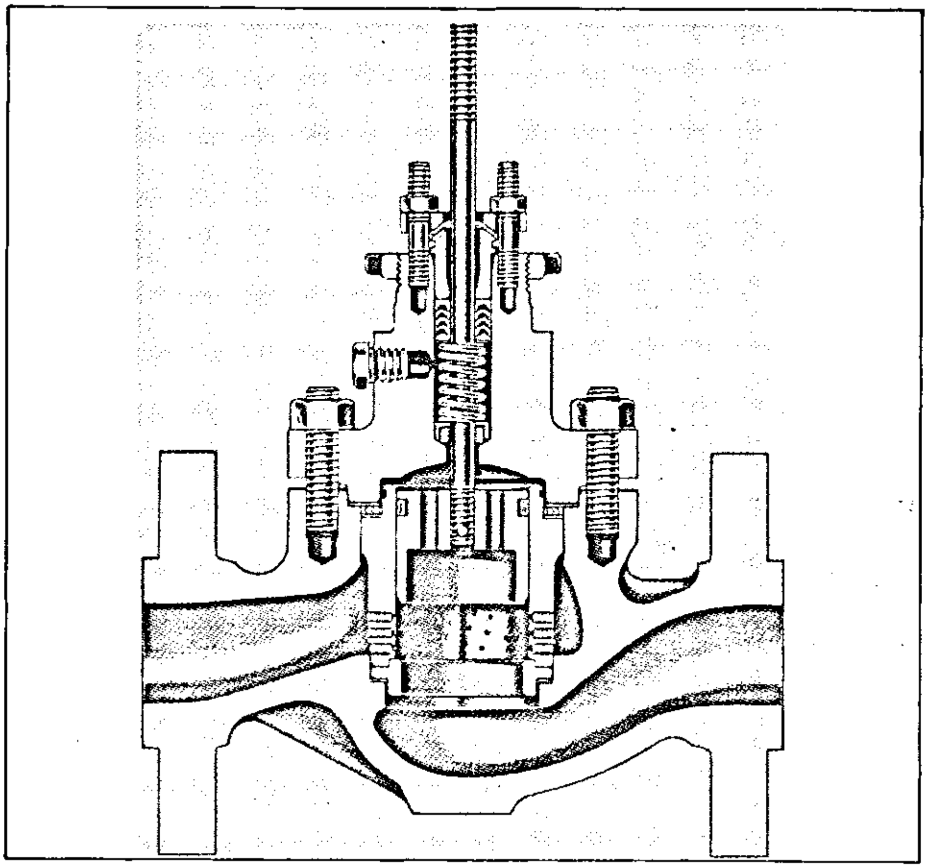
2. Of the foreign components, alkalies and carbon are uniformly distributed in the direction of furnace height; zinc is locally deposited. There is a correlation between alkali and carbon deposits. Alkali and carbon deposits are large on the hot-face side and are more prevalent in the lower stack where wear is more pronounced.

3. The degree of deterioration of refractories is proportional to the deposition of foreign components. Failures related to the deposition of foreign components are cracking, microtexture destruction and bursting by the formation of minerals of alkali compounds.
Since alkali vapors were first determined to be the cause of wear of blast furnace refractories, search has been undertaken for a testing method which can simulate property changes in actual furnace linings. The result is a new alkali vapor testing method which provides quantitative evaluation in the laboratory. *Iron and Steel Engineer, June 1978.*

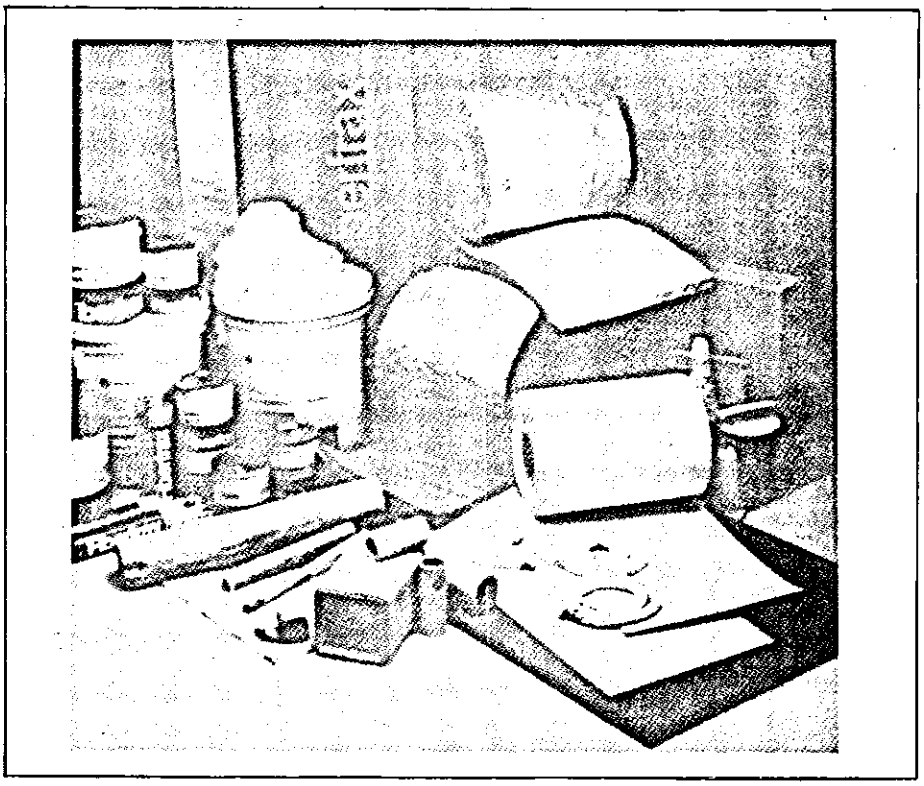
ENGINEERING NOISE CONTROL IN THE STEEL INDUSTRY

Potentially hazardous noise levels are produced by many steel making, shaping and fabricating operations. In most cases, these hazardous noise levels are presently being controlled through the use of personal hearing protective equipment, such as ear plugs or ear muffs. However, the proposed revision in the OSHA Noise Exposure Regulation states specifically that engineering controls must be used to eliminate excessive noise exposures. It also states that engineering controls must be utilized even though noise levels are not reduced sufficiently to meet compliance, and that research and development must be conducted by industry to develop methods for noise reduction where technology does not presently exist.

Some recommended methods for noise reduction are: 1) reduce the noise levels at the source; 2) block the transmission path of the noise; and/or 3) reduce the



Quiet control valve design on the cold blast line experienced a 10 dbA noise reduction.



Made from the basic bulk fiber material, ceramic fiber is available in many forms — blankets, felt, textiles and many others.

reverberant level of the noise. These methods represent the proper approach, however, each individual noise problem must be analyzed to determine which method (or methods) needs to be used to eliminate the problem in the most efficient manner.

Usually, this requires that the relative importance of each noise source in an area of concern be determined so the noise reduction obtained as each source is controlled can be predicted. For example, noise control materials applied to a secondary noise source will result in little or no noise reduction in the area of concern. *Iron and Steel Engineer, June 1978.*

CUT COSTS AND SAVE FUEL WITH CERAMIC LININGS

As has been found over a five-year period, ceramic fiber blankets and felts have thermal insulating properties roughly twice as good as conventional insulating refractories. Thus, a new or replacement lining can achieve reduced shell temperatures resulting in significant fuel savings from reduced heat losses. In older units suffering from excessive heat losses due to deteriorated refractory linings, a replacement ceramic fiber lining can cut such losses by as much as 50%. In many units, this means an actual fuel savings of several percent.

Typically, most new and replacement linings provide a shell temperature of 160°F to 200°F. With ceramic fiber, this can be achieved by using roughly half the thickness usually required with insulating refractories. As an example, a typical primary reformer designed for continuous operation at 2000°F would require about 10 to 12 in. of conventional insulating brick to get a 200°F shell. With ceramic fiber, only 6 in. are needed.

This leads to another advantage. Because ceramic fiber linings generally have an overall density of only 6 to 8 lbs/cu. ft. and the lining thickness needed is only about half, the overall weight is about 15 to 20% that of a conventional insulating refractory including all necessary anchors and hardware. This is important when you consider the reduction in steel costs and the ease of handling on the job site. Repairs to convection sections, hot gas ducts, and stacks become easier and less expensive. *Industrial World, February 1978.*

domestic prices

TABLE I
DOMESTIC RETAIL METAL PRICES
(In Philippine Pesos)
December 1978-February, 1979

ITEMS	UNIT	PRICE
G.I. Roofing Sheets:		
Corrugated, Gauge # 26 x 32"	Linear ft.	₱ 5.10
Corrugated, Gauge # 31 x 32"	Linear ft.	3.15
Plain, Gauge 26 x 36"	"	5.10
Aluminum Sheets (1100 Alloy):		
.016 x 36 x 8'	Sheet	60.70
.019 x 36 x 8'	"	71.10
.024 x 36 x 8'	"	88.75
.027 x 36 x 8'	"	99.75
.032 x 36 x 8'	"	117.45
Square Bars, 20' :		
3/8" x 3/8"	Each	14.50-15.00
1/2" x 1/2"	"	20.00-22.00
5/8" x 5/8"	"	37.00-38.00
1" x 1"	"	Unquoted
Round Bars, 20' :		
1/4" (5mm)	Each	4.50-5.00
3/4" (std.)	"	42.00-43.00
3/8" (9mm)	"	11.50-12.00
1/2" (11mm)	"	19.50-21.00
5/8" (14mm)	"	28.00-30.00

TABLE I
DOMESTIC RETAIL METAL PRICES
(In Philippine Pesos)
December 1978-February, 1979

ITEMS	UNIT	PRICE
Angle Bars, 20' :		
1/8" x 3/4"	Each	₱ 22.00-23.00
1/8" x 1"	"	28.00-30.00
3/16" x 1"	"	36.00-38.00
1/4" x 1"	"	47.00-48.00
Flat Bars (mm. size) 20' :		
1/8" x 3/8"	Each	10.00-12.00
1/8" x 1/2"	"	11.00-12.00
3/16" x 1"	"	25.00-26.00
1/4 x 1/2"	"	19.00-20.00
Galvanized Iron Pipes (Ordinary) 20' :		
1/2"	Each	39.00-40.00
3/4"	"	56.00-58.00
1"	"	80.00-82.00
1-1/2"	"	135.00-140.00
2"	"	170.00-175.00
Black Iron Pipes, 20' :		
1/4"	Each	₱ 41.00-42.00
1/2"	"	35.50-36.00
1"	"	60.00-65.00
1-1/2"	"	115.00-120.00
2"	"	140.00-150.00

Source: Bureau of Domestic Trade
Ministry of Trade
Quezon City, Philippines

TABLE 2

Japan Monthly Average Price
(In U.S. $ per M.T. unless otherwise indicated)
December, 1978–February, 1979

IRON & STEEL	December	January	February
Round Bar, 9 mm	312.36	316.07	317.32
16 – 25 mm	314.09	319.07	320.27
Flat Bar, 6 x 50 mm	316.67	345.54	353.56
Equal Angle, 6 x 50 mm	322.15	330.39	329.96
10 x 90 mm	328.05	340.88	339.02
Channel, 6 x 65 x 125 mm	341.93	335.07	345.13
H – Shape, 9/14 x 250 x 250 mm	438.98	439.04	433.62
Hot – Rolled Sheet (3 x 6), 1.6 mm	481.61	483.94	479.98
Cold – Rolled Sheet (3 x 6), 1.2 mm	481.03	491.42	490.94
Medium Plate, 3. 2 x 3 x 6	470.91	471.59	465.23
Plate, 6 x 4 x 8	456.76	456.19	450.06
9 x 4 x 8	450.33	449.78	445.00
Gas Pipe (black), 15A (1/2 inch) (per kg)	.49	.49	.49
Water Pipe (white) 15A (1/2 inch) (per kg)	.71	.70	.69
Galvanized Sheet			
(plain), 0.30 mm	607.06	605.17	609.91
(corrugated), 0.25 (per sheet)	1.92	1.91	1.88
Wire Rod, 5.5 mm	102.19	102.16	102.16
Round Nail, 100 mm (4 inches)	536.89	548.43	547.40
Iron Wire, No. 8	498.33	506.58	505.26
Annealed Iron Wire, No. 8	479.33	483.09	480.40
Barbed Wire, No. 14	707.85	707.34	697.84
Tinplate, 90 L (0.257 mm)	615.46	612.77	605.30
Wire Rope – JIS (per 200 m)			
Ist Grade, zinc coated (24 x 6)			
10 mm	2.12	2.17	2.14
20 mm	560.44	558.69	558.19
NON – FERROUS METALS (per kg)			
Electro. Copper	1,643.40	1,700.30	1,984.80
Electro. Zinc	792.63	811.40	833.16
Electro. Lead	924.69	1,014.10	1,096.91
Tin	15,033.42	14,488.73	14,864.40
Antimony	3,404.46	3,078.67	3,388.00
Nickel	6,169.67	6,150.67	6,068.20
Selenium	5,912.69	5,894.50	5,815.37
Bismuth	1,336.76	1,230.16	1,213.64
Cadmium	10,308.48	10,233.50	10,138.97
Mercury	2,793.48	2,938.69	3,034.11
Aluminum	1,428.88	1,446.66	1,492.19

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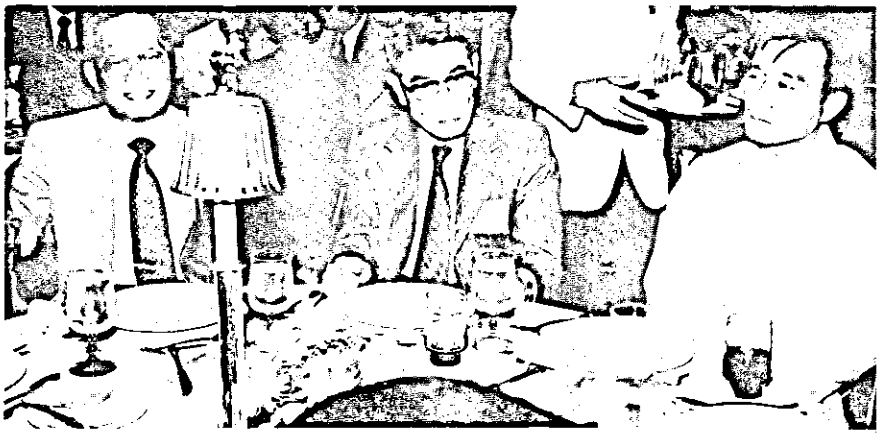
THREE STUDY MISSIONS VISIT MIRDC

The World Bank, NSC and KSC of Japan, and MIDC (Indonesia) sent study mission arrived last February 4 February for various purposes, among which are assessment of the status of the metals industry in the country, its capabilities in setting up an integrated steel mill, and the industry's research and development practices. Their activities included close coordination with the MIRDC as well as plant visits in Metro Manila and the provinces.

The 13-man Japanese feasibility study mission to the Philippines last February 4 and conducted a final review on the Philippine integrated steel mill. The mission covered all the pertinent areas, namely: raw material, infrastructure, demand forecast, finance, plant planning, production control, hot strip mill, cold rolling, and steel making.

Leading the mission was Toshihiko Ariga of NSC, assisted by Shohei Sato of KSC. The members were Akira Oda, Hisao Shimizu, Fujio Yamaguchi, Akira Tsujigami, Hidetsugu Nishimura, Shinsuke Hashimoto, Toshiaki Sakaguti, Yoshihiko Yoshihara, Michio Ookubo, Yoshiki Tajiri, and Yukitoshi Nagasawa.

This feasibility study mission was arranged by the Ministry of Industry and the Metal Industry Research and Development Center (MIDC), both of which will be taking an active hand in the development of the first integrated steel mill in the Philippines.



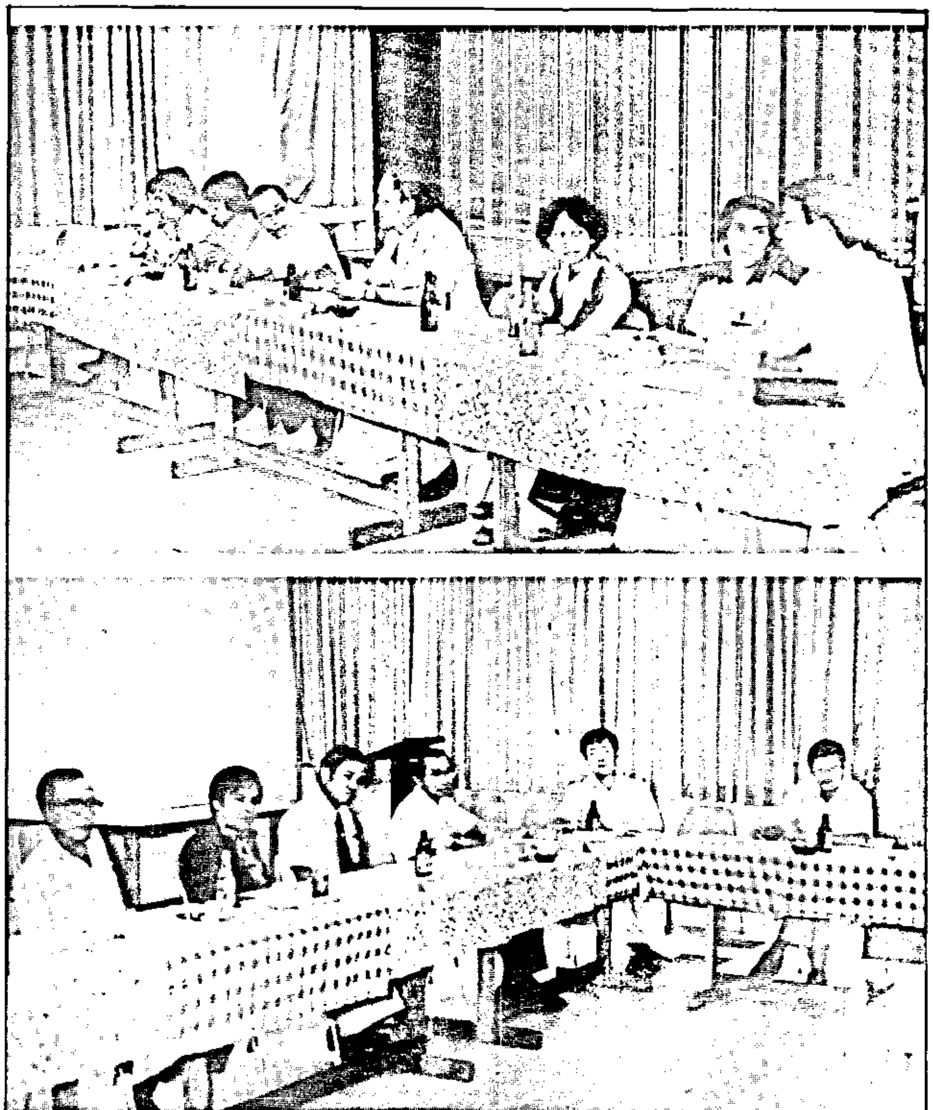
Members of the Japanese Final Feasibility Study Mission met with the Philippine Counterpart Team during their visit to the country to discuss the completion of the report on the setting up of the Philippines' first integrated steel mill. Shown (above) are Dr. Antonio V. Arizabal, Shohei Laito (Kawasaki Steel Corp.), Yukitoshi Nagasawa (Japan Int'l Cooperation Agency), (below) Nicanor C. Villaseñor, Jr., Toshihiko Ariga (Nippon Steel Corp.) and Juanito C. Fernandez (Bureau of Mines).

The World Bank Mission, headed by Barend A. de Vries, arrived last February 5 for a 3-week visit. The mission was conducted primarily to see whether the industrial community of the Philippines can be opened up and redirected towards the continuance of export activities and utilization of labor. Also, the mission aimed its efforts at pinpointing the industries that would effectively absorb labor, and a formulation of a basis for the relocation of investments.

Assessing the engineering and metal working industry were Harry Choi and Yung Whee Ree, while William O'Neil handled the primary metals industry.

The group conducted plant visits to MIRDC, other plants around Metro Manila, and three companies in Cagayan de Oro and Iligan. Highlighting their study were meetings with the Automotive Industry Board, the Automotive Manufacturers' Institute, Inc., Philippine Shipbuilders Association, and representatives from the metalworking sector and the metalcasting industry (Society of Manufacturing Engineers, Philippine Foundry Society, and the Metalworking Industry Association of the Philippines).

During the following week, a 4-member mission from Indonesia conducted a comparative study on research and development management in the country, dwelling particularly on the role played by the MIRDC as intermediary between the various metals and allied engineering industries and the government sector.



Shown are members of the World Bank Industrial Sector Mission meeting with members of the Philippine Foundry Society, Society of Manufacturing Engineers, Metalworking Industries Association of the Philippines and MIRDC to pinpoint problems affecting the metalworking and light engineering sector, in order to provide for a redirection of assistance in the local industries.

The mission was composed of Effendi Sudarsono and J.M. Peter Ohello, Chiefs of Rand D Division, Metal Engineering, Ind., S. Haroon Rasjid, Head, Division of Industrial Development, MIDC, and Afandi Dachlan, Director, MIDC.

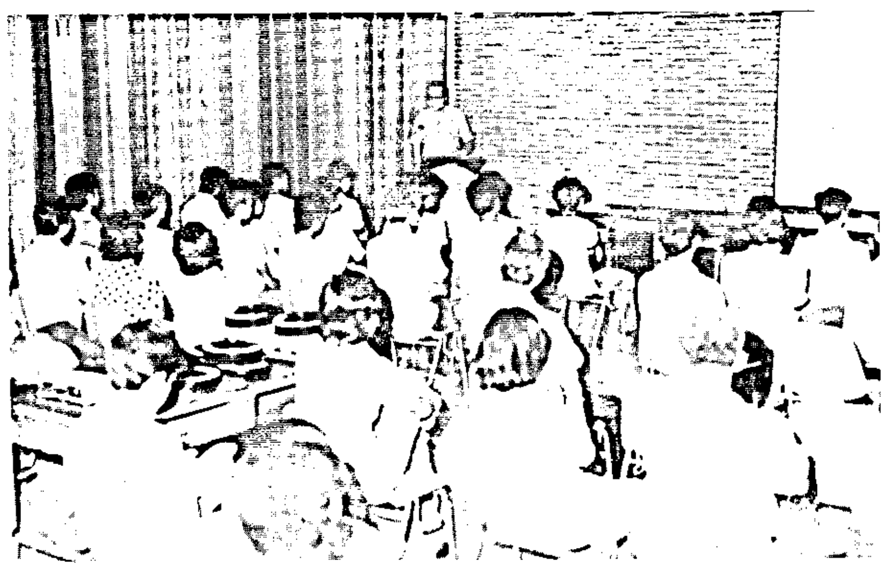
The group stayed from February 12-17, conducting plant visits to the NIST, NSDB, the U.P. Metallurgical Laboratories in Diliman, Quezon City, and manufacturing firms around Metro Manila which are affiliated with the MIRDC.

FRENCH GOVERNMENT DONATES EQUIPMENT

The French government, represented by the French International Technical Cooperation Agency (ACTIM), donated a set of instrumentation equipment last February 22, 1979 to the Metals Industry Research and Development Center (MIRDC). The formal turnover ceremonies were held at the MIRDC instrumentation laboratories in Bicutan, Taguig, Metro Manila,with French Ambassador Rafael-Leonard Touze in attendance.

The instrumentation equipment includes: electronic indicating controller; potentiometer indicator; pneumatic indicating controller; pneumatic miniature recorder: and Pyromat temperature indicator.

Among those present during the turnover were Jack Vattaire, ACTIM Chairman, Dr. Melecio S. Magno, NSDB Minister, and Dr. Antonio V. Arizabal, Executive Director of MIRDC.



Top: Dr. Arizabal, Executive Director of MIRDC is shown with Chairman Melecio S. Magno of NSDB and French officials during the formal turnover of the instrumentation equipment donated by the French government to MIRDC.

Bottom: Benjamin T. Damian, Assistant Executive Director for Technical Operations of MIRDC, briefs the incoming technician trainees held in Bicutan, Taguig, Metro Manila.

ARIZABAL ATTENDS ASEAN-EEC CONFERENCE

Dr. Antonio V. Arizabal left with the Philippine delegation led by Industry Minister Vicente T. Paterno last February 24, 1979 to attend the Second ASEAN-EEC Industrial Cooperation Conference in Jakarta, Indonesia.

The conference was participated in by government and private sectors of both the European and ASEAN countries, for the purpose of bringing about practical and substantive business discussions among participants. Pertinent areas covered by the conference for the metals and allied engineering industries were: the electrical and electronic industry; precision engineering; chemical industries; and machinery and metal engineering.

NEW TRAINEES BRIEFED

The MIRDC held a briefing for 23 incoming technician trainees last March 22, 1979 in Bicutan, Taguig, Metro Manila. These trainees will undergo a four-year course for technicians in all areas of the foundry, heat treatment, and materials testing and inspection operations.

Taken up during the briefing were objectives of the MIRDC technician training program, the technician training contract, and personnel policies and trainee benefits. Giving a comprehensive over-view of MIRDC was the institutional slide presentation, which was incorporated into the briefing program.

Among those present to welcome the trainees were: Atty. Jose G. Bautista, Jr., Assistant Executive Director for Administration; Benjamin T. Damian, Assistant Executive Director for Technical Operations; Atty. Chita O. Angeles, Legal and Policy Counsel: Beatriz D. Orinion, Manager, Management Services Department; and Rosa G. Tejada, Manager, Information and Training Department.

SEMINARS

A seminar on "Mechanical Testing of Metals and Metal Products" was held last Februarv 12 to 16, 1979 at the MIRDC seminar room, 5th Flr. Ortigas Bldg., Ortigas Ave., Pasig, Metro Manila.

The course was an introduction into the basic principle and methods of mechanical testing. It also dealt with the application of various testing techniques in quality assurance, materials research and development work, and scientific testing. The course was designed for engineers and technicians involved in destructive testing of metals and metal products.

The MIRDC resource speakers were: Tagumpay P. Cruz, supervising mechanical metallurgist, Wilfredo L. Balmores, testing and inspection engineer, and Emiliano O. Amparo, mechanical metallurgist.

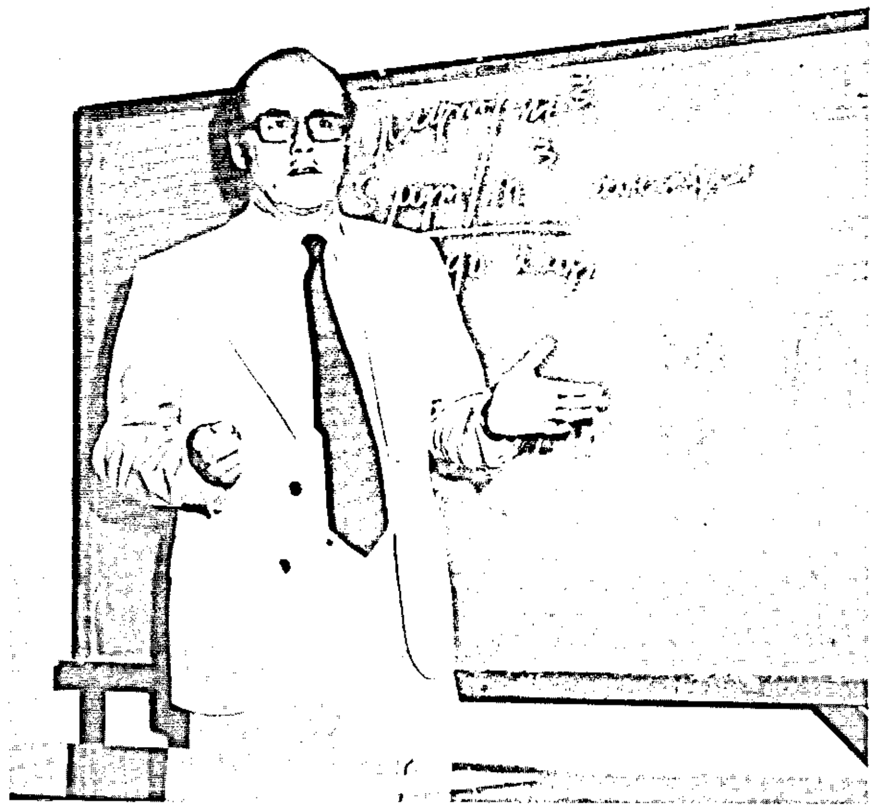
The Metals Industry Research and Development Center now offers training courses on industrial measuring instrumentation and process control, designed to suit a wide range of applications in industries such as metals, chemicals and petrochemicals, paper, sugar, cement, glass and food.

These training courses deal with temperature measurement and control, flow measurement and conrol, principles of automatic process control, control valves and process control, trouble shooting and fundamentals of operational amplifier.

In this series of courses, lecturers will be composed of the MIRDC instrumentation staff headed by Robert Fardin, instrumentation engineering adviser, and Emmanuel Dayo, head of the industrial instrumentation group.

The first course, dealing with pressure measurement and control started last March 5-9, 1979. Topics were: physical principles of pressure and measurement; pressure measuring devices (vacuum to H.P.); indicators, receivers and transmitters; installation of pressure measuring instruments; and principle of automatic pressure control. Lectures and laboratory work were held at the MIRDC Laboratories Bldg., NSDB Compound, Bicutan, Taguig, Metro Manila.

Dr. Brian Hickman, Director General of the Australian Lead and Zinc Associations and concurrent Vice President of Zinc and Lead International Service, conducted a seminar last March 2, 1979 on "Occupational and Environmental Health Effects of Lead." This was conducted in cooperation with the MIRDC Seminar Coordination Section, and was held at the MIRDC Seminar Room.



Shown is Dr. Brian Hickman, Director General of the Australian Lead and Zinc Associations and concurrent Vice President of Zinc and Lead International Service, speaking in connection with the seminar on "Occupational and Environmental Health Effects of Lead," held at the MIRDC Seminar Room.

Among the topics covered were exposure limits, air monitoring requirements, methods of compliance, and implementation times. All the areas discussed were in relation to the OSHA Occupational Standard for Lead, which directly benefits and safeguards the health of employees directly exposed to the hazards of lead technology.

ARRIVALS/DEPARTURES

Eight machinists, one welder III and three engineers left during the first quarter of 1979 under the various technical assistance programs extended to the MIRDC.

The machinists will undergo a 23-month extensive training program on machine tool manufacture and mold & die manufacture in West Germany, under the auspices of the MIRDC- German Technical Assistance Program. For machine tool manufacture, the trainees are Saturnino de la Cruz, Herminio Josef, Rodelio Lamban, Pedro Queddeng, Roger San Juan, and William Tabin. Fernando Rafols, Jr. and Alberto Salandanan underwent a 33-day training on modern & die manufacture. All eight trainees left last January 4, 1979.

Sand engineer Melba M. Valdez underwent a 33-day training on modern foundry technology using local materials under the joint research project sponsored by MIRDC, AIST and MITI, Japan. She will be staying in Japan from February 22 to March 26, 1979.

In the meantime, two trainees will be leaving in April for Austria on a program for instruction on welding technology. This 3-month program is under the MIRDC-Austrian Technical Assistance project. The trainees are Aristeo Mercado, welder III, and Feliciano Dungca, junior engineer.

Assistant engineer Edgardo B. Lopez, Jr. left last March 24 to undergo training on mechanical maintenance for engineers in Texas, USA. This 6-month training is under the auspices of the United Nations International Development Organization (UNIDO).

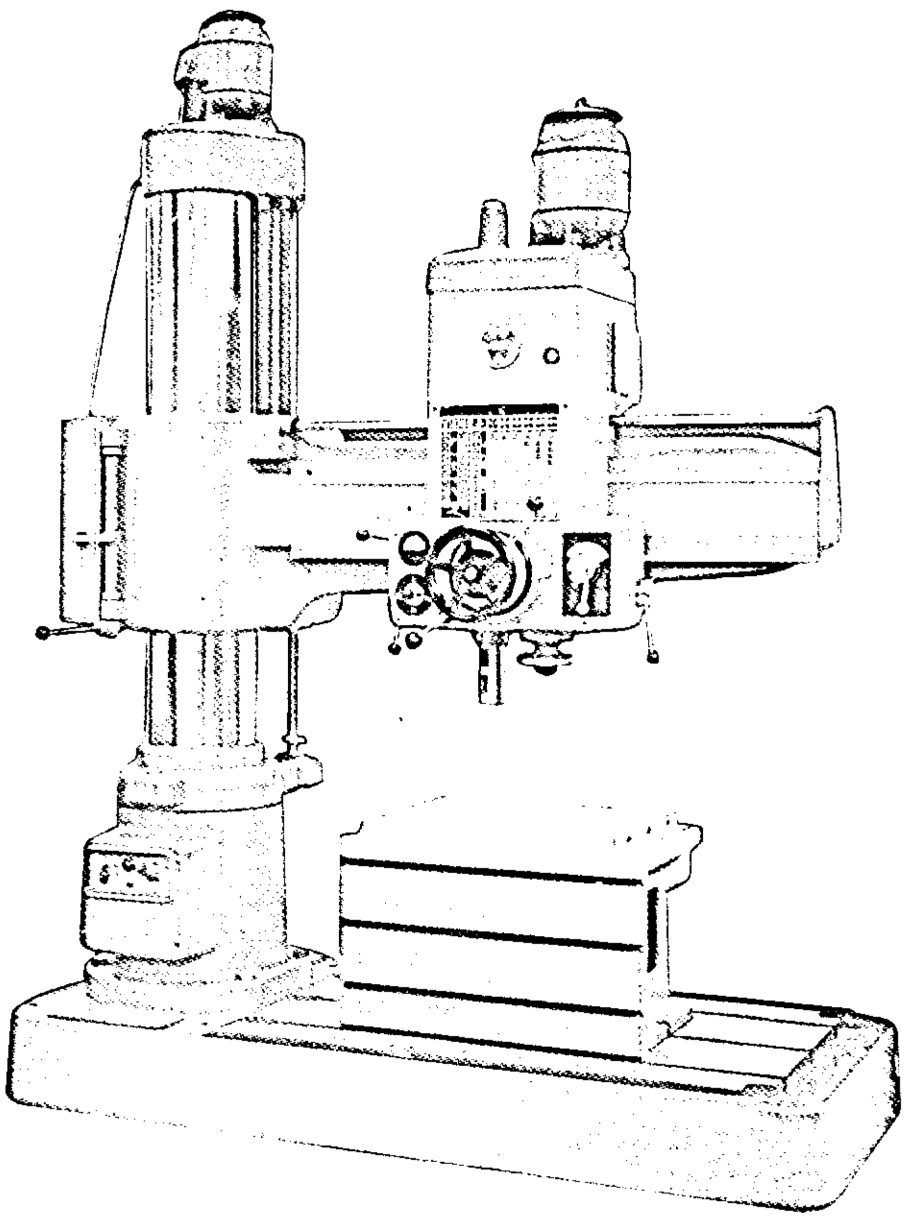
Benedicto Contreras, Jr., technical inspector I, recently arrived after six months of training in metrology and quality control inspection in the UK and Switzerland as a UNIDO/ UNDP program grantee. **PM**

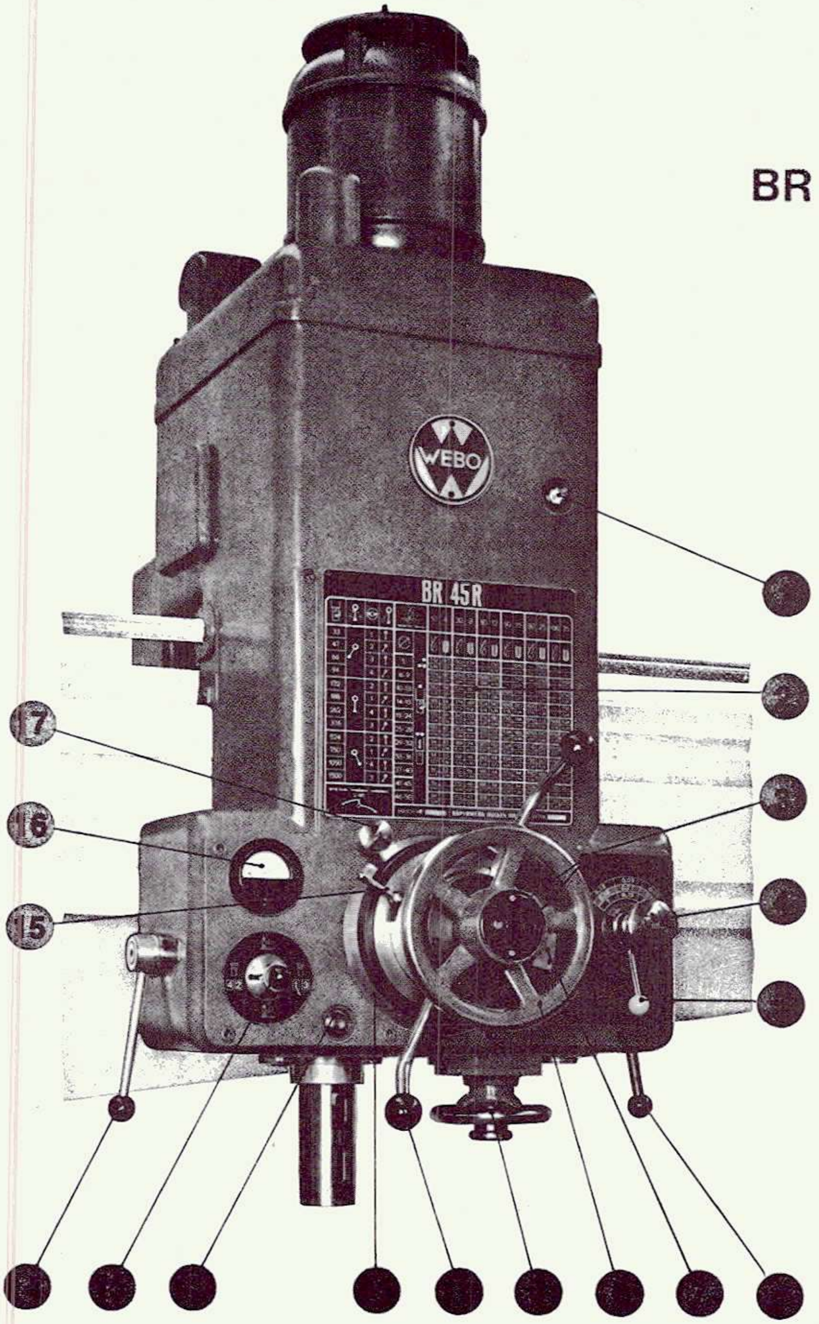
WEBO BR 50 RADIAL DRILLING MACHINE

The WEBO BR 50 Radial Drilling Machine is now being utilized by MIRDC's Mechanical Workshops and Training Department in Bicutan, Taguig. The BR 50 is only one of several fast, reliable, high-powered, and precise drilling machines in the WEBO line.

The machine features a 6-speed gearbox with pole changing motor which provides 12 spindle speeds. Aside from this, the machine also has:

- Multi-disc reversing clutch with 1.4-fold left-hand speed
- Bracking in neutral position of reversing clutch
- Large feed range through 9-step feed gearing
- Feed range of either .06 – 1mm/rev or .12 – 2 mm/rev
- Precise feed engagement and disengagement through solenoid clutch and gearing brake
- Easily movable drilling head moves on ball bearing rollers running on steel gibs
- Easy and sensitive pivoting of radial arm, due to roller bearing supported outer sleeve of column
- Secure and precise clamping of arm drilling head
- Time-proven arrangement of controls
- High drilling performance through rigid construction
- High-powered drive and sturdy drilling spindle with nitrided spindle sleeve





BR 35/45/50 controls

① Oil circulation sight glass

② Speed Table

③ Double push-button switch for electric clamping (special equipment)

④ Feed selecting knob

⑤ Selecting lever determine the feed group

⑥ Multi-disc clutch with brake for clockwise and counter-clockwise rotation

⑦ Vernier for drilling depth release

⑧ Hand wheel for traversing drilling head on the arm

⑨ Hand wheel for fine adjustment of the spindle

⑩ Hand levers high-speed spindle adjustment and feed engagement

⑪ Drilling depth scale

⑫ Oil sight glass

⑬ 4-way switch for movements of the arm "UP" – "Down" and motor speed "SLOW" – "FAST"

⑭ Main drive change lever

⑮ Lever for drilling depth setting

⑯ Ammeter

⑰ Feed release knob

new arrivals

MIRDC library

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NACE: NACE Publications 3H156	:	Some considerations in the economics for tanker corrosion.
NACE: NACE Publication 3D170	:	Modern electrical methods for determining corrosion rates.
NACE: NACE Publication 3A164	:	Problems in the use of corrosion inhibitors in automobile engine cooling systems.
NACE: NACE Publication 5A151	:	Materials of construction for handling sulfuric acid.

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Through the EEI Foundation, we are spending nearly ₱4 million annually for technical scholarships as well as for operation of our own skills training centers all over the country.

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Orders	217.5 million	635.5 million
Earnings	13.2 million	95.3 million
Payroll & Fringes	15.6 million	62.5 million
Taxes Paid	9.4 million	13.9 million
Employees	2,872	8,260

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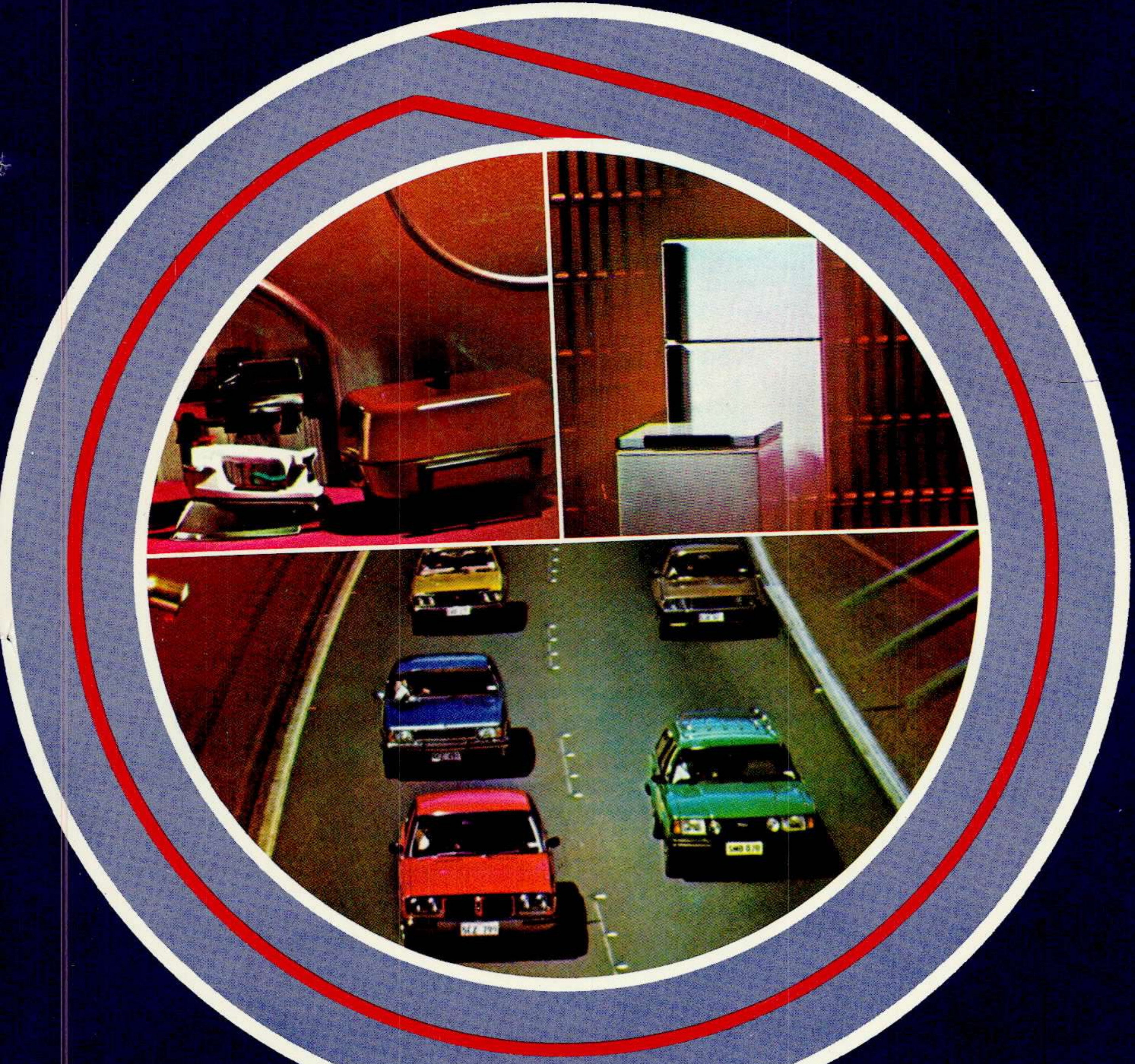
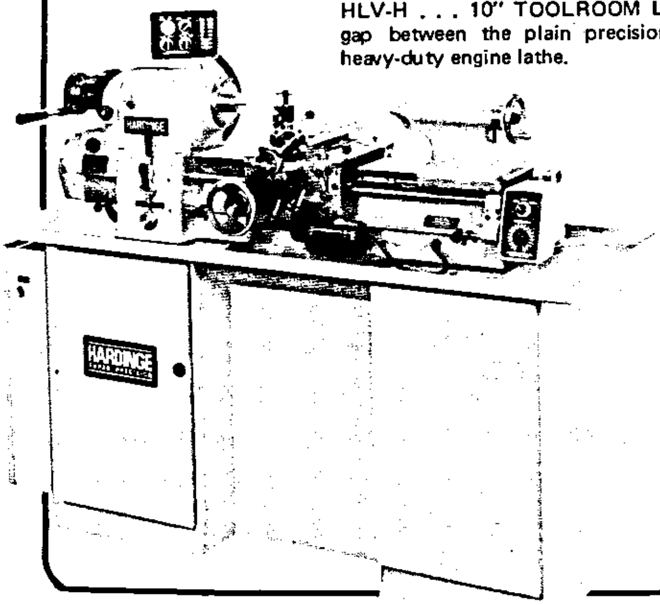
PHILIPPINE metals





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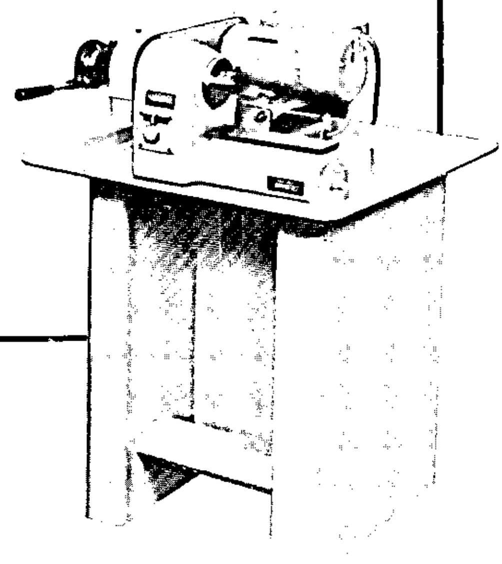

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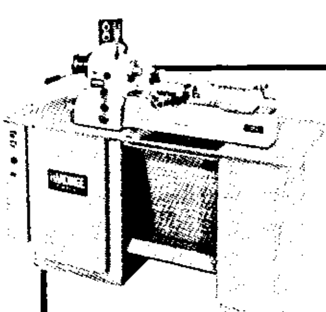

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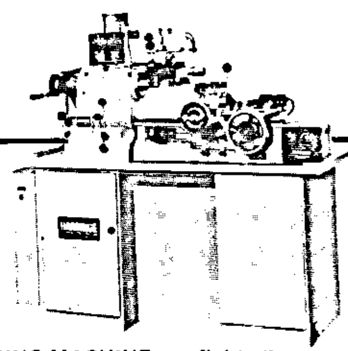

HC-AT . . . This CHUCKING MACHINE can finish diameters, shoulders and end faces, and cut precision threads in one setting. Produces closer tolerance parts on a production basis.

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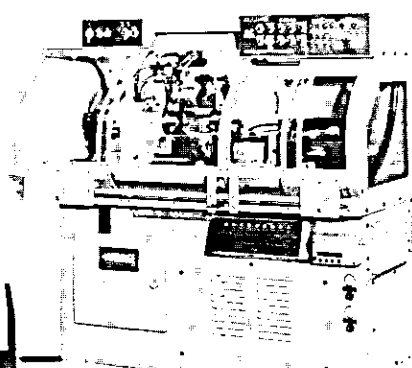

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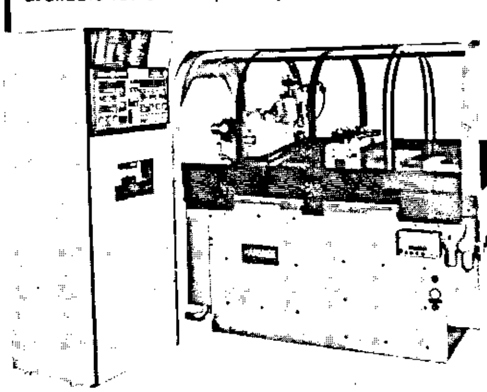

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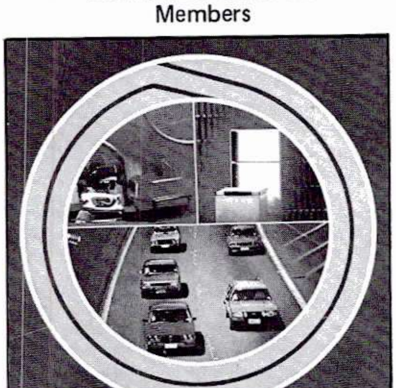

On the Cover: Bundy Pacific Tubing (Phils.), Inc. fabricates Bundyweld steel tubing into various shapes for use in the automotive, appliance, construction, farm machinery, chemical and food processing industries.

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THE METALS INDUSTRY TODAY

**Speech delivered by Minister Vicente T. Paterno during the opening ceremonies of the "First Metals Industry Show 1979".*

I am indeed happy and proud to be here today, on the opening of the "First Metals Industry Show 1979", an exhibition which emphatically aims to portray the distinctive capability of the Filipino in the metals industry. It is unfortunate that little is known about the extensive industrial progress we have achieved in the past twenty years in this sector. This exhibition project is one earnest move by the private sector to dispel this pervading ignorance, which has, in no small measure, slackened our national effort towards industrialization.

The promotion of our country's industries has never been before given as much priority by the government as in the passing decade. This has been spurred by the unsettling oil crisis, worldwide inflation and serious recession in the country's trading partners, which caused mounting repercussions in our economy. In solving these economic dislocations, the government has vigorously pursued its industrial development programs, for this indeed plays a critical role in a nation's struggle for economic progress.

The metals industry in our country occupies a vital position in the nationwide move towards industrialization. As we have seen from several studies made, this industry serves as a strategic parameter of a country's social and economic development. This is so because it encompasses many other industrial sectors such as the automotive, appliance, agriculture, construction and machinery sectors. To put it more explicitly, any development in the level of industrialization requires, ultimately, linkages with these various sectors.

In our country today, there are approximately 2,000 metalworking firms with a total labor force of more than 50,000. With a heavy concentration of such firms in the greater Manila area, the resulting growth imbalance is being resolved through the gradual dispersal of this industry throughout the country, particularly to the countryside.

The domestic demand for our metals products has increased in the passing years because of the expansion of economic activities and the improved investment climate. Moreover, the domestic manufacture of these products has received greater stimulation from the recent industrialization strategies of the government which emphasize the backward integration of industries, such as the ongoing local content manufacturing program for cars, trucks and motorcycles. It cannot be denied, however, that there is still a big room for development.

On the international scene, our country has to date managed to export considerable quantities of various metalworked products. More than twenty years ago, we had to import most basic iron and steel products. However, the recent expansions in the industry, including primary facilities such as plate mill, continuous casting machines, bar and rod mills, electric and arc melting furnaces brought us more than enough supplies. Some of our country's export markets include Argentina, Nationalist China, Thailand, Turkey, Guam and the US.

Our importation of metal products, however, has continued to claim a dominant portion of the total domestic market. Although this has slowed down through the years, it is still unfortunate in view of our country's industrial potentials which have not been fully tapped.

It is apparent that the metals industry in our country today is beset with problems of varying magnitude. These include financing, shortage of skilled manpower, lack of technology, rising input prices, raw material shortages, product diversification, underutilization of capacity, local competition, and our inability to meet the export market. To combat these problems, the government has drawn out its development programs, as it staunchly pursues its course towards industrialization.

Based on our five-year Philippine development plan for 1978-1982, one of the things which we hope to establish within the spectrum of the metals industry is a chapter devoted to industry, which gives priority to all the industrial development programs that are being encouraged in the context of the planning of all agencies of the government. From this we hope to develop some expertise or specialized skills in the industry. One of the goals which we seek to attain in this aspect is the growth of the transport manufacturing programs, such as the Progressive Car Manufacturing Program.

In addition to this, the government shall pursue a Maritime Industry Development Program, which seeks to build and encourage a shipbuilding industry. Likewise, it shall try to develop greater sophistication and expansion of our industries in the manufacture of machine tools. Our Investment Priority Program, in particular, includes the manufacture of lathes, drill presses, milling machines, wedged grills, mechanical presses and shapers, among others.

We have said before that the metals industry maintains a limelight position in our move towards industrialization. With the expansion and increase in sophistication of other industries like sugar, wood working, textiles, machinery and construction, the demand for all types of machinery and other equipment shall correspondingly increase.

On the development of skills, the government has considerably spent its resources in the implementation of various training programs and the building of technological institutions. There has been, however, a problem on the duplication of training programs by many institutions. To solve this common occurrence, the President issued a letter of instruction in June, 1978 directing the chairman of the Presidential Commission on Reorganization to look into this widespread duplication of efforts. It is hoped that through this, responsibilities shall be delineated and a better efficiency in the conduct of training programs shall be attained.

At present, formal and non-formal training programs are being conducted by the Metals Industry Research and Development Center (MIRDC), the National Manpower and Youth Council (NMYC), the Kabataang Barangay, the Ministry of Agriculture, the Ministry of Labor, NACIDA and other agencies. These programs are well attuned to the knowledge and skills requirements of the trainees and are based on the particular resources of agencies.

The MIRDC, in particular, has been an effective instrument for providing technical services to the metals and engineering industries of the country, having been in operation for the past nine years. Its Mechanical Workshops Department offers training programs on the different aspects of precision machining, tool and die making, metal working, heat treatment, metrology and inspection. Complementing these services, the MIRDC also offers its services to small and medium-scale industries through the use of its laboratory facilities which are equipped with analytical and test instruments for quality control and inspection.

Going back to the major thrusts of the national effort towards industrialization, one of the most important goals of the New Society for the metals industry is to foster an industrial revolution through the promotion of exports. The history of the Philippine economy shows that growth was stunted because of the scarcity of foreign exchange resources brought about by policies that failed to generate exports. To correct this, it is imperative to have the right combination of industrial and agricultural policies that will encourage export and, consequently, foreign exchange. If we can thus effectively create an export-oriented industry that is based on metals, we can have an enlarged share in the growing trade within ASEAN as well as with other western countries. The ASEAN countries have been putting serious efforts at improving coordination of their national industrial and trade policy which has progressed in larger scales since 1975.

I would like to personally congratulate the MIRDC for continuing to link forces with the private sector as exemplified by this First Metals Industry Show.

In the light of all these development programs, the "First Metals Industry Show 1979" comes as a befitting answer to the call for industrialization. By focusing mainly on the local capabilities of our metalworking industries, this exhibition, first of all, shall sow in the general public a better understanding of the extent of science and technology as applied to the metals industry in the Philippines.

As a corollary, the significance of this project lies in the underlying objective to present to foreign investors the export potential of our indigenous products and equipment. Through this medium, we hope to generate foreign exchange earnings, which as I have mentioned earlier, is one objective given major priority by our government. We hope, moreover, that a thorough understanding of our capabilities shall subsequently lead to our country's long-awaited independence from imports.

As we move towards industrial progress in the domestic and international markets however, we cannot leave out the quality standards which we have to impose on our products. The establishment of products standards has been one of the main industrial programs of the government. The Philippine Bureau of Standards, for instance, has adopted the PS Certification Mark Scheme of Inspection, under which the production processes and quality control systems of industrial plants are examined to ascertain whether such are capable of manufacturing products which are of the quality required by the relevant standard.

The Iron & Steel Authority meanwhile has been created to promote, strengthen, consolidate and rationalize the various aspects of the iron and steel industry. Particularly, it has the power to require firms to conform to established standards, including standards on weights and measure, product quality control and pollution control.

It is important to note at this point, however, that the commitment of the manufacturers is the first step to be taken in the drive towards quality assurance. The management should have the intent to take prompt and practical actions to make sure its products are within standards. This is where the role of the private sector assumes greater significance.

Before I end this address, I wish to call on all the youth of today who still have so much to learn about the metals industry. May this exhibit succeed in relaying to you the accomplishments, as well as the needs, of the metals industry. I seek your involvement in this area in the future, not because of the financial remunerations you can obtain from it, but because of what you can contribute to its development. Your contribution to the productivity of our economy through the metals industry would be most needed to achieve for our country a faster pace of growth.

With this, I would like to congratulate the organizers of this industrial exhibition, and all the exhibitors who have participated in this undertaking. I wish to commend particularly the members of the Executive Committee, for determinedly launching this huge project with the main purpose of exposing our industrial capabilities. It is heartening to note that the private sector is indeed doing its role as an active partner of the government in the current drive towards industrial progress. **PM**

The 8th Private Sector-MIRDC Workshop Seminar, the opening of which coincided with the First Metals Industry Show (featured in our "MIRDC News" section) was held last May 18-19 at the Hotel Intercontinental, Manila. The opening ceremonies was well attended by business leaders and entrepreneurs, with Industry Mnister Vicente T. Paterno as the guest speaker. Our editorial this issue features Minister Paterno's message to the local metals industry, urging the sectors concerned to seek unity within the industry in order to promote growth as well as individual interests of small and medium sized firms.

In his message, Minister Paterno stresses the fact that "the metals industry in the country occupies a vital position in the nationwide move towards industrialization. As may be gleaned from several studies made in this area, the industry serves as a strategic parameter of any country's social and economic development. This is because it encompasses many other industrial sectors such as the automotive, appliance, agricultural, construction and machinery sectors."

The second portion of "Recent Developments in Blast Furnace Technology" by C. H. Best of Davy International is presented in this issue, comprising such areas as furnace charging system, hot blast stoves, the bell-less top, gas cleaning and energy recovery, and stoves.

With Davy-Wurth's bell-less top the furnace size is no longer an embarrassment, as the charge can be distributed over whatever diameter of stockline simply by providing a chute of the correct length, with the chute being of relatively low cost and easy to change. The bell-less top also reduces the problem of sealing against high pressures.

Oil-in water emulsions are currently in use as lubricants and hydraulic fluids for a number of applications. The advantages of low price, good thermal capacity, and inflammability make them an attractive choice. However, the complexity of their nature requires rigid control during their preparation and use. Dr. T. A. Dow of Battelle Columbus Laboratories expounds widely on this topic in "A Rheology Model for Oil-in-Water," which shows the results of measurements of film thickness and frictional force in a rolling/ sliding disk contact for a neat oil and emulsions containing various percentages of neat oil. A discussion of the results leads to a model which describes the relative influence of oil and water in the high-pressure contact region.

Cold cleaning and vapor cleaning are the two basic techniques to choose between in selecting a process for rosin flux removal. An understanding of the mechanism, equipment, advantages and disadvantages of each of these alternative techniques is essential in making a suitable process selection for any given cleaning job. An evaluation of the relative merits of these alternative methods and cleaner types can be found in "How to Evaluate and Select Solvent Cleaners for Rosin Flux Removal," by Alvin F. Schneider, Product Engineering Manager of Alpha Metals, Inc. The paper describes various criteria which can be used to evaluate and select solvent cleaners that are effective, economical, safe and compatible with OSHA and EPA regulations. New data on azeotropic properties and flash point measurements are also presented.

"Adaptive Gain Control" by Stephen Maselli of Taylor Instrument Company considers a new approach that enables a wide range of users to take advantage of adaptive control on a wide range of processes. Rather than considering only tighter set-point control, it acknowledges the need for many other goals. Adaptive gain control is used to refer to a situation where a feedback controller's gain is automatically changed. These gain changes can produce many different results depending on what variables are allowed to change the gain and how the controller is tuned. The paper also features sample applications for each goal or benefit.

The second in a series of articles on "Rationalization with Pneumatics" by Werner Deppert of FESTO deals with program-controlled finishing lathe, its sequence of operations, reducing nonproductive time by alternating the working condition, and equipment used to carry out the processes. The program-controlled finishing lathe can finish-machine premachined knob coverings, using a diamond tool to turn the flat surface, outside surface and a chamfer. The sequence of operations includes manual insertion of the workpiece, clamping, longitudinal turning and facing, chamfering, releasing, and manually changing the workpiece. In reducing nonproductive time by alternating the working condition, FESTO's pneumatically-controlled, fully automatic special-purpose drilling machine has an alternating program to drill in eight indexed steps with no idle stroke.

Cayetano F. Ferreria, a consultant of DMG, Inc. touches on a relevant topic in "Bridging the Technology Gap in the Foundry Industry". This involves raising the technology level through overseas training, taking advantage of technology transfer programs as offered in the country by the MIRDC, and additional thrusts in quality control especially for precision castings. Some of the basic problems of the local foundry industry are also dealt with in this paper. In the all-out effort for continued growth, Ferreria recommends the setting up of a properly planned Metalcasting Estate, where all supporting industries can be situated.

Our "Cover Story" for this issue is Bundy Pacific Tubing (Phils.), Inc., which is a joint business venture between Pacific Oxygen and Acetylene Co. and Bundy Tubing Co. (Australia) Pty., Ltd. The company's main line of production is Bundyweld tubing used in automotive, farm machinery, trucks and tractors, refrigeration and air conditioning, gas stoves and ranges, and other unlimited applications. Bundyweld tubing is made from copper coated steel which is rolled to specified inside and outside diameters, then brazed to form a double-walled steel tube.

This issue's feature for "Men in the Metals industry" is Pacificador C. Directo, who is popular within the business sector as the highly enterprising and youthful President and Chairman of the Board of Directric Industries, Inc. Directo's innate determination and will to succeed usually gets him what he wants, because he knows how to work for it. Aside from steering his company towards impressive growth and expansion, Directo spends a considerable part of his waking hours by serving as ex-officio director of the Society of Manufacturing Engineers — Manila Chapter 165, being president of the Capitol Lions (Host) club of Quezon City, District 301-D, occupying the chairmanship of the board of directors for the Association of Philippine Airconditioning & Refrigeration Contractors, Inc., as well as being regular member in several civic and technical organizations.

This quarter brings back "In the Limelight" covering the Tin Can Manufacturers' Association of the Philippines, Inc., which serves as the sentinel for high quality prime grade production of tin cans in the country. The association was founded on the belief that working for consumers' welfare is the key to growth and stability. Thus, aside from rationalizing the price of tin cans, it has also conducted seminars and workshops on the upgrading of the quality of tin cans, specifically food-grade cans, for consumer safety. **pm**

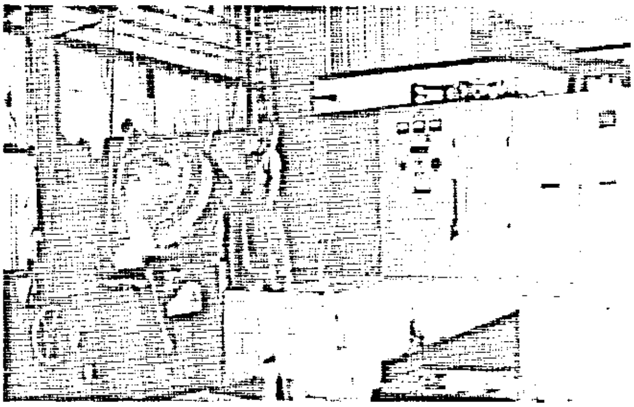
INDUCTOTHERM

Has an induction melting, holding or duplexing furnace to suit any foundry requirement.

VIP POWER-TRAK

Solid state electronic frequency converter for high power density in small to medium size furnaces. Fast melts—maximum alloy flexibility.

Frequencies:	500, 1000, 3000 Hz
Power Ratings:	75 to 2500 kW
Furnace Capacities:	3 to 10,000 kg



TRI·LINE

Solid state transformer-type frequency converter for 180 (150) Hz power on medium size melting furnaces. Ideal for single-shift melting because it features better starting characteristics than a mains frequency unit and eliminates holding molten metal overnight.

Power Ratings:	125 to 3500 kW
Furnace Capacities:	300 to 20,000 kg

MAIN·LINE

Mains frequency coreless melting equipment for low cost, high production melting of gray, nodular, or malleable iron. Best suited to multi-shift production with regular taps of 1/4 to 1/2 furnace capacity. Factory-assembled and packaged for quick installation with minimum space requirements.

Power Ratings:	1000 to 23,000 kW
Furnace Capacities:	3500 to 100,000 kg

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DEVELOPMENTS IN BLAST FURNACE DESIGN (2)

C. H. BEST
Davy Ashmore International

Furnace Charging System

The plant control configuration for a modern blast furnace materials feeding and charging control system is shown in Figure 13. The first level computer undertakes on-line calculations for burden material balance and furnace top discharges. It also communicates material selections of type and weight, bell-less top gate position and discharge pattern to the second level programmable controllers. The functions required in the second level are divided between a number of controllers. This ensures a number of secure zones with controlled system degradation. Separate programmable controllers are included for weighing, stockhouse charging control and furnace top control including material tracking from stockhouse. These controllers undertake all sequence and control functions for their respective areas receiving commands from either a computer or from a desk mounted semi-automatic system.

The weighing system ensures that material weights charged are accurate to the required set point and adjusts for error and coke moisture content. Nucleonic type probe devices are used to generate coke moisture and bulk density measurements.

The stockhouse charging control system sequences and starts belts and feeders filling the weigh hoppers as determined by the charge programme and receiving start/stop signals from the weighing system.

The furnace top programmable controller operates from the furnace stockline, initiating discharges from the ferrous and coke weigh hoppers on to the main charge conveyor. It also transfers material identities and weights and tracks material along the conveyor. The controller also sequences the top hopper, adjusts the gate setting for material type and discharges the material into the furnace. To obtain the desired profile at the stockline it is necessary to correctly programme the selection of the rings to be used and the quantity per ring.

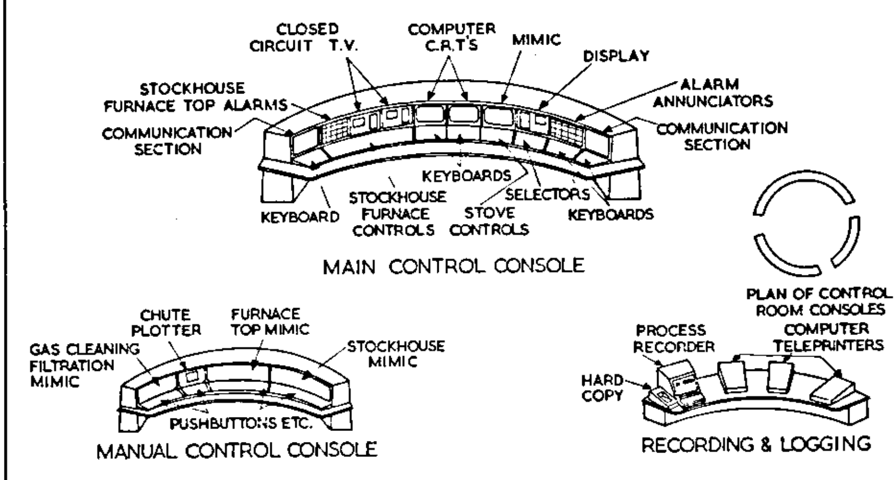


Fig. 13-A CONTROL ROOM CONFIGURATION ORIGINAL CONCEPT

The first part of this paper was published in the January-March 1979 issue of Philippine Metals.

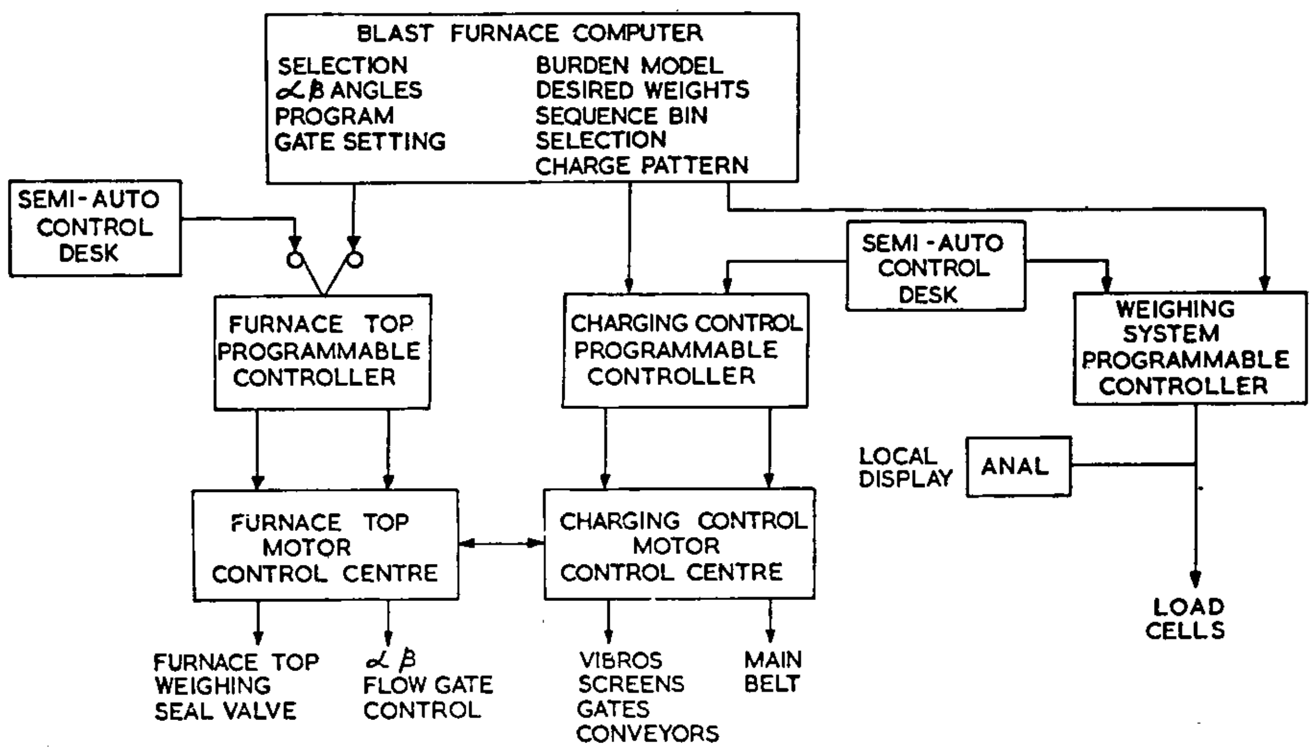


Fig. 13-B CHARGING CONTROL OVERALL HARDWARE CONFIGURATION

Nucleonic type probe devices are used to generate furnace top hopper empty signals.

Hot Blast Stoves

In order to take full advantage of the developments in hot blast stove design it has been necessary to improve the associated control systems. Modern analysis equipment is used to determine the combustion gas calorific value and Wobbe index and for oxygen content in the stove flue gases.

Power actuators are used for valve operation with conventional feedback instrument control loops including cascaded control for gas/air ratio.

Systems based on programmable controllers are used to sequence stove changeover.

Complete automatic staggered parallel operation of stoves is possible using a digital mini-computer.

The control hierarchy for the furnace at Acominas comprises three levels of control; however, in the initial stage only the second and third levels are implemented.

The furnace incorporates a shared display system and the layout of the control room desk is shown in Figure 14.

BELL LESS TOP

"Necessity is the mother of invention." This is an old English proverb which has undoubtedly motivated the invention of the Davy-Wurth "bell-less" top. The top equipment of a blast furnace has two functions: first to distribute charge material inside the furnace, and second to provide an effective seal against furnace top pressure. Traditionally, bells have been used to do this. The double-bell system, known universally as the McKee top, consists of two bells of which only one is open at any time, the other maintaining a seal. This type of top is capable of operation with top pressures up to about .6/.7 bar but is unsuitable for any higher pressure.

The main problem facing designers of high top pressure furnaces is to charge the furnace without excessive wear on seating surfaces with resultant rapid deterioration of effective sealing. Many devices based on the bell principle have been mooted and tried in practice but perhaps the most significant step forward in design philosophy is the differentiation between the two functions of material handling and distribution on the one hand and gas sealing on the other. The result of this has been the use of hard-surfaced seats for bells, gates and chutes which handle flowing materials while soft seats kept out of the way of flowing materials have been used as seals. All the tops that have been developed from the McKee top, and this includes the various Japanese tops which have been specifically designed to operate at high top pressures, embody this concept in varying degrees but it is most fully realized in the Davy-Wurth top, in which the rotating chute replaces the large bell as the distributor and has no sealing function whatsoever, this being taken over entirely by the seal valves placed at the top and bottom of the holding hoppers.

The various types of tops in use today, therefore, divide themselves into three groups quite clearly. First of all there are those using bells for both functions, secondly those using bells and seal valves, and thirdly the Davy-Wurth top which uses a rotating chute for distribution of the

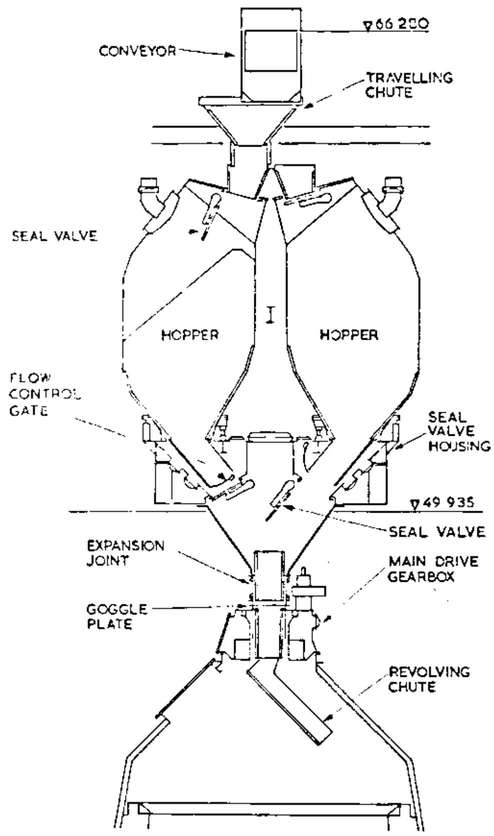


Fig. 14. BELL-LESS TOP, ACOMINAS NO. 1 BF

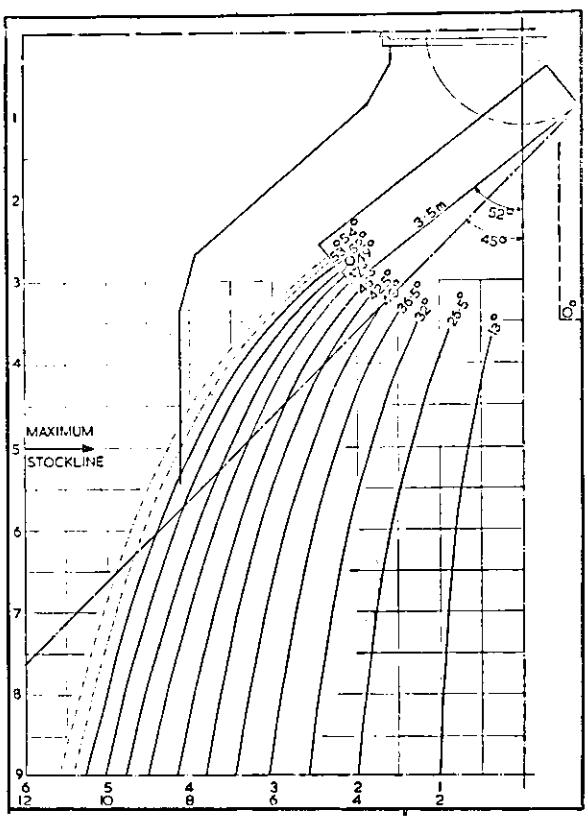


Fig. 15. DAVY-WURTH TOP: EQUAL DENSITY CENTRELINE CURVES FOR CHUTE

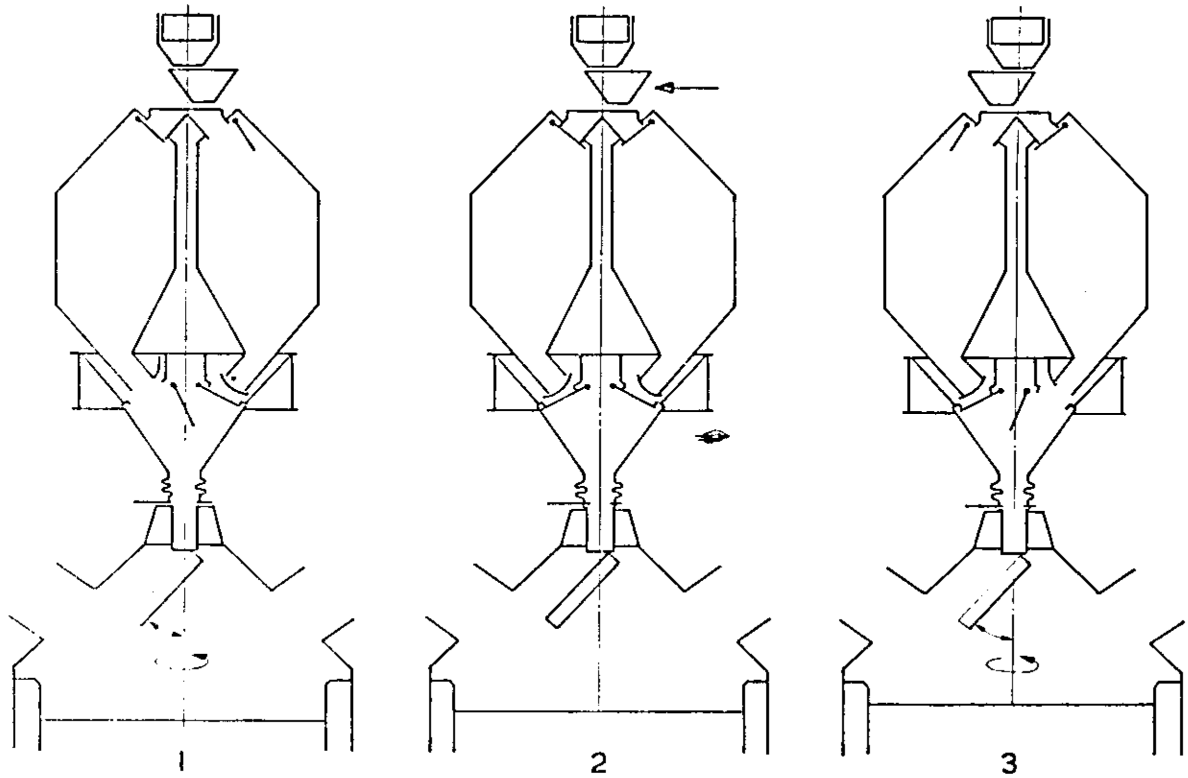


Fig. 16. DAVY-WURTH BELL-LESS TOP, STAGE BY STAGE

charge material on to the stockline, and valves for sealing. The advantages of eliminating the large bell in particular can be recognised in many aspects of furnace operation. First of all, in terms of distribution, as the size of furnaces becomes greater, the bell itself is less and less capable of achieving the required distribution by itself and it has been necessary to use a device known as moveable throat armour, which assists in distribution in large diameter furnaces, but which itself is a further source of expenditure and maintenance.

Perhaps the greatest advantage in eliminating the large bell is its size and weight. On a modern 14M hearth furnace a typical large bell would have a diameter of 7.6 ton metres and the unit weight of bell and hopper would approach 200 tons. When one bears in mind that this unit must be lifted into position by special hoists situated some 80 metres above ground level, the necessity for finding an alternative means of charging the blast furnace can be readily appreciated. From the maintenance viewpoint, too, there are advantages in that the value of essential spares can be up to eight times as much for a top with bells, depending on the type, than for a bell-less top.

With a bell-less top the furnace size is no longer an embarrassment as the charge can be distributed over whatever diameter of stockline we have, simply by providing a chute of the correct length, the chute being of relatively low cost and easy to change. Moreover, the problem of sealing against high pressures is reduced as the seal must only be made over the circumference of the valves which is very much less than that of a bell. The seal valves themselves, fitted at the inlet and outlet of each top hopper, are designed specifically for sealing, although at the outlet of the top hopper itself there is a separate gate called the "material gate" which bears the brunt of any abrasive attack from the material while keeping the soft seats of the seal valves out of the flow of charge materials. The question of distribution of the charge on to the stockline of the furnace is one which has not yet been resolved in the case of the bell-less top, because of its large potential in terms of distribution and it simply has not been possible, in the short time for which this type of top has been in use, to have accumulated sufficient operating data to analyze fully its potential in terms of its effect on furnace operation.

At the heart of the bell-less top system, of course, is the gearbox which is not only capable of rotating the chute but also of tilting it to enable the charge to be deposited in rings of differing radius from the centre of the furnace to the wall. To do this the gearbox has to be situated virtually in the top cone of the furnace. This was the feature of the bell-less top system which required the most initial thought, and considerable conviction in its likelihood of success was needed in the development phase. The means adopted to keep the gearbox cool and clean were to keep it pressurised with a flow of inert gas both to keep the gearbox itself at a reasonably low working temperature, and to prevent the ingress of dirty hot blast furnace gas directly from the stockline which could cause premature wear by abrasion. However, the design has now been proven in practice, the use of nitrogen instead of blast furnace gas being a preferable cooling and pressurising medium although natural gas can be used as well.

The adoption of the bell-less top greatly simplifies the maintenance problems on a blast furnace top. First of all the chute itself which weighs between 6 and 8 tons can be changed in one shift. The operation is not complicated and does not require any special equipment except for the chute lifting cradle which is used to take hold of the chute while it is disengaged from the gearbox and withdrawn from the furnace top cone. While this work is going on the furnace top is open and the stockline itself ignited, so not only is there no danger from fumes or gas, but the stockline can be readily seen and the profile checked with the charging pattern that has been employed. An assessment of the maintenance requirements of a typical bell-less top operating on a 14M hearth furnace is given in the Table below.

As suggested earlier, the full potential of the bell-less top in terms of distribution has not yet been determined. This is in part due to the large number of combinations of which the rotating tilting chute is capable because of its ability to put materials in a number of concentric rings, in one ring only, or even in a part of a ring. This versatility has led to the idea that the number of possibilities is so great that virtually any distribution can be achieved with this type of equipment and that any furnace operating condition, which can be even remotely related to distribution, can similarly be controlled.

The simplest method of charging materials into different rings is based on "time per ring." The time taken for the hoppers to discharge into the furnace must be related to the time selected for the rotation of the chute in a precise manner. This is a basic condition for this mode of operation of the bell-less top which is charging by time, and an accurate and reliable "hopper empty" signal must be available.

Charging by time is the method that has been used on most of the bell-less top installations to date but it is not the one, however, that allows the greatest potential. Most of the bell-less tops recently installed and certainly those being installed, at the present time, have the hoppers mounted on load cells with means for compensating for the effect of necessary connections to the top hoppers, such as equalising and relief connections and the shaft of the material flow gate, as well as the "up-lift" from the furnace top pressure. They are also being equipped with computers which permit the full development of all the possible charging patterns which are possible with the bell-less top.

Returning to the method of charging by time, however, this is quite simply a matter of dividing the total time set for the rotation of the chute into the number of rings desired. For example, if it is anticipated that the flow of material out of the hopper will take, let us say 90 seconds, and it is decided to charge into line rings, then each ring will have 10 seconds. It is, as mentioned earlier, extremely important in this case that the discharge time of the material should correspond exactly

Item	Working Life (Millions of tonnes of Material handled)	Time to Change or Repair
Seal Valves (Upper and lower)	5	1/2 Shift
Material Gate	24	1 Shift
Elevating Gearboxes	15	2 Shifts
Vertical Feed Pipe	24	1 Shift
Rotating Chute	5-10	1 Shift
Wearing Plates	Depending on position & material 3-12	1 Shift in each location

Typical data of a Davy-Wurth bell-less top is as follows:

Rotating Chute	Min Length 3.0 m
Rotating Chute	Max Length 5.0 m
Speed of Rotation	8 RPM
Rotation Motor	10 kW at 1500 RPM
Elevating Motor	4 kW
Elevation Angles	0° to 54°
Seal Valves – Nominal dia's	700 & 1000 mm
Suitable for Furnace Top Pressures up to	3.0 kg/cm^2
Weight of Primary Gear Box	2.4 Tonnes
Weight of Main Gear Box	23.0 Tonnes
Outrigger Capacity	30 to 40 Tonnes

to the rotation time of the chute, having made due allowance for the in-flight time of material from the material flow gate to the profile of the blast furnace. Otherwise, even with the correct setting being made to the logic equipment, the material will not fall in the rings allocated. If, for example, the chute rotation time is set too long then the material will preferentially fall into the first rings selected and the last one or more will be starved completely. If, on the other hand, the rotation time of the chute is set too short then material will still be falling when the chute has finished its quota of rings.

One of the essential features of a bell-less top operating on time is a good signal for the hopper empty condition and it is usual to have two of these, one as a back-up to the other, and in cases where load cells are fitted to the hoppers an alternative hopper empty signal is hereby also provided. With this arrangement, the discharge time of materials should be carefully logged by control-room personnel or by computer if one is installed. When the charge programme selector is set up the material flow gate position for each material is required. Depending on the logic this may or may not be automatically set when the material is selected, for example coke could carry with it the automatic selection of a certain flow gate setting, similarly with sinter and so on. Alternatively, this selection could be done manually.

This method of charging by time is completely satisfactory for charging into any number of the total number of 11 rings and for charging in one ring alone or for sector charging, provided that the discharge time of the material is correctly related to the selected rotational time of the chute. If, however, it is desired to charge by weight, then an associated computer can control the operation of the chute completely so that any desired proportion of the total weight of the material in the top hopper, as measured by the load cells, can be discharged to any ring on the furnace stockline. This means, of course, that the question of matching the discharge time to the chute rotation time is not so critical since the chute will not move from one position to another until the required amount of material by weight has been discharged onto that ring. There is one requirement, however, in respect to discharge time and that is if the required number of rings is large. Let us say that more than one complete ring is required in one or more positions such that the total requirement corresponds to more than 11 complete rings, then the discharge time must be lengthened accordingly to allow the chute sufficient time to deposit the required number of complete rings. The speed of revolution of the chute is 8 r.p.m. and therefore 7½ seconds are required for one complete revolution. If 12 complete rings are required, therefore a total material discharge time of 90 seconds is required.

There is one other method of operating the top and that is to operate by the time on the assumption that the hopper will empty at a uniform rate with respect to time. If this premise is accepted, then it is possible to operate the top on a weight basis substituting time for weight and conferring upon the top the full flexibility as described above. It will, however, be necessary to check from time to time that the time rate of discharge remains constant, and if load cells are not provided on the top hoppers then a separate test rig would be necessary to check the linearity against time of any new charge materials being considered for use. Such a method of operation may well be the best one, however, testwork carried out by Davy strongly suggests that flow of materials is linear to well within the accuracy of the load cell weighing equipment. Such an approach would considerably simplify the design of the top hoppers and the associated equipment, and result in cost savings.

The effect of the bell-less top on furnace operation, while not yet fully explored, has certainly shown that the temperature distribution across the furnace from centre to wall can be controlled, and although there is no definite evidence that the coke rate of a furnace or its production capacity can be significantly improved by the bell-less top, it has been shown that changing the charging pattern can control such factors as "wall-working." Such control is obviously valuable in its effect on the life of the refractories of the furnace. There is a certain amount of evidence available from furnaces which are fitted with stave cooling, that by feeding coke to the walls preferentially the temperatures actually registered on the staves themselves as well as the heat losses picked up by the cooling circuits are increased. The reverse effect is observed if sinter or pellets are charged to the wall instead. It is very easy with the bell-less top to change the charging pattern in this way and it has been found that furnaces are extremely sensitive to small changes in charging pattern.

In conclusion, it can be said that the bell-less top has made a highly significant contribution to blast furnace technology and came along, or perhaps it would be better to say had to come along, at a time when the size of furnaces had reached the point where the use of tops including bell systems had just about reached the limit of their viability both in terms of initial cost and in cost of maintenance. In terms of furnace operation the bell-less top has probably opened up a new era in terms of the way in which the distribution at least in the top of a furnace stack can be controlled. It remains to be seen whether or not the benefits on furnace operation can be converted into improvements in production and coke rate relative to those which have already been achieved on the best furnaces equipped with bells.

In view of the foregoing it will not come as any surprise that, since the inception of the "bell-less" top design in the early 70's, blast furnace operators all over the world have bought 76 of them for furnaces of all sizes both new and old. It is now a rare occurrence for a new or re-built blast furnace to be equipped with anything other than a bell-less top.

GAS CLEANING AND ENERGY RECOVERY IN THE BLAST FURNACE

With the use of blast furnace stoves, one of the main treatments required for blast furnace gas is to ensure that it is clean enough to be used in the stoves without impairing the efficiency of heat transfer in the refractories. To enable this to be achieved the particulate matter is limited to 10 mg/Nm^3. In order to achieve this level of cleanliness a highly efficient gas cleaning system must be used. In the early days where top gas pressure was relatively low this proved a difficult problem, as wet scrubbing processes demand high pressure to achieve good cleanliness.

Although most modern furnaces are designed for high top pressure operation over the past few years, Davy has designed furnaces for various customers which cover the full range of top pressure operation.

At Surahammar in Sweden a small blast furnace was designed and built with a top pressure of 0.14 bar. The gas cleaning system employed was a dustcatcher to separate out the large dust particles followed by a variable throat' venturi scrubber. Since the pressure available for cleaning over the venturi scrubber was limited, this was followed by an electrostatic precipitator to give the appropriate degree of cleanliness for blast furnace gas to be used in the stoves. The system at Surahammar is typical of many low top pressure furnaces.

Later as a rebuilding of a more modern furnace, Davy designed and built a blast furnace top for installation at the British Steel Corporation's works at Corby. This furnace was to operate with a top gas pressure of 0.6 bar. The gas cleaning system employed a dry dustcatcher for the removal of large particles as usual and this was followed by a two-stage variable orifice wet scrubber. In this case the top pressure was more than adequate to achieve the appropriate cleanliness using the wet scrubbers alone. The two-stage wet scrubber unit was mounted in a tower structure. The pressure drop over the first stage was relatively low at 150 mm, and this was maintained at a constant level for varying gas flows by a hydraulic control system accepting signals generated by the differential pressure. After this stage an off-take leading back to the furnace top was used to carry the semi-clean gas so that pressure drops across the bell mechanisms could be equalised.

The second stage of the scrubber was similar in design to the first, receiving its signal for position control from the furnace top pressure measurement. With the top pressure at any level above 0.2 bar, sufficient scrubbing was achieved for passing the gas to the blast furnace distribution system and for further use in the stoves.

New furnaces built by Davy more recently are the 11.2 metre hearth dia. furnace at British Steel Corporation's works at Llanwern. This operates at a top pressure of 1.3 bar; the 11.2 metre dia. furnace for Ahmsa operates at 1.5 bar; and finally the 14 metre dia. furnace under construction for the British Steel Corporation at Redcar which will operate at a top pressure of 2.5 bar. In these furnaces top pressure is again controlled by using the variable positioning of a gas cleaning system.

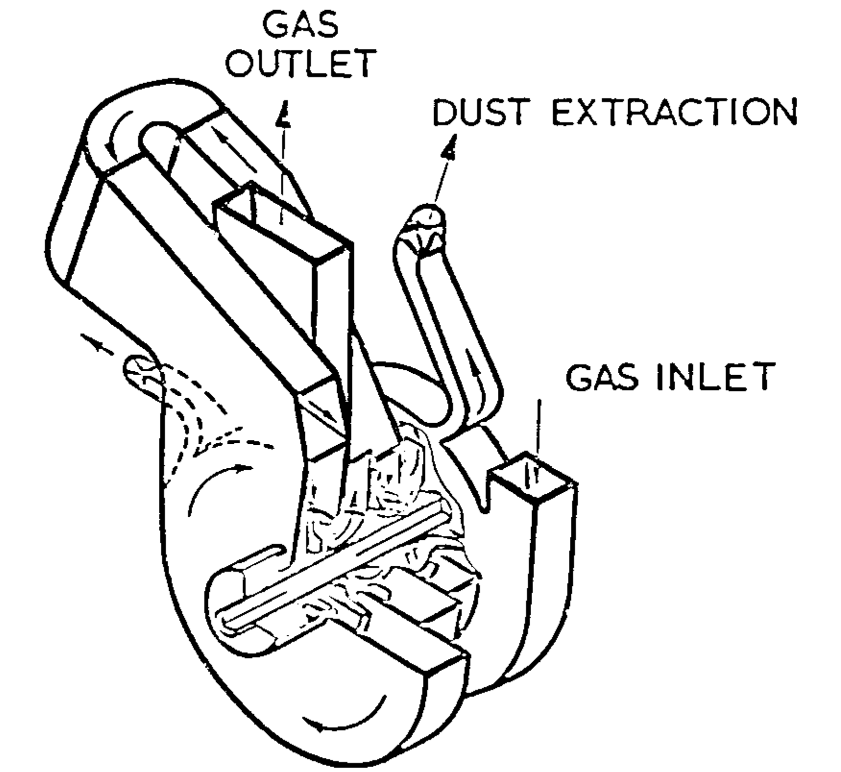


Fig. 17. TWO STAGE TOP GAS TURBINE

At Llanwern and Redcar double cone type washers of Bischoff design are used, whereas at Ahmsa, the Lurgi type variable ring gap scrubber is used. In each of these cases no septum valve is used.

The above illustrates the progression of top pressure operation and in the later cases a considerable degree of energy is lost unnecessarily in reducing the pressure of the clean gas to that required for the blast furnace gas distribution system. Despite this energy loss, this progression illustrates that more efficient and economic blast furnace operation is achieved by increases in top pressure. However, this progress to increase production was based on the fundamental need to increase the amount of air or oxygen supplied to the furnace so that coke and iron bearing materials could be charged more quickly.

One of the limiting factors in attempting to increase the wind rate of blast furnaces is the lifting effect that is caused by the large volume of gases blowing upward through the burden. This lifting effect prevents the burden from descending normally and uniformly causing a loss rather than an increase in production.

Compression of the gases entering the furnace reduces their volume and hence their flow velocity. This reduces the lifting effect and the dust emission from the burden while intensifying the physical and chemical processes in which the gases interact with the burden materials. This higher pressure within the blast furnace is generally maintained by a septum valve located in the downstream gas system. High top pressure imposes far more exacting demands on blast furnace closures, necessitates gas cleaning facilities designed for higher service pressure, and requires pressure regulation provision in the gas line to control the furnace pressure.

Apart from these technical problems which have already been satisfactorily solved, this high-top pressure technique requires more blowing power and considerably increases the cost of compressing the blast delivered to the furnace, while all the pneumatic energy contained in the high pressure top gas is lost within the septum valve or in the gas cleaning system.

At present furnaces operate at top pressure higher than 1 atm gauge, and practically all newly built blast furnaces are designed for high top pressure.

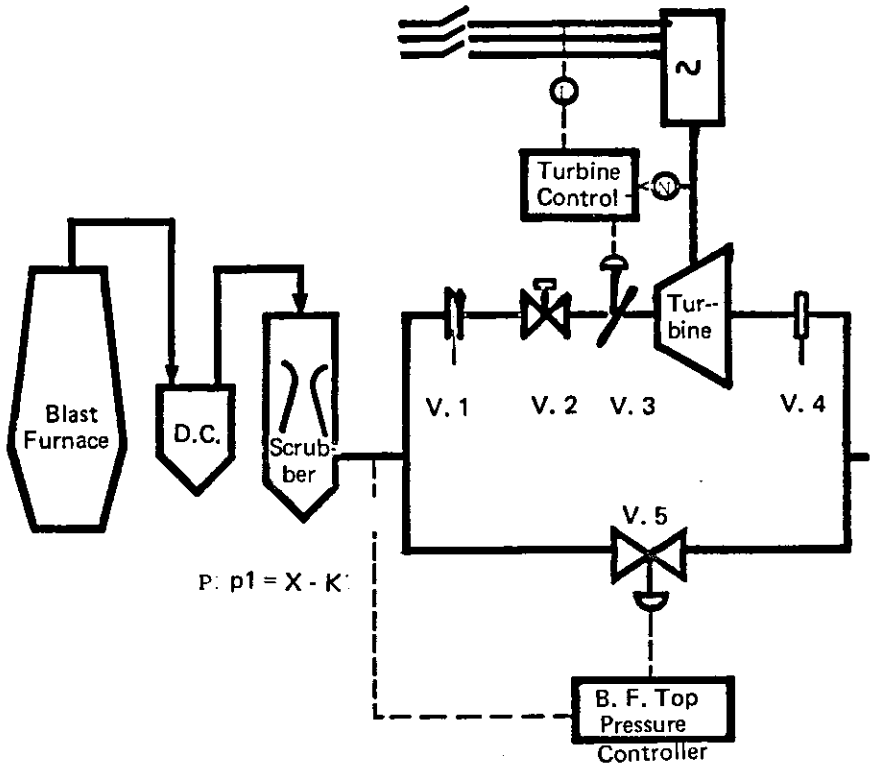


Fig. 18. TOP GAS TURBINE, FIRST REGULATION SYSTEM

In spite of high blower power requirements, it became apparent in the 1960's that high top pressure blast furnaces would be installed at increasing rates. It became attractive to design and perfect a process that would reduce the high energy requirements of these furnaces.

The solution studied was to expand the blast furnace gas through a turbine, instead of wasting its considerable energy through static expansion in a septum valve. The practical difficulty was to build a turbine resistant to the high abrasive and plugging potential of the dirty B.F. off-gas.

The first consideration was whether the turbine should be axial or centripetal. The axial machine is more sophisticated, has high efficiency, but the relative speed of the gas along the blades is high, and the latter are exposed to severe wear when the gas is dusty and/or wet.

The centripetal turbine, besides its mechanical simplicity, offers the following advantages:

The dust particles that enter the volute have a tendency to be removed centrifugally and can quite easily be eliminated while providing an important cleaning effect by centrifugal separation. This considerably diminishes the amount of dust which finally contacts the impeller.

The relative speeds of the gas along the blades are much lower than in an axial turbine, and the dust particles have less of an impact effect.

The above analysis led SOFRAIR, a French company, to utilize a centripetal turbine for this application.

Two pilot plants were developed to study two locations for the turbine within the system. In the first test, the gas was taken hot and dry after the dust catcher and centrifugal separators, then sent back to the low pressure line, located after the septum valve. From this test it was concluded that the process was successful when the temperature of the gas at the inlet of the turbine was high enough to avoid any condensation during the expansion. This minimum temperature, depending upon the gas analysis, was about 170°C (340°F). When it was lower, the gas had to be reheated by means of partial combustion, which reduced the value of the gas sent to the stoves.

A second test was performed using the alternate approach of taking the gas which has been cleaned and saturated by a scrubber to the turbine.

The test unit was equipped with special water injection devices inside the machine and combined with the intense condensation within the turbine, washing the internals to prevent building up and wear. The test proved the feasibility and reliability of the wet system.

Although it was determined that it is feasible to put the turbine on the hot blast furnace gas, which theoretically provides more energy recovery since the gas temperature is higher, this advantage was lost by the necessity of reheating the gas by partial combustion when the temperature of the top gas is lower than 170°C (340°F). The wet system which proved to be much simpler and more reliable than the dry system was selected for commercial applications.

Regulation of the Turbine

The stator of the SOFRAIR energy recovery turbine is equipped with a regulation flap which modifies the pressure flow-power characteristics of the machine while maintaining high efficiency. Situated at the entrance of the volute, a place where the gas has not as yet been accelerated, this particularly simple valve is not exposed to the very destructive effects of impacts of droplets, abrasion by dust in suspension to which more conventional devices situated at the periphery of the impeller would be. Depending on the customer's preferred operation, three regulation schemes are possible. Each scheme has individual advantages and are described in the following text.

Scheme 1 — Fig. 18

This scheme is characterised by constant power recovery and a septum valve in parallel with the turbine. This septum valve normally controls the furnace top pressure. Examples of this type of installation are: MIZUSHIMA — BF No. 2 (KAWASAKI STEEL CORP.); and FUKUYAMA — BF No. 4 (NIPPON KOKAN).

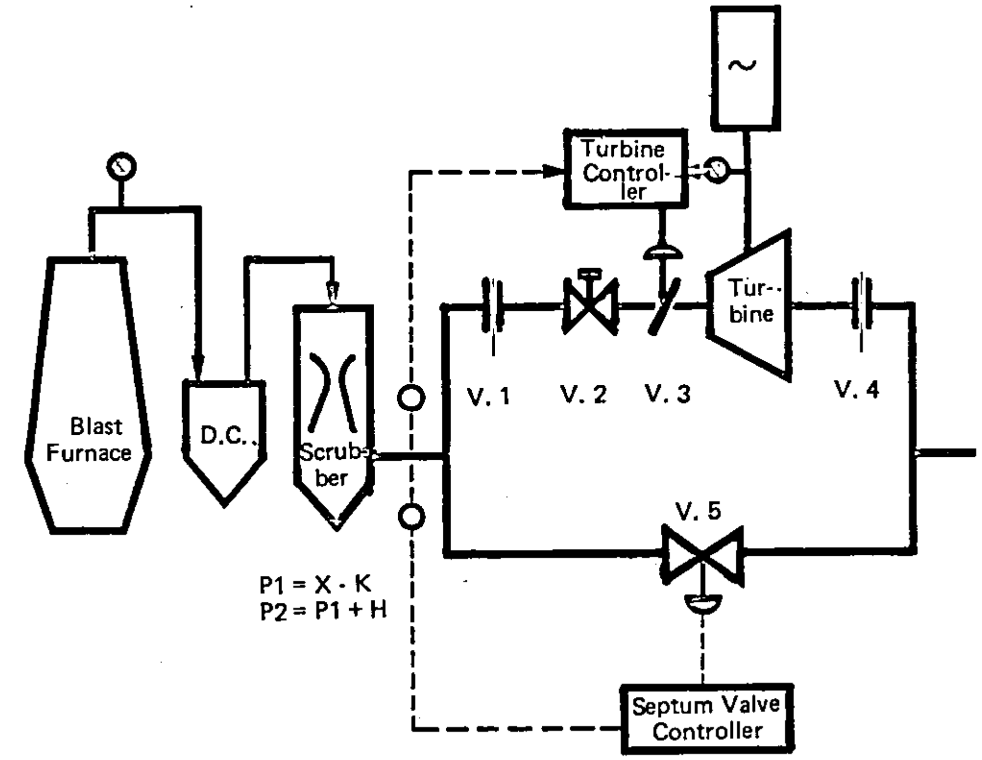


Fig. 19. TOP GAS TURBINE, SECOND REGULATION SYSTEM

Under normal operation the B.F. top pressure required is X bars. The differential pressure between the top of the B.F. and the outlet of the scrubber is constant and equal to K bars. The valves V. 1, V. 2, V.4 are fully open. The B.F. top pressure is automatically controlled by the septum valve which absorbs 10-20% of the total nominal flow. The generator load is kept constant by the regulation flap of the turbine.

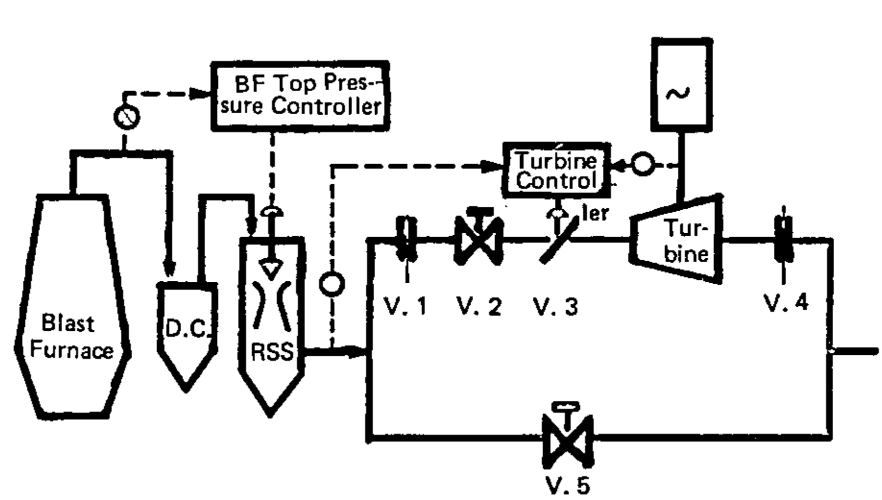
In order to start the unit, valves V.2 and V.3 are fully closed and the B.F. is under stable high top pressure operation. The top pressure is controlled by the septum valve at X bars. All the ancillaries (lubricating and hydraulic units) are operational.

In order to start the turbine, the safety valve is opened manually from the local control desks, and the regulation flap of the turbine is switched to speed control. Since the objective is synchronous speed, the flap opens. In order to have smoother acceleration, as long as the flap is governed by speed regulation, it is not allowed to open more than 30%. As soon as the control speed is reached, a contact set by the tachometer initiates the automatic closing of the generator circuit breaker. If the grid line refuses the new electrical input, the flap continues maintaining the speed. If the grid line accepts the load, the turbine speed becomes synchronous to the grid and the load control circuit of the turbine flap takes control automatically. The more the operator increases the reference load on the turbine, the more the flap opens. Finally, the turbine will absorb an almost constant flow representing about 80% of the total nominal flow, while the septum will absorb the flow variations for given pressures. In order to remove the turbine from the line the safety valve is open, the septum valve controls the top pressure, and the turbine flap is under generator load control. The operator diminishes the reference load to be held, which closes the flap. When the electrical output becomes zero, the breaker is opened. During this time, the septum valve gradually absorbs more and more flow, up to 100%, at which time the safety valve is then shut.

Ocassionally, an emergency stop could occur if a secondary alarm (very high temperature on one bearing for example) occurs. The safety valve and the regulation flap close very quickly. Consequently, the septum valve opens quickly in order to absorb the flow and maintain the high top pressure at X bars. In the event the power grid cannot accept the electrical load, the generator load control is automatically switched over to the turbine speed control, which closes the flap of the turbine. The septum valve operates as in the emergency stop sequence. In the event of a furnace slip, gas flow can increase substantially. The septum valve will absorb more flow, and the flap of the turbine will not move. A corollary is a quick reduction in BF gas flow such as occurs when the snort valve must be opened. Initially, the top pressure will be controlled by the partial closing of the regulating butterfly of the septum. Beyond a set limit, the top pressure can no longer be controlled, even by the complete closing of the septum, as long as the turbine flap remains fully open. To avoid this situation, the reference load to be kept by the flap of the turbine is automatically and temporarily reduced to a very small value.

Scheme 2 – Fig. 19

This scheme is characterised by maximum power recovery and a septum valve is parallel with the turbine. The top pressure is normally controlled by the turbine flap. Examples of this type of installations are: MIZUSHIMA – B. F. No. 3 and No. 4 (KAWASAKI STEEL CORP.); and THIONVILLE – B.F. No. 1 (USINOR).



D.C. = Dust catcher
RSS = Ring slit scrubber
V.1 = Upstream isolating valve
V.4 = Downstream isolating valve
V.2 = Buttersfly safety valve
V.5 = Septum valve or equivalent
V.3 = Regulation flap (located inside the turbine)

Fig. 20. TOP GAS TURBINE, THIRD REGULATION SYSTEM

Under normal operation the reference pressure to be kept at the top of the B.F. is X bars. The differential pressure between the top of the B.F. and the outlet of the scrubber is constant and equal to K bars. The valves V.1, V.2 and V. 4 are fully open. The pressure to be kept by the regulation flap at the outlet of the scrubber is constant and equal to K bars. The valves V.1, V.2 and V.4 are fully open. The pressure to be kept by the regulation flap at the outlet of the scrubber is fixed at (X-K) bars. The pressure to be kept by the regulating butterly at the outlet of the scrubber is fixed at (X-K) +H bars. In normal operation, the septum valve is closed, and 100% of the gas flow expands within the turbine, the flap of which assures top pressure regulation at X bars.

In order to start the unit, the valves V.2 and V.3 are fully closed, and the blast furnace is under stable high top pressure operation, and the top pressure is controlled by the septum valve at (X + H) bars. All the ancillaries (lubricating and hydraulic units) are operational.

In order to start the turbine, the safety valve is opened manually from the local control desks, and the regulation flap of the turbine is switched to speed control. Since the objective is synchronous speed, the flap opens, in order to have smoother acceleration, and as long as the flap is governed by speed regulation, it is not allowed to open more than 30%. As soon as the control speed is reached, a contact set by the tachometer initiates the automatic closing of the generator circuit breaker. If the line refuses the new electrical input, the flap continues maintaining the speed. If the line accepts that new load, the turbine speed becomes synchronous to the grid, and the scrubber outlet pressure control circuit of the turbine flap assumes control automatically. At the moment the flap reaches pressure control, the pressure at the outlet of the scrubber is (X-K) + H bars, so the flap will open gradually to take the pressure down to (X - K) bars, while the septum valve will fully close in order to maintain the pressure at (X - K) + H bars. As the flap opens, energy recovery increases. It should be stressed that the transfer of the flow from the septum to the turbine will be made very smoothly. In order to remove the turbine from the line, the safety valve is open, the septum valve is closed, and the regulation flap of the turbine is under scrubber outlet pressure control. The reference pressure of the flap is increased to (X - K) + 2 H bars so that the septum valve will gradually absorb the entire flow. When the energy recovery has dropped to zero, the breaker is opened. The safety valve is then shut.

Occasionally, an emergency stop will occur if a secondary alarm signal occurs. The safety valve and the regulation flap close very quickly and at the same time, the septum valve quickly opens in order to keep the scrubber outlet at control pressure. In the event the power grid cannot accept the electrical load, the scrubber outlet pressure control is switched over to the turbine speed control which closes the flap of the turbine. The septum valve operates as in the emergency stop sequences. In case the blast furnace slips, if the gas flow temporarily exceeds the maximum capacity of the turbine at full opening of the flap, the scrubber outlet pressure will increase up to (X - K) + H and the septum will absorb the excess flow in order to maintain the pressure at this value. This "peak absorption" control transition will be perfectly smooth. A very fast reduction in gas flow caused by the snort valve opening, for example, will cause the flap of the turbine to close (as the butterfly of a septum valve would do) in order to maintain the counter pressure at the required level X.

Scheme 3 (Fig. 20)

This control method is characterised by maximum power recovery. The turbine is placed in series with a high energy scrubber which controls furnace top pressure. An example of this type of installation is KURE – B.F. No. 1 (NISSIN STEEL).

Under normal operating conditions, the valves V.1, V.2 and V.4 are fully opened, the by-pass valve V.5 is fully closed, the B.F. top pressure is automatically controlled by the scrubber at the reference level X bars, and the turbine inlet pressure is automatically controlled by the flap of the turbine. The reference turbine inlet pressure to be maintained is adjustable, but in no case can the operator select a value that exceeds the pressure corresponding to the blast furnace top pressure setting minus the minimum allowable differential pressure across the scrubber. With valves V.2 and V.3 fully closed and the by-pass valve V.5 fully open, the blast furnace under stable high pressure operation, and the top pressure controlled by the scrubber, the turbine may be started. Safety valve V.2 is opened manually from the local control desk, and the regulation flap of the turbine is switched to speed control. Since the target is synchronous speed, the flap opens. The by-pass valve is partly closed, which creates a difference of pressure between the inlet and the outlet of the turbine. When the turbine is started, and as soon as the unit is sufficiently close to the synchronous speed, a signal from the tachometer initiates the automatic closing of the generator circuit breaker. If the line refuses the new electrical input, the flap continues maintaining the speed. If the line accepts the new load, the turbine speed becomes synchronous to the grid and the turbine inlet pressure control circuit of the turbine flap assumes control automatically. Once the units are coupled, the by-pass valve is fully closed while the turbine inlet pressure datum is raised. In order to remove the turbine from the line, the safety valve is fully open, the by-pass valve is closed, and the regulation flap of the turbine is under inlet pressure control. The by-pass valve is gradually opened, which induces the gradual closing of the flap in order to maintain the turbine inlet pressure. The gas flow through the turbine is reduced and the generator circuit breaker is automatically opened when the generator out-put is reduced to zero. The by-pass valve is fully open and the safety valve is shut. Occasionally, an emergency stop will occur if a secondary alarm signal occurs, and the safety valve and the regulation flap close very quickly. At the same time, the by-pass valve is fully opened by the "open" signal from the turbine controller. The opening speed of the by-pass valve is adapted to the closing speed of the scrubber in order to allow the scrubber enough time to come to a position where it creates the required pressure drop. In the event the power grid cannot accept the electrical load, the turbine inlet pressure control is switched to the turbine speed control which closes the flap of the turbine. At the same time, the by-pass valve is opened by the "open" signal from the turbine controller. A new coupling will be possible as soon as the electrical network is in a position to accept this load. In the case of a blast furnace slip, the gas flow can temporarily exceed the maximum capacity of the turbine at full opening of the flap. To avoid any abnormal increase of pressure, an "open" signal is supplied to the by-pass valve as soon as the turbine inlet pressure becomes higher than the reference setting by 3 to 4 per cent. When the turbine inlet pressure recovers its normal level, the "open" signal to the by-pass valve is cut off and the latter automatically closes (with calculated delay). If the gas volume to the turbine decreases very rapidly (for example, if the snort valve is opened) the scrubber and the flap of the turbine will close quickly in order to maintain the counter pressure at the required level. The above control systems allow a very flexible adaptation of the turbine to any specific situation and requirement.

It must be emphasized that all the operations necessary to assume the complete regulation of the energy recovery system are automatic. Field installations have demonstrated that these units do not interfere in any way with blast furnace operations.

Machinery Driven by Turbine

Usually the turbine is used to drive a generator and provide electrical energy. One can use synchronous alternators as well as induction-type generators for this purpose. The advantages of the induction-type generator are low capital cost, and simplicity of the coupling procedure to the grid (no electrical angle problems, less precise speed regulation required). The disadvantages of induction generators are reduction in efficiency of about 1% and reactive current requirements. The final choice should be in favour of the induction type generator whenever the grid makes it possible.

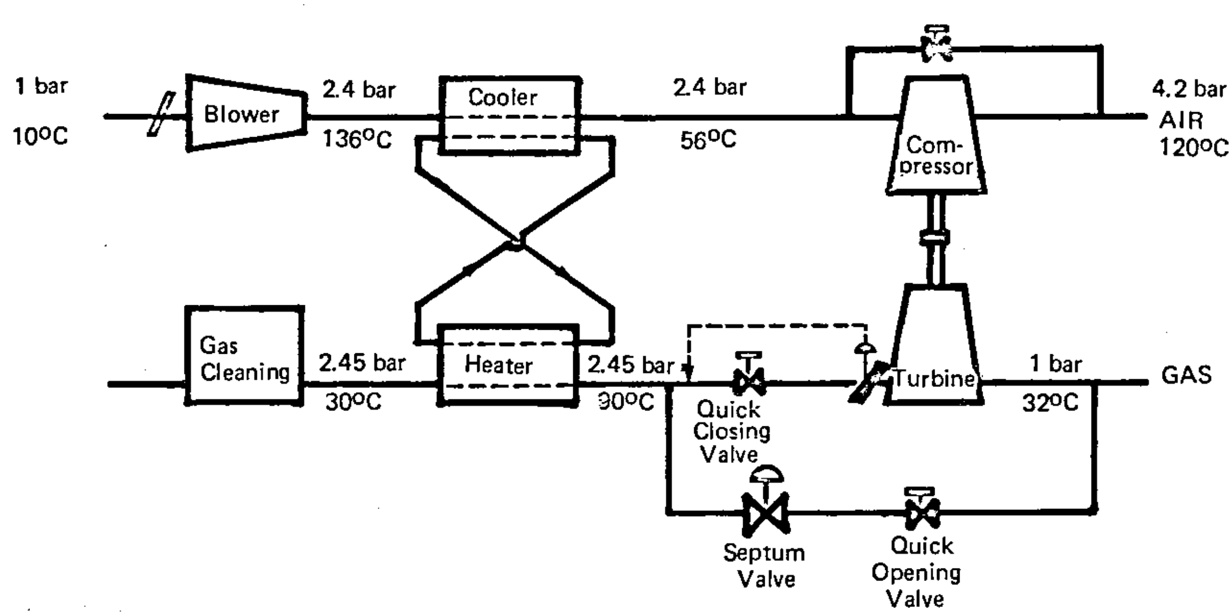


Fig. 21. TOP GAS TURBINE TO AID BLAST FURNACE BLOWER

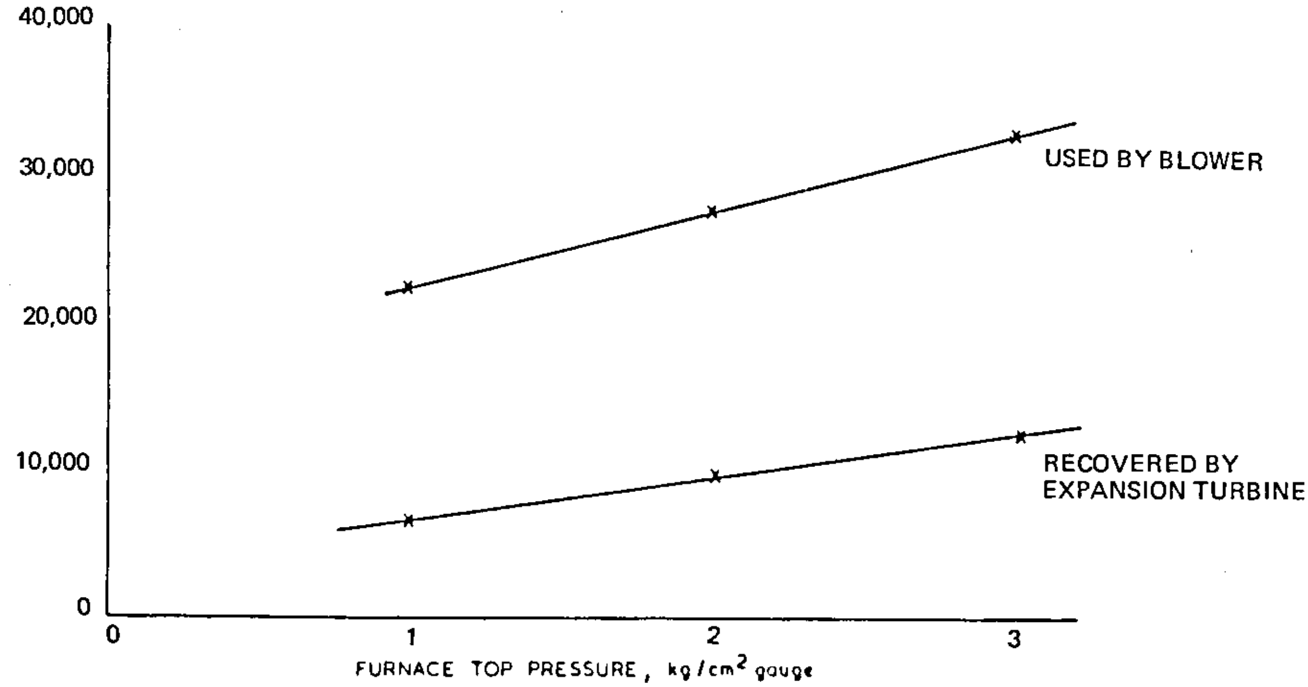


Fig. 22. BLOWER POWER AND RECOVERABLE POWER AT VARIOUS TOP PRESSURES

It is not necessary to generate power as electricity at the installation built for USINOR demonstrates. The centripetal turbine drives a centrifugal compressor working in series with the existing main blower. In order to improve the efficiency of the system, the wind is cooled between the main blower and the additional compression stage, and the heat recovered is used to reheat the B.F. gas before admission to the turbine. There are significant advantages to this unusual solution, and it avoids all the intermediate electrical losses. There is no speed regulation, only an overspeed control, and the total blowing power of the system has been increased. The production rate of the blast furnace has been increased without any modification to the existing main blower. The turbine supplies 45% of the total blowing power. The main drawback to this solution is that the blast furnace partly depends upon the energy recovery system, and the furnace operation is closely connected to turbine operation and the reliability of the compressor.

In the above system about 45% of the top gas energy can be recovered, whereas in the generation of electrical power over 20% of the energy is recovered.

STOVES

The type of stove in use twenty years ago showed very little variation from the original stove designed by Cowper in 1860. It was fired by blast furnace gas, and consisted of a vertical combustion chamber, with a chequer chamber adjacent to it, both housed in cylindrical shell. This type of stove was used to give blast temperatures up to 800°C for a very large number of years. The main problems in the early stoves were blocking of the passages in the chequer work due to the dust in the blast furnace gas and any deviations in design were largely to make cleaning easier.

The importance of the hot blast stove in the early days of the blast furnace went a lot further than merely using waste gas from the blast furnace in order to put some of its heat back into the process. In 1828 when the idea of using hot blast was first postulated and tried by Neilson, a Scottish gas works engineer, the effect on iron production was so dramatic that it was immediately adopted, firstly throughout the United Kingdom and then in the rest of the world, even though it took a further 30 years before the reason for its effectiveness was known. Not only did hot blast improve the economics of ironmaking, a temperature of 150°C being sufficient to reduce the amount of coke required to make a ton of iron from 5 tons to 3 tons, but it also made it possible to use anthracite coal and to smelt ores which were previously unusable. Subsequent increases in blast temperature to around 300°C further reduced coke requirements to just over 1½ tons, and as temperatures increased to the level obtainable with the Cowper stove the effect of temperature on coke rate was stabilised at the equivalent of the increase in heat input.

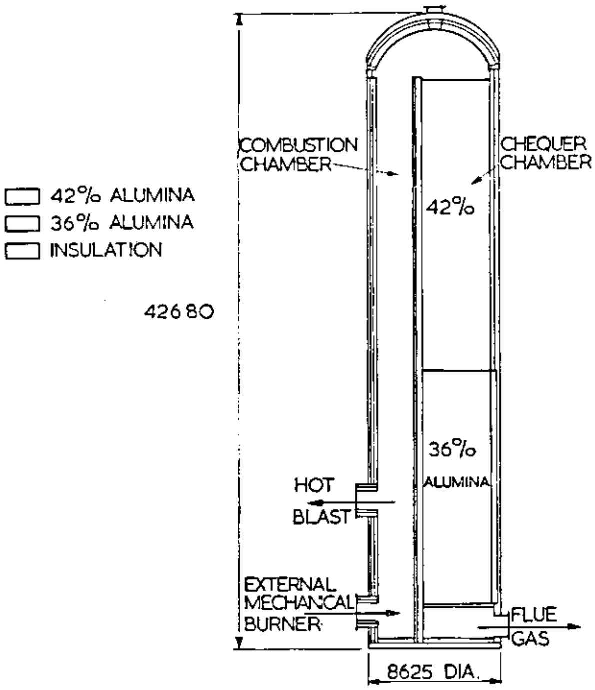


Fig. 23. CONVENTIONAL DESIGN

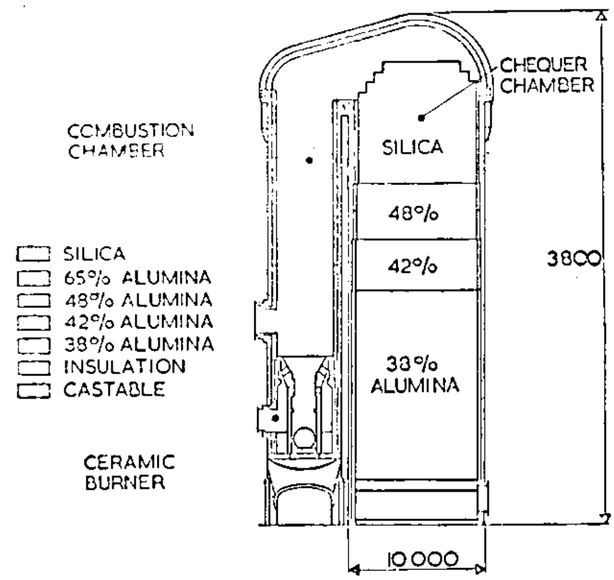


Fig. 24. DIDIER DESIGN

The early Cowper stove installations employed two stoves, one on-gas and one on-blast, and the use of a third stove has been brought about by requirements of consistency of operation, bearing in mind the problems of clogging with dust and other possible equipment failures.

Since the 1950's the growing shortage of coking coal once again put an emphasis on the need for high blast temperature to reduce coke rate to the absolute minimum and this, along with other developments, principally that of burden preparation, have now combined to reduce the coke rate to about half a ton for every ton of iron produced.

To meet the requirements for higher temperatures, it was realised that a revision in stove design was necessary because the existing designs were not suited to blast temperatures above 1000°C. The main problem lay with the dividing wall between the combustion chamber and the chequer chamber, where the high temperature gradient produced spalling and brickwork failures which resulted in "shortcircuiting" of the heating gas, and resultant failure of the stoves to achieve their design performance. The first efforts to overcome this problem were to separate the combustion chamber from the chequer chamber and, at the same time, to provide refractory material with greater resistance to high temperature, because by now the goal has been set of a blast temperature in the region of 1350°C requiring dome temperatures in excess of 1550°C. The choice of silica refractories for the higher temperature zones had considerably reduced refractory problems and the use of high top pressure on blast furnaces had made it possible to scrub the gasses, by using the top pressure, to a degree of cleanliness never before achieved, and it was no longer necessary to be preoccupied about cleaning the flues. The design problems of the stove shifted from the brickwork to the steelwork and, because the combustion chamber and the chequer chamber were now enclosed in separate vessels with differing temperature cycles, the problem became one of allowing for differential movement of the two vessels. This has been dealt with in different ways by different stove designers, typical examples being Didier, Koppers, and Marten and Pagenstecher. In the Didier case, the problem is tackled by building a cantilever dome from the chequer chamber from which the combustion chamber is partially suspended and partially supported on a hydraulic platform which allows for vertical movement. The hot blast connection arrangement must therefore also provide for some movement. In the Koppers design, a Cardan type expansion arrangement is included in the connecting duct between the chequer chamber and the combustion chamber, both of these being fixed to the ground. In the M & P design, the combustion chamber is pre-stressed while cold so that under operating conditions the stress is removed by the increased thermal expansion of the combustion chamber relative to the chequer chamber.

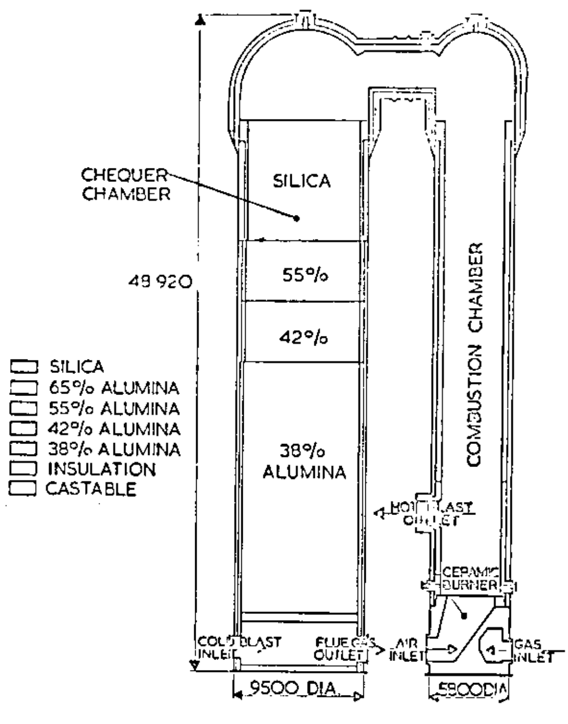


Fig. 25. KOPPERS DESIGN

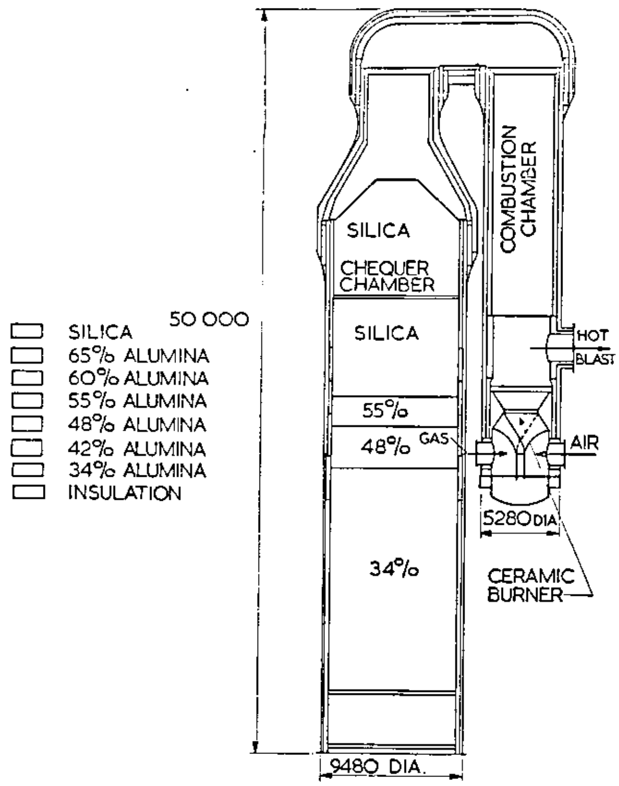


Fig. 26. MARTEN AND PAGENSTECHER DESIGN

Each of these solutions represents viable design, and they are all operating in high temperature installations. An alternative approach, however, has been made by Hoogovens who have stayed with the single chamber idea of the original stoves and have tackled the refractory problem itself. The main direction of their development work has been the partition wall between combustion chamber and chequer chamber which they have thickened to incorporate an insulating wall inside the main partition wall and for extra security have included a steel plate to prevent any short-circuiting should a brickwork failure occur. There have, of course, been other developments which apply to all the designs of stove mentioned which include separating the ring wall of the various chambers from the dome brickwork, hence allowing the ring walls to move freely.

In the Hoogovens design of stove, a careful study of the relative thermal expansion and contraction of the various refractory components within the stove has been made and in this respect the dimensional stability of silica at high temperatures has been beneficial.

The result of all this work is that there are now available stoves which are perfectly capable of providing hot blast at a temperature of 1350°C.

The problem, however, has now shifted back to the steelwork in all designs of stove with the appearance of intercrystalline stress corrosion which seems to start at a dome temperature of about 1400°C and become rapidly more prevalent as the dome temperature is increased. The exact cause of this corrosion is not yet known with certainty, but it is strongly connected with the presence of NO_x which is synthesized from nitrogen and oxygen at high temperatures and condenses on the inside of the stove shell if the temperature is low enough. So far counter-measures are to insulate the outer surface of the shell so as to maintain the inside temperature above the dewpoint of the acid or to protect the inside surface of the shell by a metallic sheet or by treatment with various types of paint. Alternatively, the stove dome operating temperature can be reduced to 1400°C to prevent the formation of the NO_x in the first place.

When the temperature of the dome is reduced, so also is the blast temperature, but it is possible to minimise the effect on the blast temperature by minimising the amount of dilution air used to control the blast temperature. The simplest way to do this would be to allow the dome temperature to fall progressively during every blast cycle of an individual stove, being restored to its maximum value when a new stove comes on gas. This was the method used by the early Cowper stoves but at some time the practice was changed to produce a constant temperature blast. The advisability of allowing the temperature to fluctuate in this "saw-tooth" manner depends on the amount by which it drops during a blast cycle and this leads us to one of the technically simplest ways of providing a uniform temperature as close as possible to the dome temperature, which is to use an installation employing large stoves and to change them frequently. This, however, would not be an economic solution and a better method is to use staggered-parallel operation whereby instead of using cold air to control the temperature blast, the air leaving a "fresh" stove is mixed with the air leaving an "old" stove so that the final temperature is closer to that of the maximum dome temperature for a given blast cycle time. Such a stove system tends to be more expensive since four stoves would be required instead of three, which is the traditional number employed in any given stove installation. Many plants, however, are foreseeing the advantage of the 4-stove system not only in making staggered-parallel operation possible, but also because the provision of the fourth stove minimises the effect on production in the event of failure in any of the units of equipment employed.

Staggered-parallel operation, however, is not easy to achieve in practice without computer control and all the 4-stove installations built by Davy have full computer control. The first one of these is at Algoma Steel Corporation in Canada, while the second which is for the British Steel Corporation's 14m blast furnace at Redcar is undergoing full simulation trials prior to commissioning. With the development of computer control, however, it becomes possible to envisage a more economic method of operating in staggered-parallel which is to operate a 3-stove system in this way. The computer system developed for the 4-stove staggered-parallel case is readily adaptable to 3-stove staggered-parallel, and by using such a system a higher blast temperature can be achieved for a given dome temperature with the same on-blast period, still retaining the possibility of continued operation with two stoves in the event of equipment failure.

In general terms, with a simple 3-stove system with cold air blast temperature control, the difference between the dome temperature and the blast temperature would be 150-200°C depending on stove sizing, whereas with 4-stove staggered-parallel this difference is reduced by about 50°C. With 3-stove staggered-parallel operation the difference would be somewhere in-between.

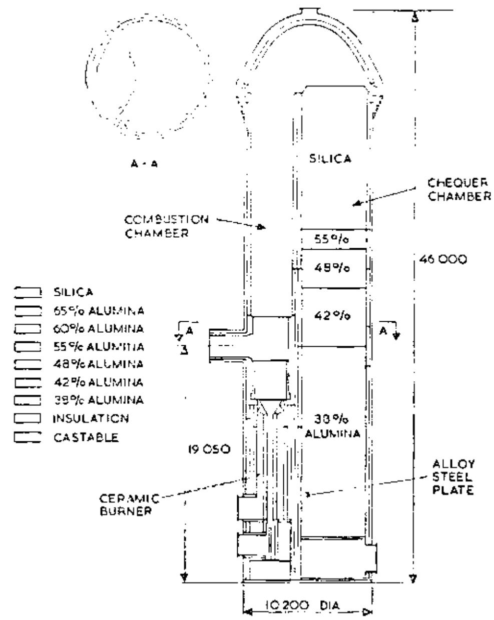


Fig. 27. HOOGOVENS DESIGN

In order to install and operate a stove installation in the most economic manner, the maximum use must be made of modern technology, not only in the refractory and steelwork design of the stoves themselves, but also in the manner in which they are operated. From the point of view of intercrystalline corrosion, dome temperature control is paramount and, since it is essential nowadays to enrich blast furnace gas with coke oven gas or natural gas in order to achieve the required dome temperatures, the addition of the enriching gas must be carried out under close control.

Davy had been involved in the design, construction, and operation of hot blast stoves for years and at the present moment are licensees of M & P for external combustion chamber stoves, and Hoogovens for internal combustion chamber stoves as well as being licensees of Hoogovens for the 4-stove staggered-parallel control system. This does not mean, however, that they are restricted to supplying only these designs of stove and in fact have supplied three sets of Didier stoves for British Steel Corporation, and have also supplied their own design of stove on a number of occasions, the last one being at Surahammar in Sweden in 1974. The wide range of involvement enjoyed by Davy with stoves of different designs puts us in a unique position to assess their rival merits and to select the best design for a particular application.

The choice of designs depends primarily on size of the installation, and on greenfield site it is clearly desirable to provide the furnace with a stove installation capable of giving as high a blast temperature as is practically feasible. At the present time it is completely feasible to provide an installation comprising three or four internal combustion chamber stoves operating in staggered-parallel, which would provide hot blast at 1300°C, with virtually no risk of intercrystalline corrosion occuring. Hoogovens is presently carrying out extensive research and development programme into means of combatting this particular problem, with the objective of making still higher temperatures completely feasible without risk.

It is Davy's firm conviction that the most economic solution to a hot blast stove installation lies in this direction, and any potential user should bear in mind that by minimising the dome temperature for any given blast temperature, the expenditure on enrichment gas is also minimised giving the total package the maximum cost effectiveness ratio.

APPENDIX 1

Operating Data	Ahmsa No. 5	Acominas
Iron make t/d	4,500	5,300
Coke rate kg/t	585	460
Oil rate kg/t	50	60/90
Burden	Lump ore 33% Pellets 67%	Sinter 100-82% Pellets 0-18%
Charging capacity % at t/d	130 at 4,500	150 at 5,300
Design HTP bar	1.5	2
Furnace Information		
Furnace construction	Free standing shell within four column tower	Free standing shell within four column tower
Hearth diameter m	11.2	11.5
Hearth area m^2	98.5	103.9
Inner volume m^3	2,510	2,761
Working volume m^3	2,163	2,294
Ratio: $\frac{\text{working volume}}{\text{Hearth area}}$	22	22.08
Height centreline tuyeres to stockline m	24.13	24.13
No. of tuyeres	28	28
Oil injection — type	Pressure atomised	Pressure atomised
Casting Floors		
No. of cast houses	2	2
No of iron notches	2	3
No. of slag notches	1	1
Cast house crane capacity	30	40/8
Main iron runner type	Fixed	Fixed
Final pouring	Tilting runner	Tilting runner
Tuyere platform	Separate floor	Separate floor
Fume extraction	—	Holds at tapholes and tilting runners Bag filters
Taphole drill	Pneumatic	Pneumatic
Clay gun	Hydraulic low level	Hydraulic low level
Tuyere stocks	Articulated	Articulated
Furnace Cooling		
Underhearth	Water	Water
Hearth jacket	Film	Film
Tuyere jacket	External box	Copper cooling plates
Bosh jacket	Film	Copper cooling plates
Stack	Copper/steel	Copper cooling plates
Cooling water system	Bosh and hearth open circuit with Cooling tower Remainder closed circuit with heat exchangers	Open circuit

Furnace Refractories	Ahmsa No. 5	Acominas
Hearth pad	Carbon	Carbon
Hearth annulus	Carbon	Carbon
Tuyere annulus	Carbon	50% Alumina
Bosh	Carbon	89% and 40% alumina
Lower stack	45% alumina	89% and 40% alumina
Upper stack	45% alumina	40% and 38% alumina

Turbo-Blower

Capacity Nm^3/min at pressure bar	5,000 at 3.6	5,700 at 4.3

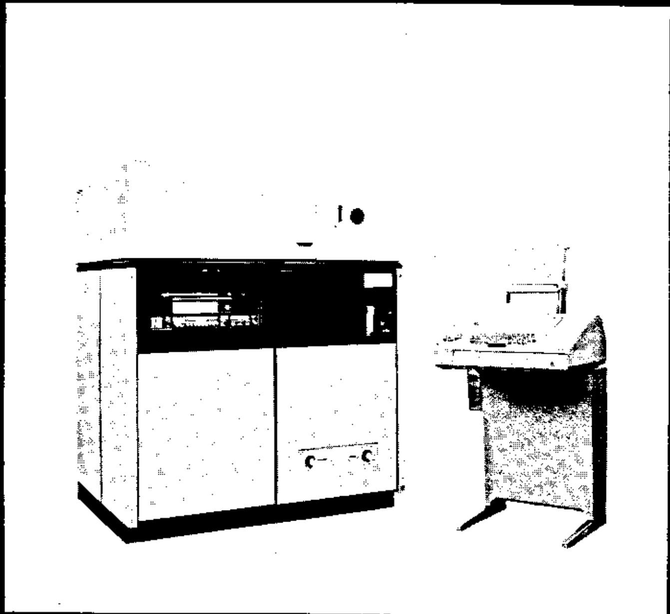
Hot Blast Stoves

Blast volume Nm^3/min	4,500	5,700
Blast pressure bar	3.2	3.3
Blast temperature at furnace °C	1,215	1,300
Dome temperature °C	1,415	1,400
Maximum flue temperature °C	400	400
No. of stoves	3	3
Operating mode	Cyclic	Cyclic
Type of stove	Internal combustion chamber	Internal combustion chamber
Time on blast, min.	35-40	30
Heating surface per stove m^2	51,000	72,820
Overall height m	40	46
Stove diameter m	8.6	10.2

Stove Refractories

Lower side walls	42% alumina	42% alumina
Middle side walls	42-48% alumina	42-48% alumina
Upper side walls	Silica	Silica
Lower chequers	38% alumina	38% alumina
Middle chequers	48-55% alumina	48-55% alumina
Upper chequers	Silica	Silica
Dome	Silica	Silica
Combustion chamber Upper	Silica	Silica
Middle	65% alumina	65% alumina
Lower	42-55% alumina	42-55% alumina
Burner	Ceramic	Ceramic

Furnace Charging (Top)	Ahmsa No. 5	Acominas
Charging method	Conveyor	Conveyor
Top distribution	Bell-Less	Bell-Less
Throat armour type	Fixed	Fixed
Valve operation	Hydraulic	Hydraulic
Equalisation	Nitrogen	Primary-semi-clean gas Secondary-nitrogen
Stockrods	Three automatic	Three automatic
Stockhouse		
Method of charging	Automatic	Automatic
Coke bins (No. x capacity m^3)	4 x 540	4 x 610
Sinter bins (No. x capacity m^3)	2 x 500	5 x 440
Pellet bins (No. x capacity m^3)	4 x 500	3 x 220
Miscellaneous bins (No. x capacity m^3)	2 x 230	2 x 220
Screening	All materials except miscellaneous	Coke and sinter
Dust extraction		Bag filter
Charge Conveyor		
Capacity t/h	1,310	3,000
Length x width x speed m x m x m/s	385 x 1.2 x 2	440 x 1.6 x 2
Angle	12	11
No. and hp of motors (kW)	4 x 112	3 x 300
Gas Cleaning Plant		
Type	Two stage variable throat venturi in one vessel.	Two stage Venturi. First Stage fixed. Second variable.
Capacity Nm^3/h at bar	378,000 at 1.5	434,000 at 2
Dust Content Inlet g/Nm^3	8	5
Outlet mg/Nm^3	5	5



HOW TO EVALUATE & SELECT SOLVENT CLEANERS FOR ROSIN FLUX REMOVAL

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ABSTRACT

The task of selecting a solvent cleaner for the removal of rosin flux residues after soldering involves consideration of many factors. One must first choose between the processes of cold cleaning and vapor cleaning. Another basic decision is whether to use a chlorinated or a fluorinated solvent type. This paper evaluates the relative merits of these alternative methods and cleaner types. It describes criteria that can be used to evaluate and select solvent cleaners that are effective, economical, safe and compatible with OSHA and EPA regulations. New data on azeotropic properties and flash point measurements are presented.

INTRODUCTION

Rosin or resin flux residues left on printed circuit boards and other electronic assemblies after soldering contain activators and their reaction and decomposition products (amine hydrochlorides, $RNH_3{}^+Cl^-$, being typical). These residues, which are ionic in nature, can lead to electrical leakage and cause corrosion if not completely removed after the soldering operation.

While the rosin itself is non-ionic and non-corrosive, it, too, should be completely removed after soldering since it partially encapsulates ionic residues from flux activators. Unremoved flux residues also can lead to sticking and malfunctioning of component switches, accumulation of dust which absorbs moisture causing shorts, and mealing and adhesion problems with conformal coatings.

Complete removal of flux residues is, therefore, a key factor in guaranteeing long-term reliability of electronic circuits and components.

BASIC CLEANING PROCESSES

Cold cleaning and vapor cleaning are the two basic techniques to choose between in selecting a process for rosin flux removal. An understanding of the mechanisms, equipment, advantages and disadvantages of each of these alternative techniques is essential in making a suitable process selection for any given cleaning job.

COLD CLEANING

Mechanism

In cold cleaning procedures, liquid contact accomplishes the solution and removal of soils rather than by means of the condensation of hot vapor. The term is usually applied to cleaning at any temperature below the boiling point of the solvent.

Equipment

The equipment used varies from simple shallow trays of solvent into which printed circuit boards are immersed by hand — to automated systems in which the boards, upon exiting from the solder wave, are conveyorized through an in-line cleaning process, frequently consisting of a series of solvent baths with counterflow circulation. In automated systems, the chemical solvency is usually mechanically aided by the liquid being pumped in a recirculating wave, by rotating brushes, spray nozzles, or ultrasonics. The cleaned boards can be dried with an air hose in hand-cleaning operations, or by means of air knives or a hot-air section in automated systems.

Creative Manufacturing Engineering Programs, Society of Manufacturing Engineers (c1977).

Advantages

- Use of relatively inexpensive equipment.
- Prevention of heat damage to parts.

Disadvantages

- Immersing work in a liquid that has been contaminated by assemblies already cleaned in it.
- Difficulty in controlling evaporative losses of the solvent.
- Need for forced drying after cleaning.
- Entrapment of solvent in "open" components.
- Requirement for a still to clean the solvent.

VAPOR CLEANING

Mechanism

In vapor cleaning, or vapor degreasing, the cleaning mechanism involves the condensation of solvent vapor directly on the cooler assembly. The condensate dissolves and carries away the soils. Condensation ceases when the assembly reaches the temperature of the vapor.

Equipment

Vapor cleaning can be accomplished in batch-type degreasers whereby soldered assemblies are accumulated in metal baskets and placed in the degreaser — or with in-line degreasers through which soldered assemblies pass on a conveyor. Besides cleaning in the solvent vapor, degreasers can be designed to allow cleaning by immersion in the boiling liquid, in the warm liquid distillate, or by spraying with liquid distillate. Usually a combination sequence such as vapor-spray-distillate-vapor is employed.

Advantages

- Minimizing of evaporation losses.
- Emergence of the assembly from the vapor in an already dry condition.
- Avoidance of soil contamination from assemblies already processed because cleaning can take place only in pure vapor and solvent distillate.

Disadvantages

- Cost of energy to boil the liquid and condense the vapor.
- Relatively high equipment costs compared to simple cold cleaning apparatus.
- The possibility of damage to heat-sensitive components.

POLAR SOLVENCY COMPARISON

Cleaning Solvents	Cold Cleaning (μgNaCl/cm^2)	Vapor Cleaning (μgNaCl/cm^2)
Chlorinated Solvent Type		
1, 1, 1 - Trichloroethane	6.0	4.0
1, 1, 1 + Polar Solvent (4%)	2.5	1.8
Perc. + Polar Solvent (10%)	0.9	1.8
Fluorinated Solvent Type		
F113 + Polar Solvent (4%)	7.3	5.0
F113 + Polar Solvent (6%)	4.6	2.4
F112 + Polar Solvent (15%)	4.6	0.9

Figure 1

CLEANER EFFECTIVENESS

To be effective, a cleaner blend should contain a non-polar solvent effective for removing non-ionic soils such as rosin and soldering oils — plus a polar solvent capable of dissolving ionic soils such as flux activators. The non-polar component is usually a halogenated solvent, either chlorinated or fluorinated type. The polar solvent is typically a low-molecular-weight alcohol such as methyl-, ethyl-, isopropyl-, or normal propyl alcohol.

IONIC SOIL REMOVAL

The capability of a cleaner for removing ionic soils and for enabling compliance to the cleanliness requirements of MIL-P-28809 can be established with the aid of an instrument which measures the quantitative level of ionic contamination on a printed circuit board following a given soldering and cleaning procedure. Figure 1 presents ionograph data which compare the relative effectiveness with which ionic flux residues can be removed by commonly used solvent cleaners. The numbers in the table represent the residual ionic contamination, expressed as micrograms of sodium chloride per square centimeter of board area, following a standardized procedure of applying flux to G10 epoxy fiberglass boards, wave soldering, and then cleaning with each of the solvent mixtures listed.

Note the superior effectiveness of the chlorinated solvent blends of 1,1,1 trichloroethane with polar solvent and perchloroethylene with polar solvent for removing ionic contamination as compared to use of straight 1,1,1 trichloroethane without a polar solvent component. Similarly, within the fluorinated solvent group containing blends of Fluorocarbon 113 and Fluorocarbon 112, note that as the polar solvent content increases so does the effectiveness for removing ionic contamination.

NON-IONIC SOIL REMOVAL

A good flux remover should contain a non-polar solvent to efficiently dissolve non-ionic soils such as rosin, yet it must not be so strong as to damage the electronic components or markings on the assembly being cleaned.

Kauri-Butanol (KB) value is a relative measure of solvency power; the higher the number, the stronger the solvent. A cleaner employing a solvent base with an intermediate KB value is desirable. Figure 2 compares the KB values of the non-polar solvent components of various cleaning solvent blends.

Perchloroethylene and 1,1,1 trichloroethane have KB values of 90 and 124 respectively, giving them a high degree of solvency for non-polar soils. Most printed circuit board materials, component plastics, and markings are not affected by normal exposure to them.

Cleaning of electronic assemblies containing plastics which are too solvent-sensitive for exposure to chlorinated solvents is accomplished with milder fluorinated solvents such as Fluorocarbon 113 and Fluorocarbon 112. The low KB value (30) makes Fluorocarbon 113 the least aggressive halogenated solvent commonly used with plastics, but also makes it relatively slow in removing rosin flux residues. Fluorocarbon 112 (KB value 70) approaches the stronger chlorinated solvents in cleaning effectiveness, yet is mild anough for use with some types of solvent-sensitive plastics.

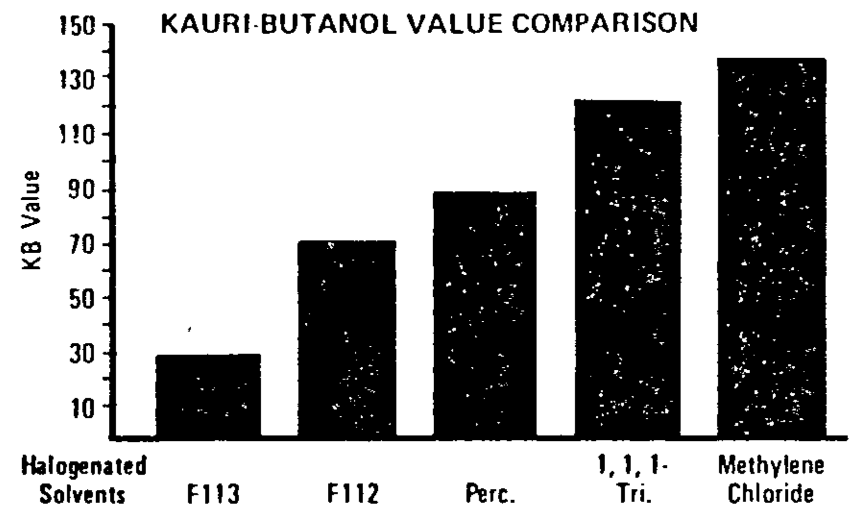

Figure 2

SOLVENT-POLYMER COMPATIBILITY

	Halogenated Solvents				
MATERIAL	MC	1,1,1	PERC.	F112	F113
ABS	C	C	C	B	A
Acetal Resin	A	A	A	A	A
Acrylic Resin	C	C	C	A	A
Cellulose Acetate	C	C	C	B	A
Epoxy Resin	A	A	A	A	A
Melamine	C	B	B	A	A
Natural Rubber	C	C	C	B	B
Neoprene	C	B	B	A	A
Nylon	A	A	A	A	A
Phenolic Resin	A	A	A	A	A
Polycarbonate	C	C	C	B	A
Polyethylene	C	B	B	B	A
Polystyrene	C	C	C	C	B
PVC	C	C	C	B	A
Silicone Rubber	C	C	C	C	C
Teflon	A	A	A	A	A

KEY:

"A" – least likely to evidence a solvent effect on the plastic.

"B" – may show a slight effect on the polymer by the solvent.

"C" – Most likely to have a solvent effect on the polymer.

Figure 3

Methylene chloride has the highest KB value (136) of any of the commonly used chlorinated solvents, making it too aggressive to component plastics for use with most electronic assemblies. Solvent blends based on methylene chloride find use in maintenance cleaning and for removing stains from ceramic substrates.

PLASTICS COMPATIBILITY WITH SOLVENTS

Figure 3 provides a starting point for selecting polymeric materials for solvent cleaning processes from a compatibility viewpoint. Solvent-polymer combinations designated with an "A" are least likely to evidence a solvent effect on the plastic. Combinations designated with a "B" may show a slight effect on the polymer by the solvent. The effect, if any, is dependent upon the particular grade of commercial polymeric material, as well as solvent exposure time and temperature. Combinations designated with a "C" are most likely to have a solvent effect on the polymer. It is recommended that each user conduct his own compatibility tests before selection

BOILING POINT STABILITY COMPARISON ON A HOT PLATE

Cleaner	Initial Boiling Point (°F)	Boiling Point after 50% Evaporation (°F)	Change in Boiling Point (Δ°F)
A	165	165	0
B	159	160	1
C	157	157	0
D	143	151	8
E	143	155	12
F	164	165	1

All cleaners are blends of 1,1,1-Trichloroethane + Polar Solvents

Figure 4

BOILING POINT STABILITY COMPARISON IN A VAPOR DEGREASER

Cleaner	Sump Temp. 4 in. Level (°F)	Sump Temp. 1 in. Level (°F)	Change Sump Temp. (Δ°F)	Vapor Temp. 4 in. Level (°F)	Vapor Temp. 1 in. Level (°F)	Change Vapor Temp. (Δ°F)
A	165	168	3	164	167	3
B	161	168	7	159	167	8
C	158	161	3	157	160	3
D	145	157	12	139	154	15
E	146	160	14	139	156	17
F	166	174	8	164	167	3

All cleaners are blends of 1,1,1-Trichloroethane + Polar Solvents.

Figure 5

of polymeric materials for assemblies and the solvents for cleaning them.

CLEANER AZEOTROPES

An azeotrope is a specific solvent blend which behaves like a single-component solvent. Its composition and boiling point remain constant during distillation.

Use of azeotropes of polar and non-polar solvents is highly desirable in vapor cleaning. The azeotrope vapors will contain both solvents, thereby enabling the vapors to remove not only rosin, but also activator flux residues and other ionic contaminants. Consistent cleaning results will be obtained since vapor composition will remain constant and the vapor temperature will not change. Additionally, use of azeotropes enables recovery of contaminated solvent by continuous distillation since the solvent composition of clean distillate fed back into the cleaning equipment will be the same as the solvent ratio of the dirty solvent.

The laboratory test in Figure 4 shows that not all vapor cleaning solvent blends have the azeotropic properties needed to maintain a constant temperature and composition in vapor cleaning. The tests consisted of heating each cleaner in a beaker on a hot plate, to boiling. The initial boiling temperature was measured. Each cleaner was then evaporated to 50% of its original volume and the boiling point again determined.

Note from Figure 4 that the boiling points of A, B, C and F after 50% evaporation remain substantially unchanged. This is an indication of their azeotropic characteristics. Note the relatively large increases in the boiling temperatures of D and E after evaporation. This is an indication of their non-azeotropic properties. D and E are, therefore, cleaners whose boiling points and compositions continually change during use in vapor degreasers — leading to inconsistent cleaning results and ruling out spent-solvent recovery by continuous-type distillation techniques in common use today.

Figure 5 compares the boiling point stability in an actual vapor degreaser of the same cleaners of Figure 4. Data in Figure 5 were obtained by operation of each solvent in a vapor degreaser at an initial sump (boiling side) level of 4 inches. The degreaser was allowed to operate until the sump level dropped to 1 inch height of solvent, through normal vapor diffusion losses, during idling. Temperatures of both sump liquid and vapor were recorded when the sump was at its initial 4 inch level and again when the sump was at the final 1 inch level.

Note the azeotropic characteristics of A and C as evidenced by a very small change in sump and vapor temperature while idling in a vapor degreaser. In comparison, note the marked changes in sump and vapor temperatures of cleaners D and E. Also, note the 6 - 7°F discrepancies, between the sump and vapor temperatures of D and E at the 4 inch level, which is an indication of different composition in the sump and vapor —namely, non-azeotropic properties. In contrast, the sump and vapor temperatures of A and C differ by only 1°F.

VAPOR CONDENSATION

The mechanism of vapor cleaning involves condensation of vapors on the cooler work surfaces, thereby dissolving and flushing away the soils. The assembly steadily heats up and eventually reaches the temperature of the vapors, at which point condensation ceases — and so does cleaning.

Cleaners based on Fluorocarbon 113 have limited time for solvent vapor condensation since the assemblies rapidly heat up from ambient temperature to the low boiling point of the cleaner (a typical boiling point being 112°F). In contrast, cleaners based on Flourocarbon 112 or 1,1,1 trichloroethane with their higher boiling points (typical boiling points being 180°F and 165°F, respectively) — result in substantially greater vapor condensation time before the assembly reaches the vapor temperature. This provides a longer cleaning period and can result in a cleaner product.

SOLVENT LOSSES IN VAPOR CLEANING

Fluorocarbon 112 has a lower vapor pressure than Fluorocarbon 113. Use of cleaners based on Fluorocarbon 112 results in less solvent losses and a lower consumption rate than use of cleaners based on Fluorocarbon 113.

For assemblies that can tolerate a more aggressive solvent, cleaner blends based on 1,1,1 trichloroethane offer a lower cost alternative as well as a lower vapor pressure than cleaner blends based on Fluorocarbon 113.

The high boiling point of perchloroethylene (250°F) usually precludes its use as a vapor cleaner with electronic assemblies that may be damaged by exposure to a high temperature.

SOLVENT LOSSES IN COLD CLEANING

Since fluorinated solvents are considerably more expensive than chlorinated solvents, they are seldom used in cold cleaning where solvent evaporation losses are difficult to control. Perchloroethylene which has approximately one-half the evaporation rate of 1,1,1 trichloroethane is an ideal solvent base for cold cleaners.

FLASH POINT CONSIDERATIONS

The degree of flammability hazard of organic solvents is most frequently determined by flash- and fire-point measurements. Flash point is defined as the lowest temperature at which application of a test flame causes the vapor at the surface of the liquid to flash (ignite). Fire point is defined as the lowest temperature at which the vapor ignites and continues to burn for at least 5 seconds.

FLASH POINT COMPARISONS BEFORE AND AFTER EVAPORATION USING TAG OPEN CUP METHOD

Cleaner	Flash Point As-Received	Flash Point after 50% Evaporation	Fire Point As-Received	Fire Point after 50% Evaporation
A	none	none	none	none
B	70°F	67°F	74°F	69°F
C	74°F	63°F	77°F	63°F
D	113°F	65°F	130°F	67°F
E	none	99°F	none	102°F
F	107°F	97°F	114°F	101°F

Note: None of the cleaners have flash points either as-received or after 50% evaporation when tested by Tag Closed Cup Method.

All cleaners are blends of 1,1,1-Trichloroethane + Polar Solvents.

Figure 6

There are several recognized techniques for measuring flash points, with the flash point value varying, depending on the method used. When comparing values, it is, therefore, important to know how the flash points were measured.

In the Tag Open Cup flash point test (ASTM No. D1310), the sample is placed in an open cup and heated at a low but constant rate. A small test flame is passed at a uniform rate across the cup at specified intervals until the vapor ignites. This method best approximates what might occur if a spark or flame came in contact with the product vapors in an idling degreaser, for example, where solvent vapor is continually in contact with combustion-supporting air.

In the Tag Closed Cup flash point test (ASTM No. D56), the sample is placed in the cup of the tester and, with the lid closed, heated at a specified constant rate. A small flame of specified size is directed into the cup at regular intervals until the vapor ignites. This second method closely approximates what might occur if solvent in a sealed drum were exposed to a spark or flame when the bung was removed.

The Tag Closed Cup flash point method gives misleading results concerning the flammability hazards as related to user safety of the types of solvent blends under discussion. With blends of chlorinated or fluorinated solvents and polar solvents such as alcohols, it is common to find no flash point by Tag Closed Cup. Yet, the same mixtures yield flash points of 70 to 120°F when the Tag Open Cup technique is used.

Some solvent flash point data is reported by yet another method, Cleveland Open Cup (ASTM No. D92). Use of this method makes products "appear" safer than they are because it results in a higher flash point value than would be obtained if the same solvent were tested by Tag Open Cup. The Cleveland Open Cup is really meant for liquids flashing above 175°F, which makes it inappropriate for use with volatile solvents.

Figure 6 lists the flash and fire points both before and after 50% evaporation, using the Tag Open Cup method, of the same group of cleaners for which boiling point data were presented in Figure 4.

It is apparent from Figure 6 that most of the cleaners listed have Tag Open Cup flash and fire points, as-received and after 50% evaporation. This is an indication of their flammability hazard. Note, however, that cleaner A does not have a flash or a fire point either as-received or after 50% evaporation. Note the tremendous decrease in the flash point of cleaner D after evaporation due to its non-azeotropic, rapidly changing composition. It should also be noted that cleaner E starts out without a flash point, but due to

FLASH POINT COMPARISONS OF VAPOR DEGREASER SUMP SAMPLES USING TAG OPEN CUP METHOD

Cleaner	Sump 1 in. Level Flash Point	Sump 1 in. Level Fire Point
A	none	none
B	76°F	106°F
C	56°F	58°F
D	73°F	83°F
E	61°F	64°F
F	61°F	64°F

All cleaners are blends of 1,1,1-Trichloroethane + Polar Solvents

Figure 7

composition changes upon evaporation, becomes flammable. Cleaners B, C and F show flash and fire points throughout.

The fact that none of the products tested in Figure 6 produced flash points by the Tag Closed Cup method, either as-received or after 50% evaporation, is an indication of that method's unsuitability for measuring the flammability hazard of halogenated solvent blends.

Figure 7 lists Tag Open Cup flash and fire points of the vapor degreaser sump solvents listed in Figure 5.

Note that cleaner A is the only cleaner that does not have a flash or fire point as the sump level decreases to 1 inch through vapor diffusion losses.

CLEANER STABILITY

Use of an improperly stabilized cleaner could result in reaction of the solvent blend with the metals from the assembly being cleaned, even with metals of the cleaning equipment itself. Such decomposition products are acidic and corrosive. Quality cleaners are formulated with complete stabilizer systems, including inhibitors and antioxidants, to prevent solvent degradation, as well as acid acceptors which neutralize any acidity that might develop.

In accomplishing their function, stabilizers are depleted in use. The rate of stabilizer depletion is dependent upon the type and quantity of flux residues being removed, the degree of solvent exposure to reactive metals such as zinc and cadmium, and the frequency with which fresh cleaner is added to the system to make up for evaporation and drag-out losses. It, therefore, becomes important to monitor the solvent in use, making certain that its stabilization "package" is still present at a sufficient level to prevent solvent degradation. This is best accomplished by checking the cleaner's acid acceptor content or its water extract pH. Many vendors have simple procedures available for performing these tests and can advise the minimum stabilizer levels for which each cleaner product is acceptable for continued use.

Once a cleaner has reached the point of soil contaminant build-up, or stabilizer depletion, at which it is not suitable for continued use, the cleaner can be reclaimed by distillation. It is recommended that 3 to 4 parts of virgin cleaner be mixed with 1 part reclaimed material when recharging the cleaning system. The stabilizers in many cleaners are recovered along with the solvents during distillation.

OSHA AND EPA CONSIDERATIONS

It is essential to the health of workers in close proximity to chemical products used in the plant, that the vapor concentration in the working environment be maintained below established threshold limit values (TLV's).

In comparing the relative toxicity of the various solvent cleaners, both the TLV and vapor pressure must be considered. Other characteristics being equal, if two solvents have the same TLV, the one with the higher vapor pressure will be more difficult to maintain below its TLV concentration. The components of most solvent cleaners commonly used in industry are readily capable of being maintained below their TLV concentration with proper ventilation equipment and practices.

Solvents such as trichloroethylene, ketones, and aromatics, have been found to contribute significantly to photochemical smog production in the atmosphere. Most vendors try to formulate cleaners with solvent constituents that have not been designated as having a high degree of photochemical reactivity and are, therefore, not overly restricted in use by existing air pollution regulations.

CONCLUSIONS

Selection of the best solvent cleaner for a particular electronic cleaning application need not be that difficult a task.

– First, choose between the simplicity of cold cleaning and the higher efficiency of vapor cleaning.
– Next, determine whether the printed circuit boards, component materials, and markings are compatible with the more effective yet more aggressive chlorinated solvent blends. Solvent-sensitive materials will dictate the use of milder, somewhat less efficient fluorinated cleaners.
– Then, try to select a cleaner that has each of these desirable properties:
    – Effectiveness of removal of both ionic and non-ionic flux residues.
    – Azeotropic properties for consistent performance and economic distillation.
    – Non-flammable by all of the common methods of flash point measurement.
    – Formulated with complete stabilizer systems.
    – Readily capable of maintenance below TLV concentration to meet OSHA requirements.

ACKNOWLEDGEMENT

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PM

A RHEOLOGY MODEL FOR OIL-IN-WATER

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ABSTRACT

Experiments have been performed to study the dynamic properties of lubricant films formed by different percentages of oil in an oil-in-water emulsion. The apparatus used was a rolling disk machine which can simulate the high-shear-rate, high-pressure, dynamic conditions which exist in the contact zone of a steel or aluminum rolling mill. The results indicated that the behavior of an emulsion is not directly related to the percentage of oil and water present. Small percentages of oil (less than 5 percent) can produce a lubricant which has significantly lower friction and higher hydrodynamic film thicknesses than the plain water.

INTRODUCTION

Oil-in-water emulsions are currently in use as lubricants and hydraulic fluids for a number of applications. The advantages of low price, good thermal capacity, and inflammability make them an attractive choice. However, the complexity of their nature requires rigid control during their preparation and use. The lubrication effectiveness of the emulsions is influenced by the state of the emulsion; that is, the size of the particles of oil and their bond with the water influence the way the emulsion performs.

One particularly important application for an emulsion is as a lubricant for rolling steel and aluminum sheet. In this context, the effectiveness of the emulsion is usually described[1] in terms of its "plate-out" capability. "Plate-out" describes the ability of the emulsion to deposit a chemically or physically attached oil film on the strip and roll surfaces. This film is measured typically by spraying or dipping a strip specimen in the emulsion and determining the amount of oil left on the strip surface. However, such evaluations do not necessarily relate to the dynamic performance of the lubricant in a rolling mill. The immersion times and the dynamics of the test situation bear no resemblance to the conditions imposed on the emulsion in the mill.

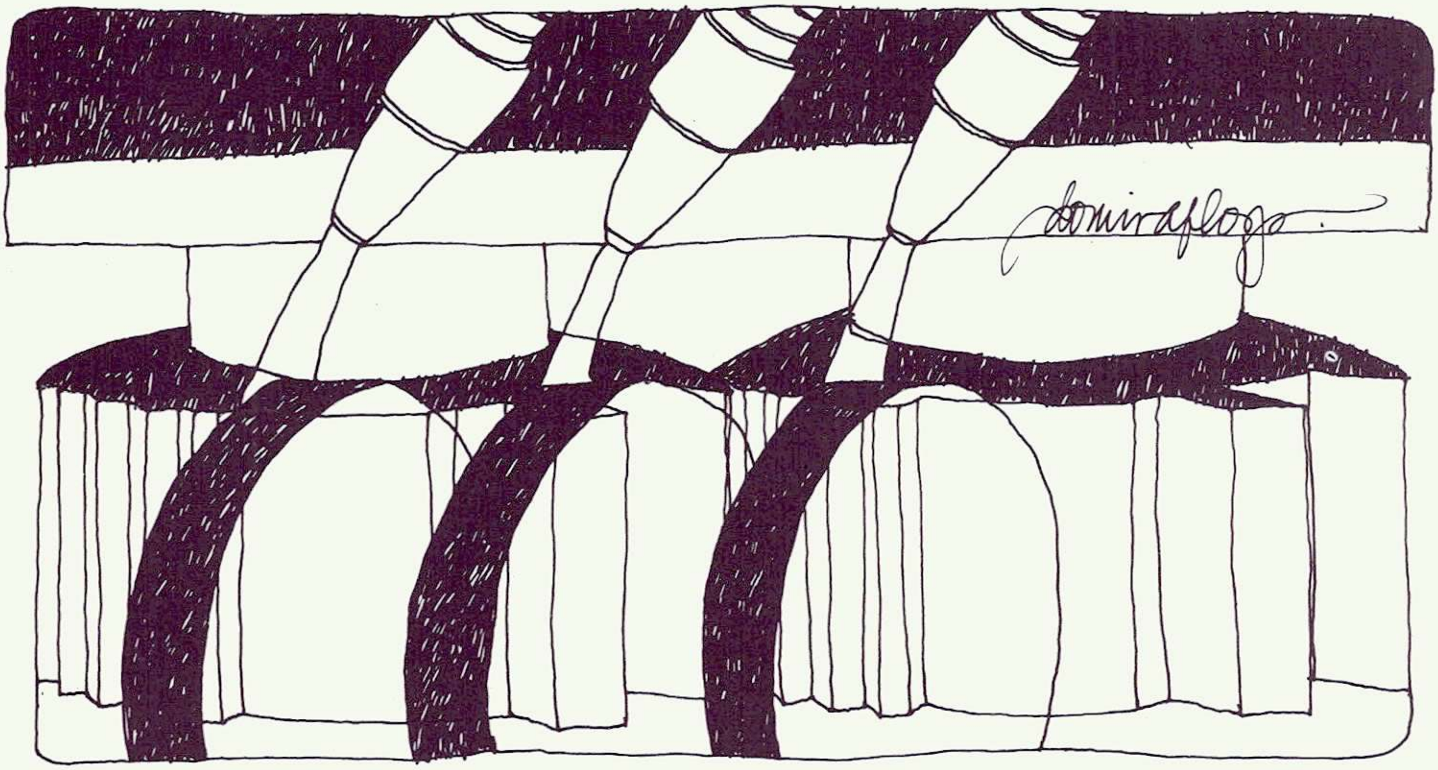
For these reasons, a new method of evaluating the dynamic performance of an emulsion has been used. This method involves jetting the emulsion into the high-pressure region between a pair of rolling disks and measuring the properties of the fluid in that region. The advantage of such experiments is that they are performed under dynamic conditions similar to those present in the contact zone of a rolling mill. The experimental method has been developed to studv lubricants[2] for applications in rolling contact bearings and gears. In these cases, the relative motion of the mating surfaces and the viscuous properties of the oil produce hydrodynamically-formed lubricant films. These films, which are formed by dynamic and not by chemical effects, can exist even for pressures greater than 1500 MPa.

The objective of this paper is to show the results of measurements of film thickness and frictional force in rolling/sliding disk contact for a neat oil and emulsions containing various percentages of that neat oil. A discussion of the results leads to a model which describes the relative influence of the oil and water in the high-pressure contact region.

EXPERIMENTAL APPARATUS

Rotating Assembly

The apparatus used for the experiments is the Battelle's



Columbus Laboratories rolling disk machine.[2] The essential features of this machine are shown in Figure 1. Two independently – driven disks are loaded together and lubricant is supplied to their contact region. This region, which theoretically has parallel sides because of the elastic deformation of the mating disks, contains a thin layer of the lubricant on the order of 0.05 to 0.5um thick. By driving the disks at different speeds, this fluid film can be sheared and its frictional properties measured. Further, because of the short time that the fluid in this contact region is retained (on the order of 50 millionths of a second) highly transient effects can be evaluated.

The disks used for the experiments have been fabricated from A1S1 M-50 steel and have a diameter of 36 mm. The disks have a lapped surface finish with a centerline-average roughness of 0.03um. The lower disk is cylindrical and the upper disk is crowned with a crown radius of 140 mm. The crown produces a contact area which has a width-to-length ratio of 6, where the length is measured in the direction of rolling. The crown on the upper disk allows for slight misalignment of the two drive axes without affecting the contact area. A load of 80 lbs on the disks produces a maximum Hertz stress of 1000 MPa.

Measurement Systems

To study the properties of the lubricant film formed between the rolling/sliding disks, two important experimental measurements must be made. The first is the traction generated across the film as a function of slip between the disks. The slippage is induced between the disks by reducing the speed of the upper disk. As shown in the inset of Figure 1, when the disks are operating at different speeds, there is a velocity distribution across the film. This variation in velocity gives rise to shear stresses in the fluid which, when added up over the area of contact, produce a force (traction) tending to move the upper disk to the right. The load cell responds to this force, thereby providing a measure of the traction in the lubricant film.

The second key measurement is the lubricant film thickness (h_o in Figure 1) developed between the disks. This extremely thin film, on the order of 1 millionth of a meter, is measured by detecting the rate of x-ray[3] transmission through the contact zone. A source is mounted behind the disks and supplies a beam of x-rays to the contact region (see Figure 1). The rate of x-rays which pass through the fluid in the contact area can be related to the thickness of that film.

EXPERIMENTAL RESULTS

Film Thickness and Traction Data

The measurements of film thickness and traction made on the disk machine can be used to study the relative performance of neat oils and emulsions. The film thickness indicates the thickness of the hydrodynamically-formed film between the mating disks, and the traction is a measure of the friction necessary to shear that film. The influence of oil percentage on these performance criteria using a tallow-based emulsion is the subject of this paper. The results are for a single load (1,000 MPa or 150,000 psi) and a single rotational speed (5,000 rpm), which corresponds to a disk surface speed of 9.5 M/Sec. The temperature of the emulsions was 65°C.

The emulsions were prepared using distilled water and a natural beef tallow oil with one-half percent of a polyethlene glycol ester added as an emulsifier. The emulsion was supplied to the contact zone with a centrifugal pump at 15 psi. A portion of the emulsion was recirculated to the pump and a propeller-type mixer was also used to insure a uniform emulsion. The particle-size distribution of the oil in the emulsion is shown in Figure 2 for an oil percentage of 5 percent. The average particle size (the particle diameter for which half the particles are larger and half are smaller) for this emulsion is 9 um. The average particle sizes for the other emulsions were as follows: 3.4 percent oil, 9 um; 10 percent oil, 11 um; 25 percent oil, 16 um; and 50 percent oil, 31 um.

Figure 3 shows the hydrodynamic film thickness measured in the disk machine for pure rolling conditions as a function of oil percentage. For pure water, there was no measured hydrodynamic film. As the percentage of oil in the water was increased, the film thickness increased up to 0.5 um for the neat oil.

The tractions measured for the neat oil and emulsions are shown in Figure 4.

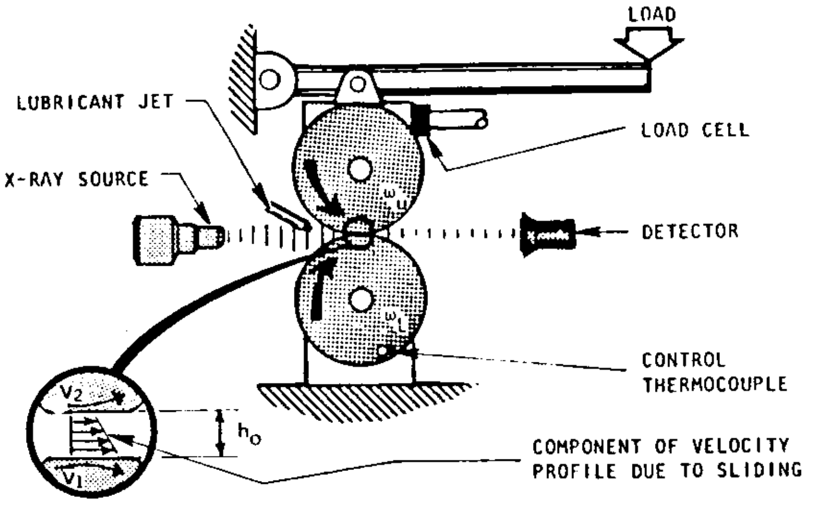


FIGURE 1. SCHEMATIC DRAWING OF ROLLING-DISK APPARATUS

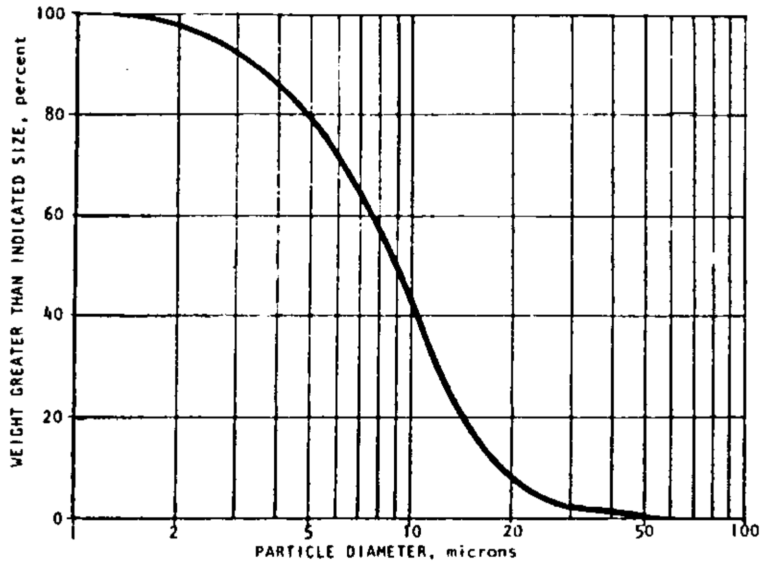


FIGURE 2. OIL PARTICLE SIZE DISTRIBUTION IN .5-PERCENT EMULSION

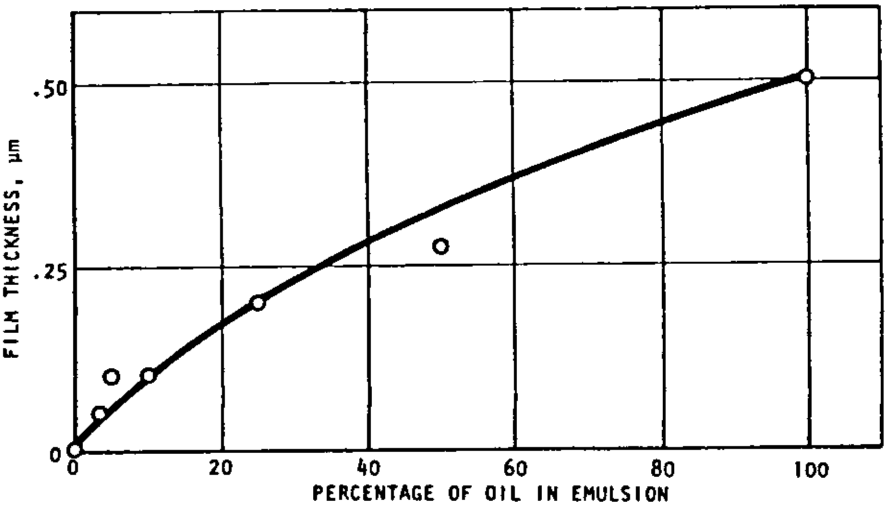


FIGURE 3. THE EFFECT OF OIL PERCENTAGE ON HYDRODYNAMIC FILM THICKNESS

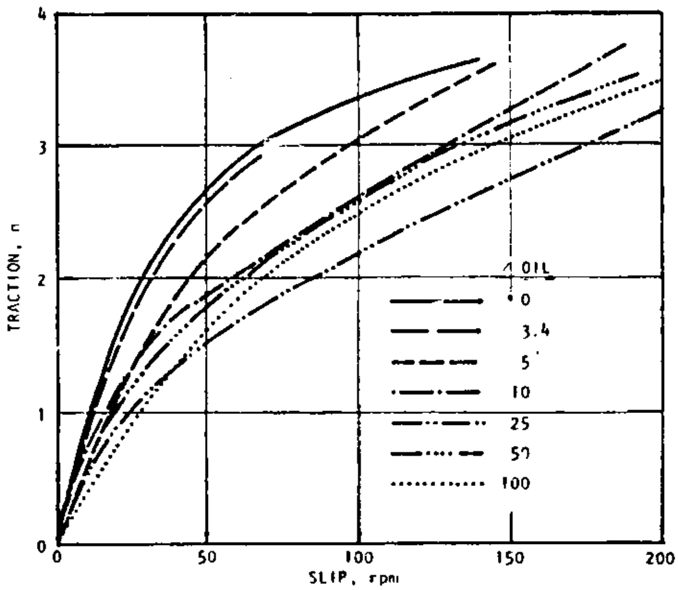


FIGURE 4. TRACTION/SLIP CURVE FOR NEAT OIL AND EMULSIONS

At zero slip, the fluid is not being sheared and, hence, the traction is zero. As the slip is increased, the film resists the motion, and the traction rises linearly for low values of slip. As the slip is further increased, other factors, including shear heating, reduce the rate of rise of the traction. In general, the traction force (friction) is reduced as the percentage of oil in the emulsion is increased. However, at large values of traction, the thermal properties of the lubricant in response to shear heating become important and may change the relative tractional values of the emulsions.

The most important region of the traction curve is the linear region near zero slip. It is in this region that the fluid is assumed to be Newtonian and the viscosity can be calculated. The slope of the traction curve at low values of slip is plotted as a function of oil percentage in Figure 5. The slope is steepest (that is, the increase in traction with slip is the greatest) for the pure water. The slope drops rapidly as small amounts of oil are added to the water, but after reaching about 15 percent oil, the change in slope as more oil is added is much less pronounced.

The slope is the smallest for the neat oil.

Interpretation of Results

The slope of the traction curve at low values of slip and the corresponding values of hydrodynamic film thickness for a range of disk loadings can be used to calculate[2] the effective viscosity of a Newtonian fluid in the contact zone. This calculation is based on the assumptions that a) the traction is a measure of shear stress in the fluid film, and b) the slip divided by the film thickness is a measure of shear rate. The calculation also takes into account the geometry of the contact and the pressure distribution.

Viscosity is defined as the parameter which relates the rate of strain (shear rate) imposed on the fluid to the resulting shear stress. If a linear relationship exists (Newtonian fluid), the shear stress (t) can be written as

$$t = u \frac{V}{h}$$

Where

u = viscosity
V = difference of the surface speeds
h = film thickness
V/h = rate of strain or shear rate

The shear stress is the tractional force divided by the area so that Equation 1 can be rearranged to read:

$$u = \frac{T}{V} \cdot h \cdot \frac{1}{AV}$$

where

T = traction
V = surface speed of disk
A = area of contact between disks
$\frac{T}{V}$ = slip in traction curves

The shear stress is not constant over the contact area, but for a given load and speed condition, the viscosity shown in Equation 2 will be proportional to the slope of the traction curve,

$$\frac{\frac{T}{V}}{V}$$

times the film thickness (h). Thus, an expression for relative viscosity (u') can be written as

$$u' = \frac{\frac{T}{V}}{V} \cdot h$$

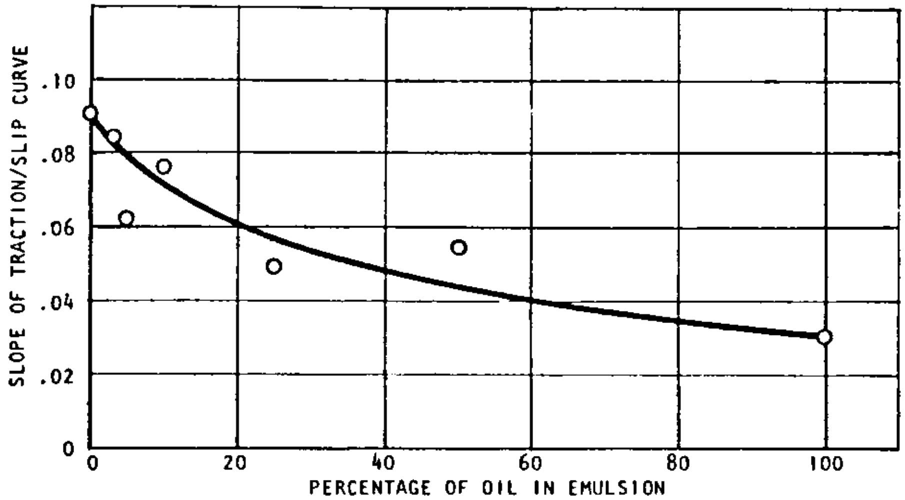


FIGURE 5. THE EFFECT OF OIL PERCENTAGE ON THE SLOPE OF THE TRACTION/SLIP CURVE

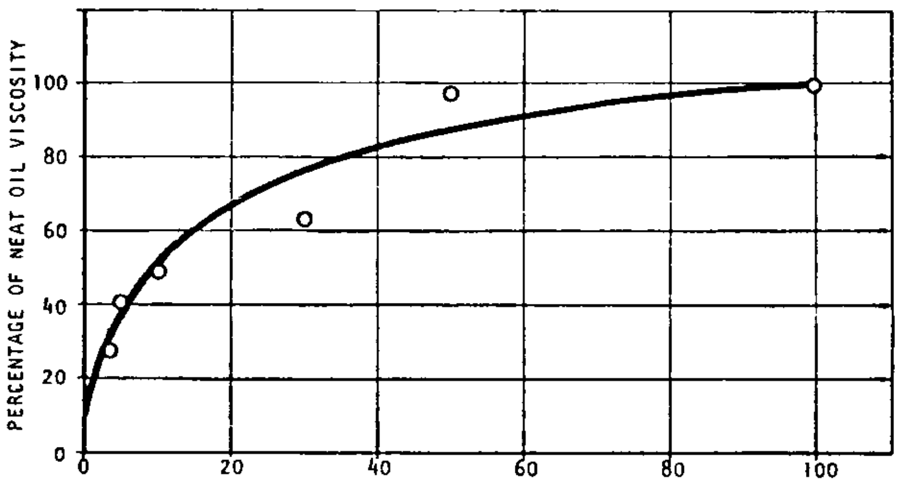


FIGURE 6. PERCENTAGE OF OIL IN EMULSION

The relative viscosity, based on a percentage of the neat oil viscosity, is plotted in Figure 6 as a function of oil percentage in the emulsion. For the water alone, the viscosity is quite low. However, the addition of only small quantities of oil to the water produces a spectacular rise in viscosity of the emulsion. In fact, an addition of 10 percent oil to the water produces a fluid with approximately half the viscosity of the neat oil, and an emulsion made up of 50 percent oil-in-water has about 90 percent of the viscosity of the neat oil.

DISCUSSION

The results of the disk-machine experiments indicate that the behavior of the emulsion is not directly related to the percentage of oil and water present. Small additions of oil can produce significant changes in the properties of the fluid film developed.

The hydrodynamic film thickness was quite different for the neat oil and the plain water. A hydrodynamic film is formed by the relative motion of the surfaces but is greatly enhanced by the change in viscosity of the fluid with pressure. The neat oil increases in viscosity from 20 cp to 24,000 cp as the pressure is raised from 0 to 1,000 MPa, whereas the water exhibits a relatively uniform, but low, viscosity over this pressure range. The water is not pulled strongly into the contact zone because of its low viscosity, and it can easily flow back out in response to the high-pressure gradient in the contact zone. Therefore, very thin films (less than 0.02 um) are formed with the water. The oil, on the other hand, because of its higher viscosity, is pulled more strongly into the contact zone by the relative motion of the surfaces and its increased viscosity with pressure reduces the flow back out of the contact zone. The result is a thick lubricant film which can exist even at pressures sufficient to plastically deform steel strip materials.

The film thickness is reduced as water is added to the oil. An explanation for this behavior can be related to the motion of the water through the conjunction region of the disks. In Figure 6, it was shown that the viscosity of the emulsion varied little as the oil percentage was reduced to 50 percent, but the film thickness shown in Figure 3 was greatly reduced. Such behavior is similar to that experienced using a neat oil if the contact is starved for lubricant; that is, the flow of oil is reduced to less than required to generate a full hydrodynamic film. The reduced film thickness will produce a higher shear rate and result in higher traction values (shear stress) for the same fluid viscosity. Thus, it would appear that the water in an emulsion is starving the contact for lubricant by its presence in the contact zone.

As more water is added to the oil, the emulsion becomes more dilute, and exhibits less of the influence of the neat oil. However, even for lubricant percentages of less than 5 percent, the resulting emulsion has significantly higher film thickness and lower tractions than the plain water.

CONCLUSIONS

This paper describes a new method for evaluating the performance of a lubricant emulsion. Dynamic conditions which exist in a metal-rolling operation are simulated and the properties of the fluid at those conditions can be examined. The data presented, although limited to a single lubricant, shows the effect of the water phase on the emulsion and establishes the sensitivity of the measurement technique. Different base oils, emulsifiers, and oil/water percentages may produce different results that have been presented here, but the method of evaluating emulsion performance based on the dynamic properties measured in the disk machine represents a more realistic approach to emulsions rheology studies.

ACKNOWLEDGEMENT

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The members of the group were:

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- National Steel Corporation
- Nippon Kokan K.K.
- Quaker Chemical Corporation
- Sidbec-Dosco
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BRIDGING THE TECHNOLOGY GAP IN THE FOUNDRY INDUSTRY

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Paper delivered during the PFS 7th Metalcasters' Convention held at DAP, Tagaytay City, 30 June 1979.

I would like to discuss with you a very important subject in the future development of the Metalcasting Industry. I will attempt to offer suggestions on Bridging the Technology Gap of the Industry.

Before going into the subject, may I present to you the highlight of the industry in the Asean region as presented in a Research Report on the Technology Transfer Needs of the Asean Countries prepared by Mitsubishi Research Institute Inc.

1. More than half of the foundries in the ASEAN countries are on a small or medium scale.
2. The indigenous foundries make castings for simple machine parts by using old fashioned equipment and based on traditional artisans.
3. There are few foundries that produce machinery castings for simple machine parts.
4. High grade machinery parts have started to be produced in joint ventures and technical aid.
5. At present, a shortage of skilled foundrymen, limitations of market, and difficulties of acquiring proper raw materials are the problems that need immediate attention.

Let us focus our spotlight on the Philippine setting:

THE PHILIPPINES

There are 166 foundries in the Philippines, most of which are small foundries with less than 49 employees. These foundries account for 64% of the total number of casting factories. Seventy-two percent (120) of these foundries are concentrated in the Manila district.

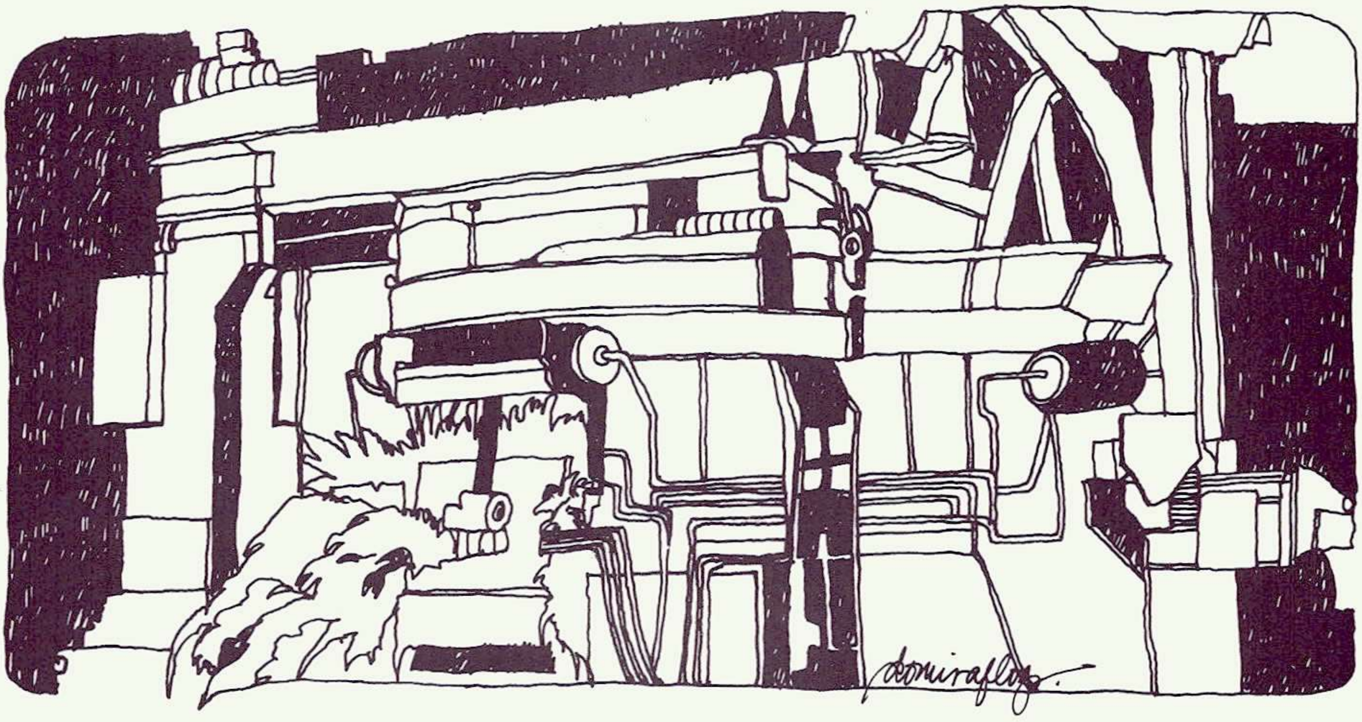
The Philippines is the largest producer of castings among the ASEAN countries with 98,500 tons of castings produced in 1976, and she imported only 25,000 tons in that year. There are an estimated 250 engineers in the casting industry along with 3,300 skilled workers. About one-third of the skilled workers have 10-20 years of experience. Very few people have more than 20 years of experience and the rest have less than 10 years of experience.

Cupolas are the most commonly used furnaces for the melting of pig iron, and there are a limited numbers of foundries that have installed production-type electric furnaces. Green sand is primarily used for making moulds.

Large foundries send engineers overseas for training and invite consultant engineers to provide training. There are some manufacturers who have licensing and royalty contracts with foreign companies in order to raise their technology level.

The MIRDC (Metals Industry Research and Development Center), a semi-government organization, provides technical training, seminars, and test facilities for improvements in special technology for management of sand and various tests, quality control, manufacture of wood moulds, melting techniques, die-cast casting methods, investments casting methods and improvements in other areas in an effort to narrow the technology gap in the Philippines.

Most of the technical problems with which the foundry industry is faced today is traceable to the present structure of the industry. The foundry industry is primarily comprised of small enterprises which are dependent upon the other traditional industries, like agriculture, construction, fishing and mining, for casting of replacement parts or for casting components needed in its expansion which does not require a high degree of quality standards.



With the industrialization program of the government in high gear, where local content programs are stressed, the all-out effort to go into non-traditional export products is encouraged. The foundries are compelled to improve and modernize their present technology and facilities to be in phase with the present demand.

Let us, therefore, look at some of the basic problems of the Philippine Foundry Industry.

1. Lack of appropriate technology.
2. Lack of quality control philosophy and facilities.
3. Lack of technical standards.
4. Lack of training on appropriate technology.
5. Lack of adequate volume of production to provide proper facilities to assure the meeting of technical and quality standards demanded by end-users.

Looking at some of the specific technology-related foundry problems, we have the following:

A. **Moulding:**

1. Availability of local graded sand.
2. Availability of appropriate grades and quality of chemicals and additives.
3. Lack of adequate moulding machines required to supply the casting requirements.
4. Lack of adequate and specialized pattern tooling facilities.

B. **Core Making**

1. Availability of sand, chemicals and additives of proper grade and specification in the local market.
2. Inadequate technology in the art and science of core making.

C. **Melting:**

1. Reliability of the quality of scrap available.
2. Lack of understanding by both the Foundry Plants and the end-users of desirable standards.

D. **Finishing:**

1. Lack of finishing facilities like Shot Blasting Machine.
2. Lack of understanding between Foundry and end-users of acceptable standards.

The casting technology is a combination of art and science of various descriptions. The elements and factors involved in the process are complex and diverse and it is sometimes difficult to predict and judge the results. Only an accumulation of experience leads to the acquisition of knowledge.

Philippine Foundries by Employer Scale and By Material

Material Employee Scale		Total	Cast Iron	Cast Steel	Aluminum	Copper Alloy	Others
Less than 20		37	15	–	11	9	2
20	– 49	58	36	4	10	8	–
50	– 99	27	18	3	5	1	–
100	– 199	20	16	2	–	2	–
Over	– 200	7	5	2	–	–	–
		90	11	26	20		
Total		149	90	11	26	20	2

Source: MIRDC, Metalcasting Industry of the Philippines, 1977

Casting technology, unlike other manufacturing technology, has a considerable amount of artistic environment which, therefore, makes casting as a difficult technology.

I would like to pick up a few of these technology-related problems and offer some suggestions and recommendations on how we can bridge the gap.

As stated awhile ago, 64% of the 166 foundries are considered small with a complement of 49 employees or less. It is, therefore, safe to assume that most of these foundries could not be organized and manned completely with people that will be able to cope with the present day demand of the industry and would, therefore, rely on indigenous skill in the organization.

It is, therefore, timely for an industry survey of the skills required and determination of the priorities after this survey is accomplished. The industry should set up a specialized institute with a specially designed program: (1) a crash program that will have to be completed in 2 years to update skills of present practitioners in the industry; and (2) a long range program to provide a continuing supply of appropriate trained manpower for future expansion.

The above training programs suggested should not only be on the theoretical approach, but also must include on-the-job training and practicum in the institutes' own facilities or in-plants of cooperating members.

The MIRDC, which has started on the endeavor, will be one of the basic technological resources to augment whatever program may be designed.

The government thru its appropriate agencies should help the industry solicit technical aid along the line of the designed program.

With this system, we will be able to develop the outlook of the participants to understand the macro and micro technical problems of the industry.

Let us now go to the problem of lack of appropriate raw materials, such as sand. As stated previously, sand is the predominant material for mould. Inasmuch as many of our casting quality problems are traceable to improper sand quality, I would suggest that the society spearhead the formation of a consortium of Foundry sand end-users, sand suppliers and other interested parties to set up a Sand Processing Plant that will be able to adequately supply the needs of the Foundry with appropriate quality, that will also hold true for other materials that need processing, as the setting up of such processing plants are governed by economics of scale. Individual small foundries are reluctant to invest in such facilities. With this scheme, the foundries will be able to get materials at reasonable cost and reliable quality as they will also have a hand in its operation.

Another area that can be looked into is the establishment of specialized support facilities that can supply tooling, moulds, patterns, repair of specialized machines and equipments, die-casting moulds, core boxes, flash, etc.

Presently, most of these are made by machine shops which cater to different industries which would, therefore, put the responsibility of supplying design to the end-user. If both the end-user and the contractor do not have enough know how, we end up with a lot of uncertainty.

Some of the larger foundries which are integrated, perform these services in-plant and service others in the industry, if there is an opportunity to do so. This, therefore, forces small and medium sized foundries to make do on what is available.

If we can establish such support industries, we will be able to utilize most of our indigenous talents to the maximum and be able to afford more sophisticated facilities to produce and perform such specialized services. This can also provide opportunities to highly specialized technologists nearing retirement or reaching redundancy in their present position to organize such facilities in a joint venture with industry, thus catalyzing an industry that will utilize the accumulated knowledge of years and years of experience.

Lastly, with 72% of the 166 foundries in Metro Manila and a number of them in congested areas which are probably having pollution problems, I would like to suggest that a study on the possibility of setting up a Metalcasting Estate properly planned, where all the related industries can be situated to support the Metalcasting Industry, be undertaken. PM

RATIONALIZATION WITH PNEUMATICS (2)

WERNER DEPPERT
BDW, FESTO

Program-Controlled Finishing Lathe. Premachined knob coverings are finish-machined on this specially developed finishing lathe. Using a diamond tool, the flat surface, outside surface and a chamfer are turned. The surfaces of the workpieces must be profiled and shiny. All movements of the saddle are performed by pneumatic-hydraulic linear units; the collet chuck is operated by a pneumatic cylinder.

Machine Control. The finishing lathe is constructed of elements that can be classified in the following groups: 1. base, 2. drive block with chuck, 3. tool feed units, and 4. control system. The base and drive block can also be used for other, similar machines. The collet chuck in the drive block is operated pneumatically by means of a double-acting cylinder. Feed of the individual tools for facing, longitudinal turning and

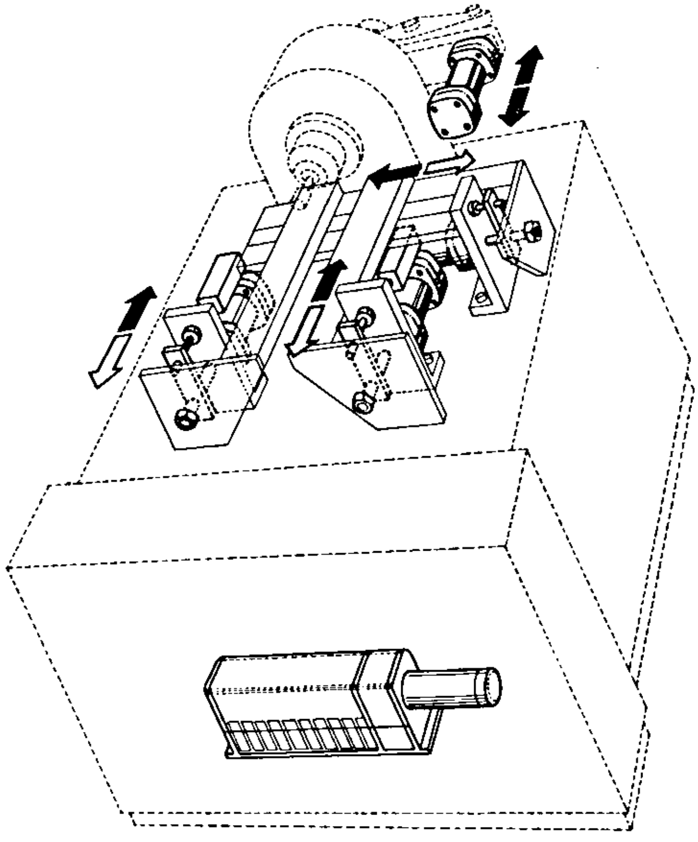


Fig. 1: Finishing lathe for machining knob coverings by means of a diamond tool. Three pneumatic-hydraulic feed units are used to execute the operations of longitudinal turning, facing and chamfering. (Company photo: F. Rambold KG/FESTO)

The first part of this paper was published in the January-March 1979 issue of Philippine Metals.

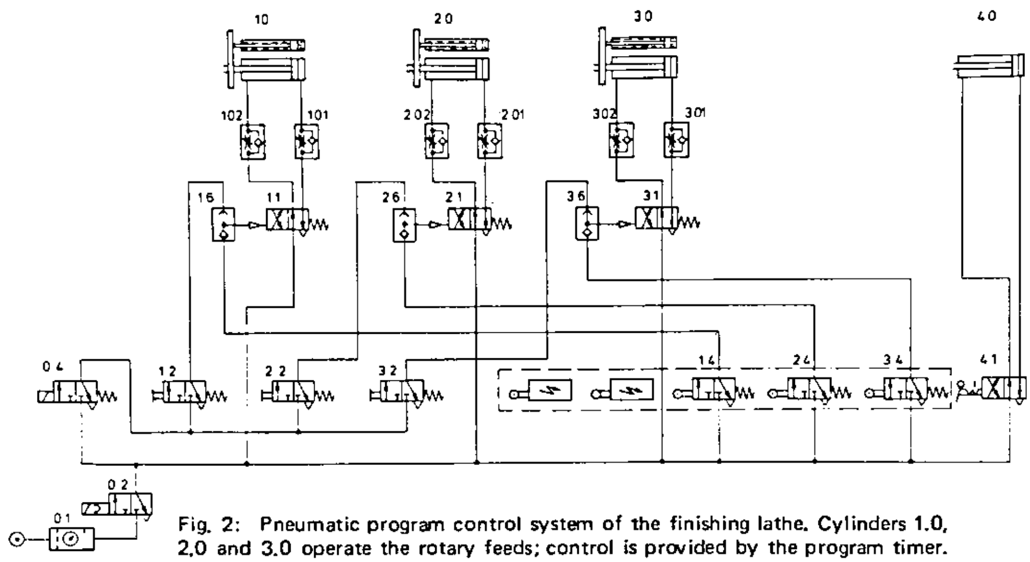


Fig. 2: Pneumatic program control system of the finishing lathe. Cylinders 1.0, 2.0 and 3.0 operate the rotary feeds; control is provided by the program timer. Manual triggering by means of valves 1.2, 2.2 and 3.2 is possible if desired. The collet chuck is operated by cylinder 4.0. (Company photo: F. Rambold KG/FESTO)

chamfering is provided by three combined pneumatic-hydraulic feed units. Each of these three units consists of a double-acting pneumatic cylinder and a smaller oil cylinder connected to it. The pneumatic cylinder develops the feed force and transmits the movement to the oil cylinder by means of a yoke. The oil flowing from one cylinder chamber to the other during the movement is directed through a flow control valve and can thus be regulated exactly. This means that the feed speed in the working direction can be adjusted exactly and is considerably lower than that for pure air feeds.

The "brain" of the finishing lathe is a program timer designed for a maximum of 10 control elements. The program shaft is electrically driven. Each control disk consists of two combined but mutually adjustable cam disks. By turning the two cam disks, the switching and idle times for each control element can be adjustment separately. The program timer can be fitted with electric limit switches, 3/2 pneumatic valves or 4/2 pneumatic valves as desired. In the finishing lathe described, two electric switches and three 3/2 valves are incorporated in the program timer. By changing the cam disks, other program times can also be run, regardless of the rotational speed of the program shaft. By changing the control elements, a modified program or other working elements can also be incorporated into the machining cycle at a later date.

Sequence of Operations. The entire sequence of operations includes manual insertion of the workpiece, clamping, longitudinal turning and facing, chamfering, releasing, and manually changing the workpiece. After the workpiece has been inserted and clamped in place by valve 4.1 and cylinder 4.0, and the starting signal has been triggered, machining takes place automatically until the workpiece is released. Other valves in the control cabinet that prevent machining from starting if the workpiece is not clamped in position, for example, are linked to the control elements of the program timer. The three turning operations overlap somewhat during automatic operation in order to achieve, in this manner, short machining times. The three machining operations can also be started manually independent of one another and of the program timer by means of valves 1.2, 2.2 and 3.2; this is absolutely necessary when setting up the lathe for workpieces with another size. The feed and return speeds can be adjusted independently. The feed speed can be adjusted additionally in the slow range by means of the flow control valve of the oil cylinder. The total time for the feed and return strokes of the feed units, however, is restricted to the maximum possible time by the program shaft.

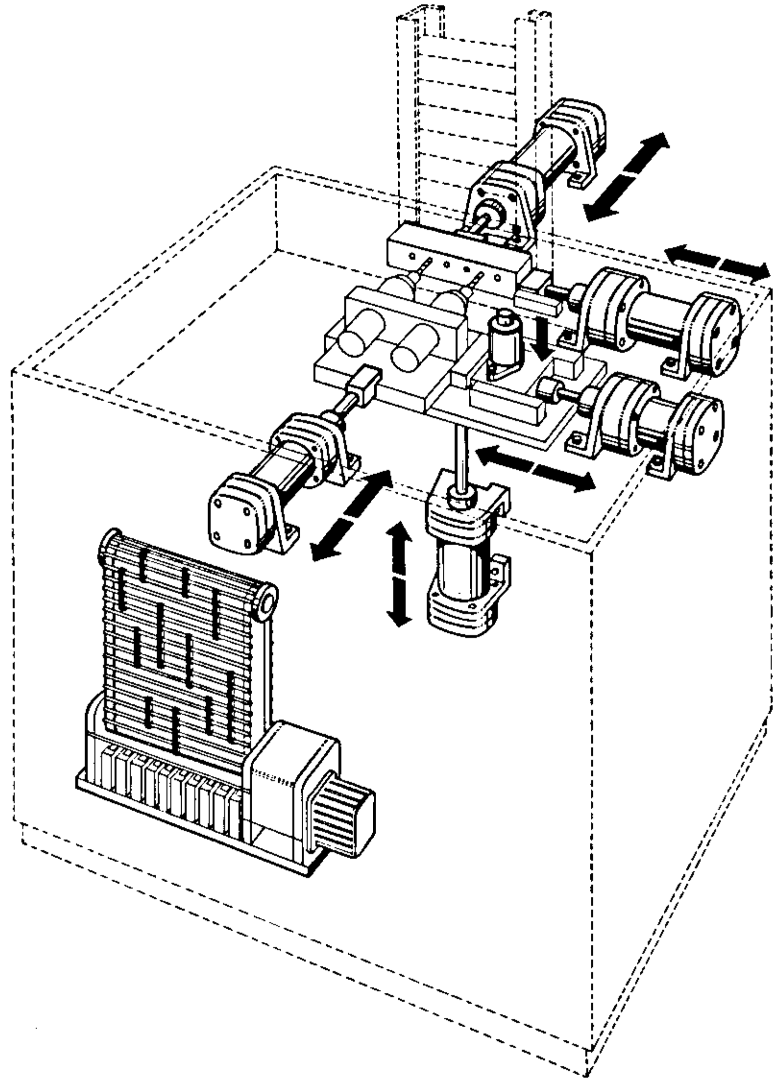


Fig. 3: Special-purpose drilling machine for indexed drilling of 16 blind-end holes and two through holes. In conjunction with signalling elements operating as a function of the distance covered, a program timer controls the machining cycle. Drilling is done alternately during the forwards and return cycles. (Company photo: A. Huber GmbH. & Co./FESTO)

Reducing Nonproductive Time by Alternating the Working Direction. On the fully automatic special-purpose drilling machine, 16 equally spaced blind-end holes 3 mm in diameter each and 2 through holes at an angle of 90° to these blind-end holes are made in a wooden strip having the dimensions 13 x 18 x 130 mm. For technical and economic reasons, only two pneumatically operated drilling spindles (5.0) are used to drill the row of holes. The same unit (7.0) is used to drill the through holes (not shown in Fig. 3 for the sake of clarity, as this unit is positioned directly beneath the workpiece). The row of holes is drilled in eight indexed steps, the two drilling spindles (5.0) are positioned exactly at the spacing between holes 1 and 9. When the cycle for a row has been completed – this corresponds to a finished workpiece – the feed does not switch back immediately, but rather a new workpiece is placed in position, and the return is likewise indexed. The drilling program thus starts alternately with the drilling of holes 1 and 9 and the drilling of holes 16 and 8. There is no idle stroke.

Machine Equipment. Except for the electric drive for the program timer, pneumatic drives are used exclusively for the entire machining unit. Together with the magazine, the base frame forms one unit and was constructed especially for this machining task. A program timer with cam belt is used to control all drives. This type of program timer was selected because it is only on a cam belt that such a program can be placed. The drilling program is placed on the belt twice, as the drilling is performed alternately during the forwards and return cycles. The cam belts for these program timers can be so assembled that, in conjunction with the program speed, various control periods ranging continuously from 9 seconds to 24 hours are possible. The actual control section can hold up to 10 control elements (electric limit switches or 3/2 valves, and optionally also up to five 4/2 valves).

The two drilling assemblies 5.0 and 7.0 are mounted on ball bearing carriages for the longitudinal and transverse motions. The drilling feed is performed by cylinders 6.0 and 8.0. The two single-acting cylinders 1.0 and 2.0 are used to hold the carriages in the respective drilling positions (cylinder 2.0 cannot be seen in Fig. 3, as it is

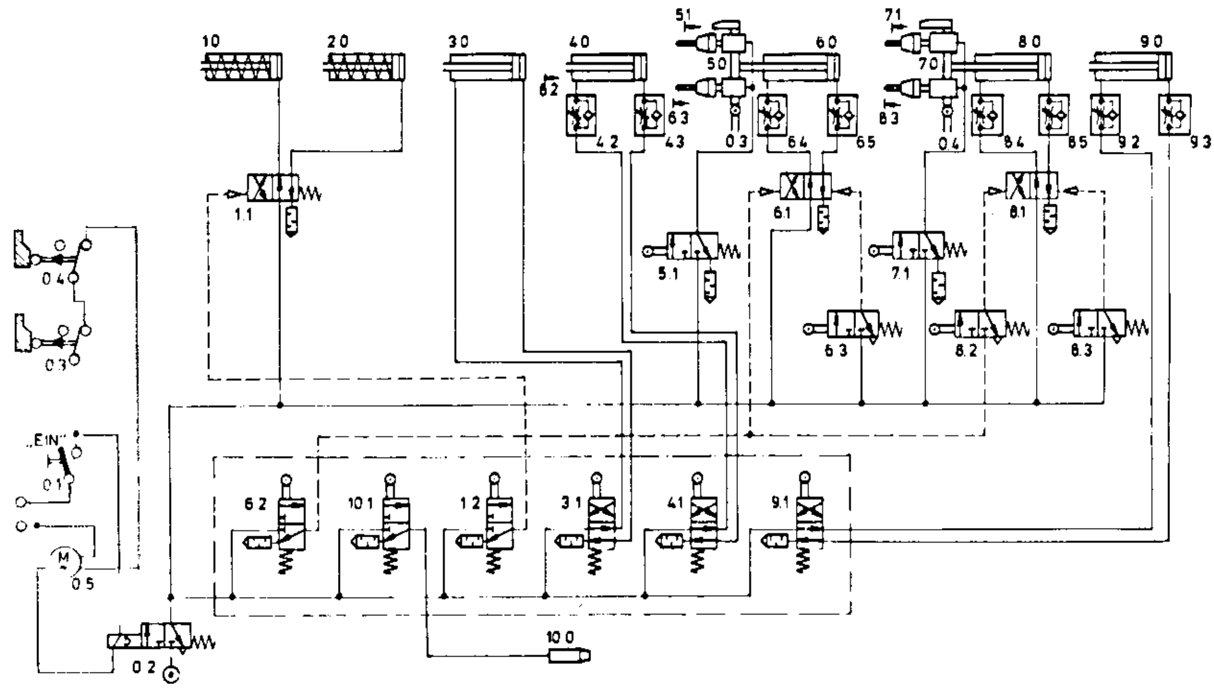


Fig. 4: Circuit diagram of the combined sequential control and program control systems for a special-purpose drilling machine. The program timer is electrically driven; all other movements are pneumatically controlled. (Company photo: A. Huber GmbH. & Co./FESTO)

beneath the worktable top). The finished workpieces are ejected by cylinder 3.0. Cylinder 4.0 controls the indexed feed for drilling the 16 holes in eight indexed steps. Cylinder 9.0 pushes the workpiece from the drip or stack magazine.

Sequence of Operations. The electrical starting signal is given manually. Simultaneously, the working air for the entire machine is connected in via the pilot-controlled solenoid valve 0.2. The workpiece discharged from the magazine is pressed against the drill jig by cylinder 9.0; this cylinder remains extended during the entire drilling period. As soon as drilling feed is initiated and the feed tables of the horizontal or vertical drilling unit have covered a certain adjustable distance, the drive motor of the program timer is shut off by limit switches 0.3 and 0.4. This assures that in the event of trouble no further indexing is possible and that further indexing is only initiated by the drill feeds as a function of the distance covered if the machine operates properly. The drilling spindles themselves are always switched on, as a function of the distance covered, by valves 5.1 and 7.1 respectively, just before drilling starts. Since the program timer is off during the drilling, return of the drills must also be initiated by valves 6.3 and 8.3 respectively as a function of the distance covered.

Once the drilling spindles are in the starting position again, the program timer is free for the next indexing step. Holding-cylinder 1.0 opens, and the workpiece is pushed to the next drilling position by cylinder 4.0. A new drilling cycle then begins. Once eight drilling cycles have been executed in one direction, cylinder 9.0 retracts and the workpiece can be ejected by cylinder 3.0. In the next step, a new workpiece is inserted, and machining can start again from the beginning, but now the holes are drilled during the return cycle. The sequence corresponds exactly to that for the forwards cycle. For this purpose, the cam belt of the program timer is fitted with two identical programs, one each for the forwards and return cycles. After every third drilling operation, air which blows the wood chips out of the drilling area is connected to air nozzle 10.0 and by valve 10.1.

The machine can be switched on in any position, regardless of whether the indexing is for the forwards or for the return cycle. **PM**

ADAPTIVE GAIN CONTROL

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INTRODUCTION

What's new about Adaptive Control?

Adaptive control has been considered for many years as a means to improve set-point control. It usually is considered in the context of adapting both dynamic and static controller responses. Viewed in this light adaptive control hasn't enjoyed wide spread industrial usage. This may be due to:

1. Tighter set-point control is not always required.
2. The hardware to implement adaptive control has been expensive and difficult to assemble into a system.
3. Dynamic and static adaptive control is very difficult to tune.

This paper considers a new approach to adaptive control that enables a wide range of users to take advantage of adaptive control on a wide range of processes. Rather than considering only tighter set-point control it acknowledges the need for many other goals. It limits the field of adaptive control to Adaptive Gain Control in order to obtain the important benefits while still maintaining workable implementation schemes. Finally, for each goal or benefit, sample applications are listed.

DEFINITIONS

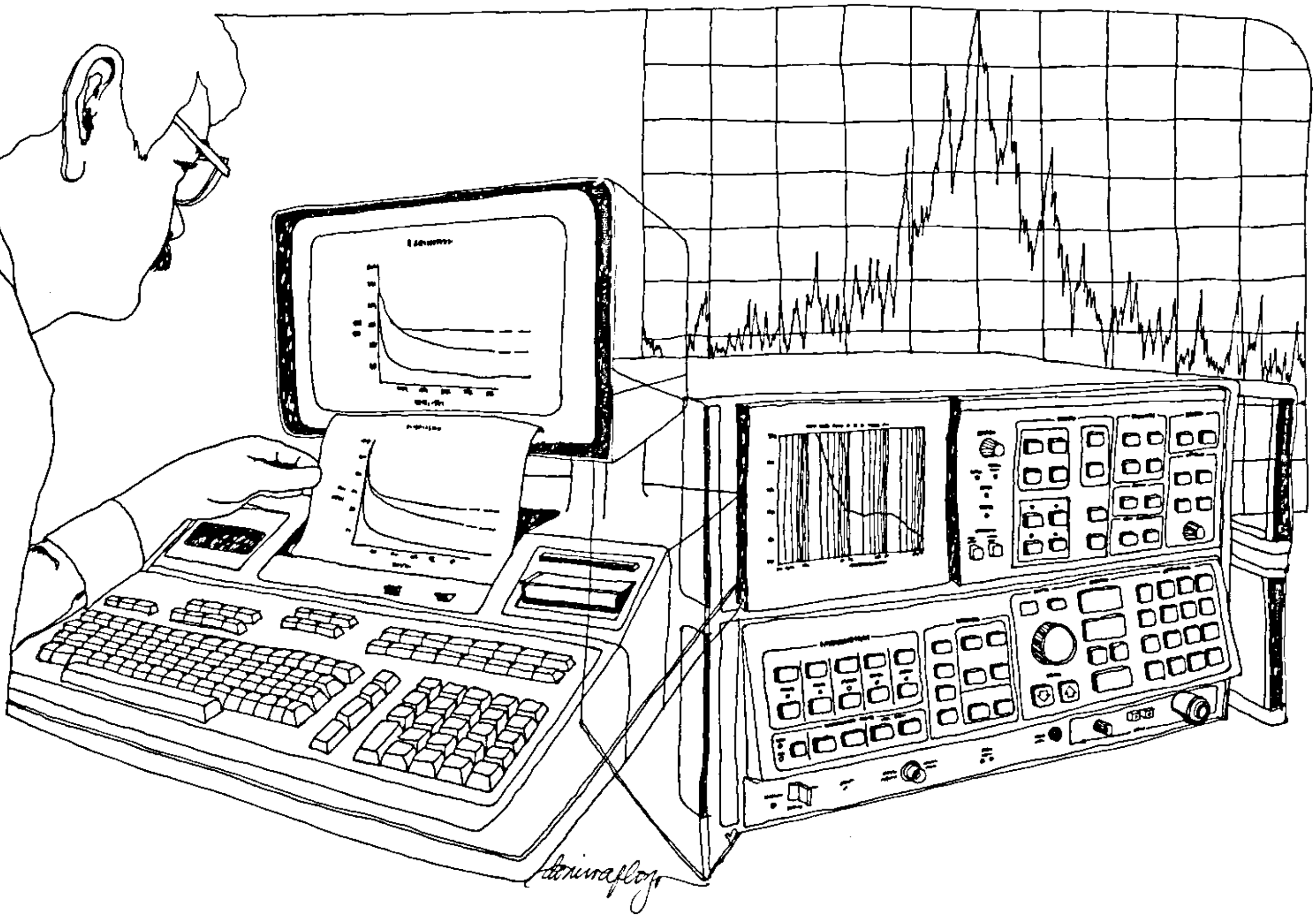
In this paper, Adaptive Gain Control will be used to refer to a situation where a feedback controller's gain is automatically changed. These gain changes can produce many different results depending on what variables are allowed to change the gain and how the controller is tuned. Only simple forms of Adaptive Gain Control will be considered.

ADAPTIVE CONTROL GOALS AND APPLICATIONS

To many people the term Adaptive Gain Control is associated with a few hard-to-control loops on a computer job. Actually, even the simplest forms of Adaptive Gain Control, which can be understood by most field personnel, can produce many dramatic user benefits. The overall plant benefits acquired by properly using simple Adaptive Gain Control are probably as powerful as the use of derivative. To justify thinking of Adaptive Gain Control as the fourth controller response, a description of eight realizable adaptive gain goals will now follow:

Realizable Adaptive Gain Control Benefits:

1. To reduce unnecessary manipulation to variables as a result of natural process or measurement noise.
2. To produce overdamped averaging control without adequate feedback control, letting the process exceed specified limits.
3. To reduce the need for precise tuning to achieve adequate feedback control.
4. To provide an effective means to greatly reduce plant control loop interactions.
5. To provide external electrical gain adjustments to enable the user to have start up, event or time-based gain changes. To provide a capability for specific specialized algorithms.
6. To achieve tighter, more responsive, regulatory control at a specific set-point.



7. To obtain comparable feedback control loop performance over a wide range of loads or set-points.
8. To obtain reasonable feedback control loop performance on the extremely nonlinear process.

BENEFIT ONE

To reduce unnecessary manipulations to variables as a result of natural process or measurement noise.

Method Used

Traditionally, if a process is very noisy, steps such as damping the transmitter, using very low gains, employing high reset rates or even using integral-only-control are used to reduce unnecessary control valve manipulation. All these techniques have their shortcomings in that although their use may reduce the controller's response to noise, they also will increase peak deviations and the oscillation period.

Adaptive Gain Control can also reduce the response to noise but without substantially degrading the quality of control. This can be done by keeping the controller gain fairly low in a region around the set-point and using higher gains for wider deviations. The width of the low gain region should exceed the maximum amplitude of the process noise.

SMOOTH TOWER FEEDS

NON-LINEAR LEVEL ON FRONT TOWERS STABILIZES DEBUTANIZER

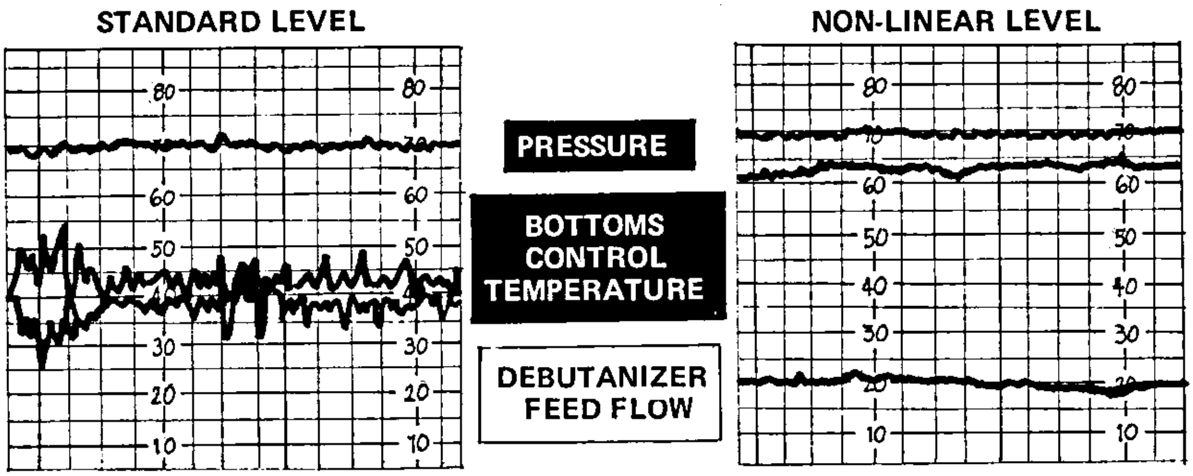


Fig. 1 Adaptive Gain Control in a Series Chain.

Controller Form Required

The gain should be based on deviation.

Turning Required

The controller would be tuned to have the lowest acceptable gain for small deviations. Reset must be employed to insure operation in this region. The width of the low gain region would be set wide enough to reject the noise. Once out of the low gain region the gain would be set to increase rapidly to prevent larger deviations. In general, tuning is probably not critical.

Sample Applications for Benefit One

There is a limited need in the chemical, gas processing and petroleum industries to reduce process noise effects. A much larger need exists in industries where the control of solids is common (i.e., food, mining and paper). These measurements are inherently lumpy or noisy and may cause conventional controls to over-control, further upsetting the plant.

BENEFIT TWO

To produce overdamped averaging control without letting the process exceed specified limits.

Method Used

This benefit is produced by basing the controller gain on deviation. The concept involved is to provide a wide region of deviation which uses very low controller gains and then employ rapidly increasing gains as the deviations exceed tolerable limits. Only a minimum of output changes are desirable.

Controller Form Required

The adaptive gain should be based on deviation.

Tuning Required

The controller is tuned for extreme overdamped over the widest possible range of deviations. Reset is required to keep the process in the low gain region. Figure 1 shows the results of using Adaptive Gain Control on the first two reboiler level loops in a series chain of distillation towers. Notice how only the smallest changes are made to the feed flow to the debutanizer.

Sample Applications for Benefit Two

A general industry need exists for effective averaging control. In the industries that employ complex interactive processes the need exists because of the syndrome of over-control. This was discussed under Benefit One, process noise reduction. In the mining industry, only constraint control, an extreme form of averaging control, is often required. The water/waste industry requires Benefit Two since plant influent averaging is highly desirable. Also, the anerobic digester feedrate control loop should employ averaging control.

BENEFIT THREE

To reduce the need for precise tuning to achieve adequate feedback control.

Method Used

A controller which could be poorly tuned and still hold the process close to its set-point would offer a solid benefit. By once again basing the controller's gain on deviation, the adaptive gain controller can produce this characteristic.

The essential concept is to provide rapidly increasing gains as the process moves away from the set-point. This tends to provide a self-tuning effect in that the process only deviates to the point of being driven back by the rapidly increasing controller action.

A common mistuning seen in the field is to have too high a reset setting and an excessively low gain setting. With an adaptive gain controller, even if the gain was 1/3 of what it should be, a distrubance would quickly drive the process to a point where the adaptive controller's gain was increased at least a factor of three. The additional error required over proper tuning would be relatively small. Without adaptive control and with the mistuning, the deviations could be two to three times as great compared to a properly tuned controller.

One of the main points in this paper is that mistuning is caused not only by human error but also by process nonlinearities. Adaptive Gain Control can either linearize these loops or improve control on existing nonlinear processes.

If the strategy is to linearize the loop, the controller must not only be the correct form but also be properly and critically tuned.

However, if the strategy is simply to accept the process' non-linearities and use the self-tuning property of deviation based Adaptive Gain Control, the tuning has only to be approximate.

The easy tuning strategy will not produce the same quality of control as the linearizing strategy. However, the quality may still be much improved over conventional control and is more attainable under field conditions.

Controller Form Required

The gain should be based on deviation.

Tuning Required

The controller would employ a simple gain increase proportional to the deviation. No gap or area of low gains would be required. Near set-point the controller gain would be set for overdamped conservative control. Reset must be used to insure operation in this region.

Sample Applications for Benefit Three

Although magazine articles sometimes may lead one to believe the chemical, petroleum, and gas processing industries are so advanced as to require hill climbing optimization, in reality the plant people in these industries would be grateful for a controller that would not have to be precisely tuned. Other users, especially in the paper, mining, steel and waste/water industries, have even greater needs for a basic self-tuning controller.

BENEFIT FOUR

To provide an effective means to reduce plant control loop interactions.

Method Used

As was discussed in Benefit Three, Adaptive Gain Control based on deviation changes the type of control from active to overdamped. The variable damping ratio characteristic has another plant benefit: control loop interaction reduction.

Control loops are not independent entities but are all interrelated through the process and utilities. For example, if you had a larger water pump in your house, everytime you turned it on and off you would affect your neighbor's water pressure and electrical voltage. That would trip their pump on and off which would affect yours and etc.

What's more, with the whole street cycling it might affect the next street and finally the entire system. Similar effects to varying degrees are seen in almost all processing plants.

To prevent interactions, one of the simplest approaches is to slow down control actions so that the loops do not excite themselves into a cycle. However, with conventional controllers, overdamped tuning results in large deviation and slow recoveries. The variable damping ratio, which adaptive gain based on deviation provides, produces both tight and overdamped control, depending on how far the process is from the set-point. This effect can reduce the constant interactive cyling so often seen in processing plants.

Tuning Required

The controller is tuned to have gain increase proportional to deviation. Reset must be employed to insure loop operation in the lower gain regions. For particularly interactive loops the base controller gain would be used to further differentiate the damping ratios or loop responses.

Sample Applications for Benefit Four

The major potential application for this benefit is in the industries with complex, interrelated and interactive processes; the chemical, petroleum gas processing and paper industries. It is reasonable to estimate that 50% of the control loops in these industries are employed on interactive processes. In all industries there is a general need for reducing interactions caused by paralleling similar processing units.

BENEFIT FIVE

To provide external electrical access to gain adjustments to enable the user to have start-up, event or time-based gain changes. To provide a capability for specific specialized algorithms.

Method Used

This benefit can be provided by basing the controller's gain on the remote analog input or the contact input.

Startup, event or time-based gain changes can be obtained by using standard alarm trips, timers or PLCs to provide a contact input to the Adaptive Gain Controller. The controller directly accepts a contact input and bumplessly changes the gain to preset value. An application example is where the gain is changed as the chemical reaction causes a change in heat transfer properties. Since this is based on time, the only hardware required is a time-relay and an adaptive gain controller.

The capability could greatly enhance the quality of regulatory control on batch processes. These processes may require responsive non-overpeaking startup and consistent tight control throughout the batch even if densities or basic reaction characteristics change dramatically. Conventional control may not handle these situations very well.

Specialized algorithms can be obtained by using the analog input to the Adaptive Gain Controller. The algorithm can be determined by the Adaptive Gain Controller's adaptive gain settings, basic controller settings, and by external scaling which uses external analog of digital computers to calculate the desired specific customer algorithms to be created. These would be limited, however, to only adaptive gain algorithms because no external reset or preact adjustments are provided.

Controller Form Required

The gain is based on a remote or contact input.

Tuning Required

No generalities can be stated since it solely depends on each specific application.

Sample Benefits for Benefit Five

The major potential applications lie in those industries which have batch processes that require good regulatory control. This would primarily include the food (retorts and evaporator), textile (dyeing), and chemical (batch reactors) industries. The remote input would be used for the most difficult applications, such as pH control.

BENEFIT SIX

To achieve tighter, more responsive, regulatory control at a single set-point.

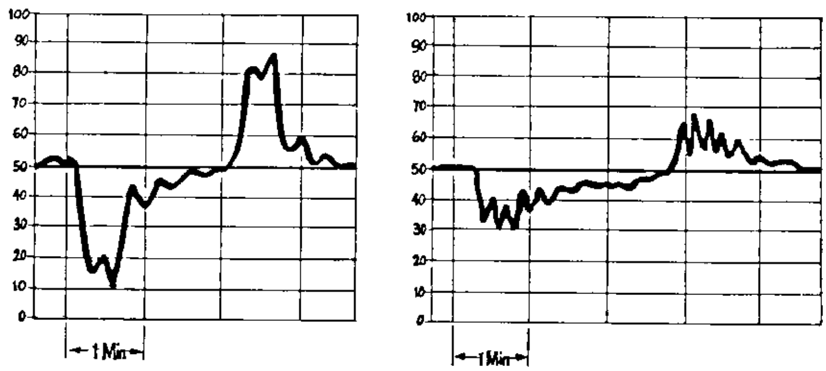


Fig. 2 Comparison Between Conventional and Adaptive Gain PI Controllers.

Method Used

By increasing a feedback controller's gain, process deviations are usually decreased. Unfortunately, the tendency for the loop to oscillate is increased. If the controller gain is increased as a function of increased deviation, a compromise can be reached where deviations and integrated errors are reduced without appreciably affecting stability.

Controller Form Required

In this case the active controller gain should be a function of deviation. It must be understood that throughout this paper, when the gain is changed, it will be done bumplessly; thus no immediate output shift occurs.

Interestingly, the actual overall input/output relationship approximates the so-called non-linear "$e + e^2$" relationship. However, rather than treating it as a special case, it will be less confusing to consider the "$e + e^2$" controller in the general context of Adaptive Gain Control.

Tuning Required

To produce Benefit Six, the Adaptive Gain Controller is tuned to provide standard quarter wave decay around the set-point. Reset must be employed to maintain normal operation near the lower gain region. As deviation increases, the controller gain is increased as much as possible without creating unacceptable decay times or conditional stability. It appears that huge gain changes (factors from 5-10) are required and can be tolerated without causing stability problems. Settings do not seem to be particularly critical in order to produce meaningful improvements in control tightness.

Figure 2 shows the results of a comparison between conventional and adaptive gain PI controllers on a computer-simulated level control loop.

A severe ramp inlet flow change was imposed on the level control loop. As Figure 2 shows, the difference in peak deviation and overall integrated error, or Control Tightness, was significant. A 100% reduction in peak error and a 50% reduction of integrated error was produced using Adaptive Gain Control.

Since the simulated process consisted of two time constants, an integration element and valve hysteresis, it probably represents a wide assortment of processes. It is fairly safe to assume similar control improvements are realizable on a variety of processes.

Sample Applications for Benefit Six

The applications for improved regulatory control is very general and crosses most industry and process lines. It is obvious that the greatest potential lies within the industries which tend to have processes that are difficult to control.

The petroleum, chemical, gas, processing and paper industries all use many similar unit operations and processes: boilers, direct fired heaters, distillation towers, compressors, chemical reactors, etc. Each of these processes can be problematical and in general would benefit by the selected use of improved regulatory control. The pipeline industry has a need for faster acting pressure controllers. The plant and power utility industry has a need for faster acting pressure controllers. The plant and power utility industry and the paper industry would benefit by improved drum level control.

BENEFIT SEVEN

To obtain comparable feedback control loop performance over a wide range of loads or set-points.

Method Used

One important reason that the quality of control often varies as loads and set-points change is that process gains can change. This is caused by non-linearities in the measurement, the actual process and the installed valve characteristics. By changing the controller's gain to compensate for these process gain changes, (i.e., keep the product of process gain times controller gain roughly constant) the control loop can perform more consistently for wide ranges of loads or set-points.

Controller Form Required

Basing the adaptive gain on the process variable is especially useful if the process gain changes as the process itself changes.

A very common example of this is the familiar DP flow transmitter. The transmitter's output is proportional to flow squared rather than flow. This gives a low gain (slope) at low flow rates and high gain (slope) at high flow rates because the output follows the square curve. At fixed set-points this effect will not be noticed since the flow will remain near the set-point. However, if the set-point is substantially changed, the control loop would perform differently at each set-point because of the process gain changes. To compensate for this effect the adaptive controller's gain can be changed to keep the process gain and controller gain product fairly constant throughout the normal range of set-points.

Besides flow measurements, many other common process non-linearity effects exist; for example, the changing cross sectional areas of cylindrical or spherical tanks and pH measurement. All these situations could have more consistent control at different set-points if adaptive gain based on the process were employed.

Basing the adaptive gain on the controller output is particularly useful if the process acts differently at high or low loads or valve positions. Most processes do act differently as the loading, or output, changes. This effect was observed in the 1940's and the so-called equal percentage valve was invented.

The idea was simple yet beautiful. The valve had a characteristic that would provide equal percentage changes to the process regardless of whether the process load required a 10% or 90% valve opening. For example, if a 1/2 PSI change was made to an equal percentage valve, it might make a 1% flow change at 100% flow rate. The percentage change of the total flow was always the same; in this case, 1 out of 10 or 10 out of 100. Hence the name equal percentage.

The concept of equal percentage is highly problematical. This is due to several factors. First, the valve's installed characteristics are not the same as the graphs on the specification sheets. Because of piping pressure drops the actual installed characteristic may be linear or even quick opening rather than the equal percentage. What's more the choice of a valve may depend on other more important considerations such as availability, cost or pressure drop. This choice usually occurs well in advance of the time the systems engineer specifies the instrumentation for the plant.

The fundamental solution to all these factors is to employ adaptive gain based on the controller's output. This controller can, by itself, act like an equal percentage valve. But even more importantly it can produce other required algorithms to keep the controller's performance consistent at high and low loads.

Tuning Required

When tuning the adaptive gain controller to produce Benefit Seven, the main goal is to produce consistent decay ratios throughout the range of expected operating conditions. A good starting point for setting the base gain would be to obtain the desired decay ratio when the process has the highest gain or worst case. Depending on which variables were chosen to vary the gain, specific disturbances should be imposed one at a time on the control loop and the adaptive portion adjusted to produce consistent decay ratios. Tuning should be fairly precise since this goal is trying to obtain tight linear control over wide process ranges.

Although some specific static gain changes could be measured or anticipated, it is generally unwise to simply make the controller have the opposite gain change effect as the process. This is because the real world is filled with multiple gain changes with the lumped net effect. Also, the process's changing dynamics (i.e., lags and dead-times) will affect the decay ratio. Thus it is important to tune the controller on the actual process itself rather than against the predicted gain changes.

Sample Applications for Benefit Seven

The main potential applications for Benefit Seven would be in industries where the turndowns or range-ability is a natural requirement for the control system. Also, industries that have control loops that are normally operated at very different set-points would have a potential need for Benefit Seven.

Specifically, plant and power utilities typically have very wide loads imposed on them. In the food industry, evaporation has very wide changes in density. The gas processing industries have specific situations where the plant feeds change drastically, imposing wide feed flow and feed composition changes on the distillation towers. The petroleum, paper and chemical industries in general have specific situations of wide operating ranges. The water/waste industry has very wide loads imposed on the dissolved O_2 control loops.

BENEFIT EIGHT

To obtain reasonable feedback control loop performance on extremely non-linear processes.

Method Used

Like Benefit Seven this goal is also achieved by changing the gain of the controller as the process gain changes so that the product of the two gains remains relatively constant. The control goals differ slightly from Benefit Seven. However, rather than improving regulatory control over wide operating ranges, this benefit provides acceptable feedback control over narrow operating regions on extremely non-linear processes.

Some processes are so non-linear that standard linear closed loop control will not work if anything but the smallest disturbances occur. With conventional control, these processes are usually operated with their controllers in manual.

Controller Form Required

The adaptive control form that is required depends solely on the specific process. The determining factor is which variable (or variables) is related to the horrible non-linearity.

For example, the level control of an evaporator with a coneshaped bottom has a non-linearity that is a function of the level process; a grossly changing cross-sectional area. In this case, adaptive gain based on process would be used to decrease the gain as the level decreased.

An example of a severe non-linearity as related to the output is applications employing split range valves. Often these valves have gross differences in sizing or gains. In this case basing the gain on output would be used.

A pH control loop has several severe non-linear effects. For example, consider the situation of treating the effluent of a plant to maintain a neutral pH. The process gains of that loop depend on the inlet flow rate, the inlet pH, the pH of the mixed treated solution, plus any gain changes caused by split range valve arrangements. In order to consistently control this very difficult process, the gain of the adaptive controller would be jointly determined by process, output and an external inlet pH signal.

Tuning Required

The approach to tuning the adaptive gain controller on these extremely non-linear processes is the same as outlined under Benefit Seven.

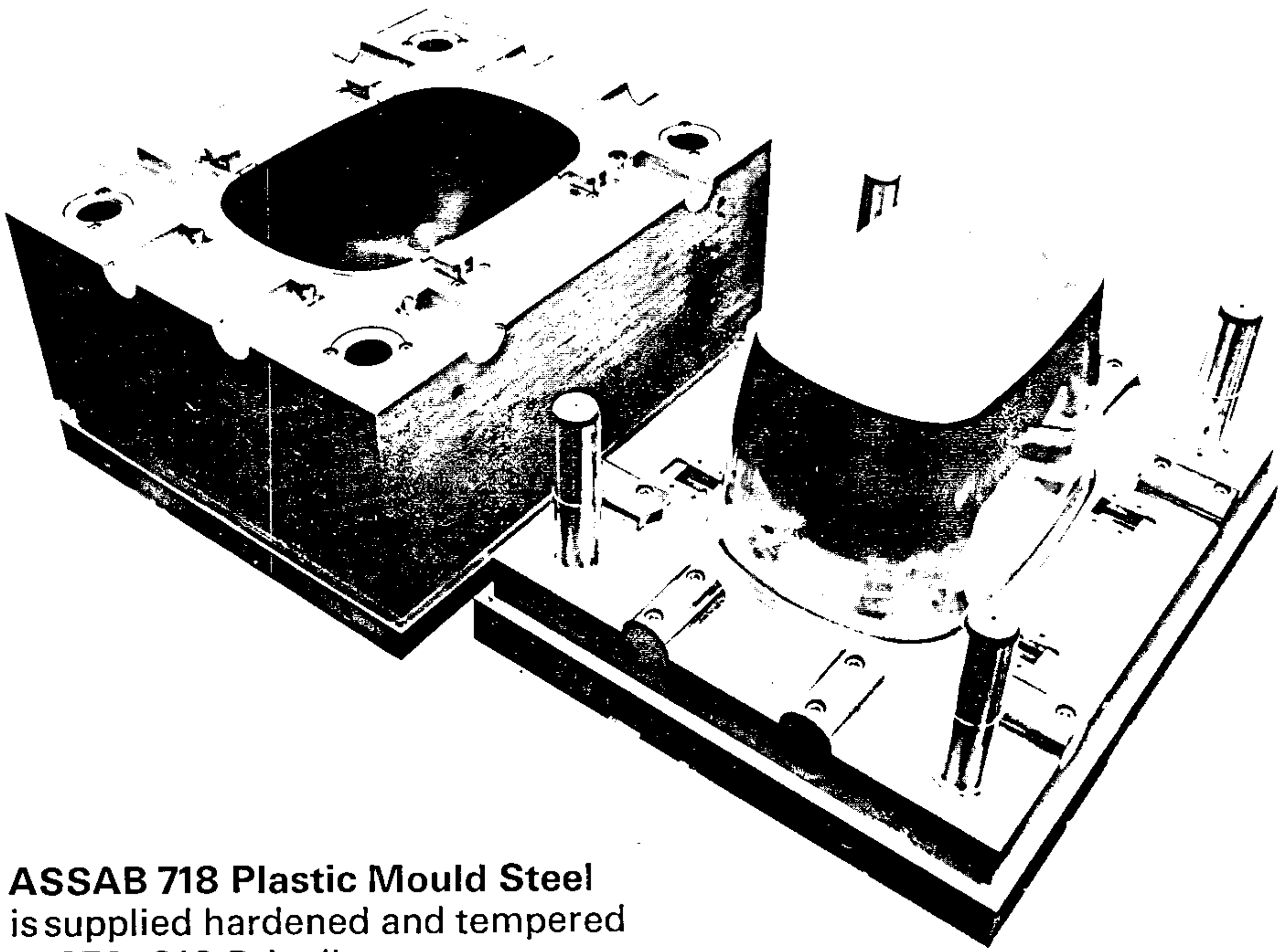
Sample Applications for Benefit Eight

Fortunately there are not many processes with such severe non-linearities as the pH control process. However, pH control is common enough in the water/waste, chemical and paper industries so that this constitutes a good specific potential application. Evaporator level control commonly found in the food and paper industries is also highly non-linear.

CONCLUSION

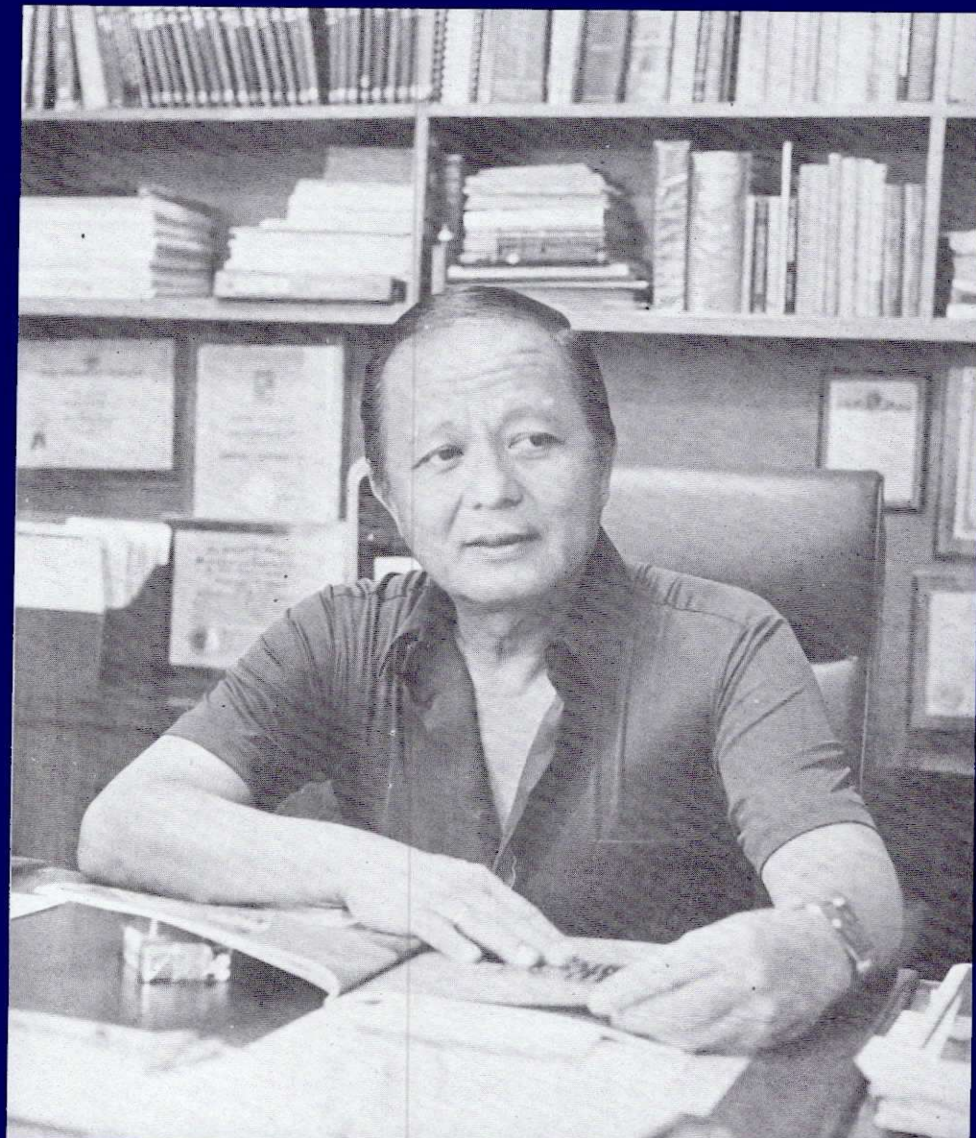
Adaptive Control has been around a long time but has been primarily considered only for tighter regulatory control. The available equipment has been very difficult to employ in systems and also tune in the field.

Taylor believes the benefits are much wider than tighter control. Couple that with a human-engineered controller which can be directly substituted for a standard controller and we hope many people will take advantage of this powerful control tool. **PM**



men in the metals industry

PACIFICADOR C. DIRECTO



The night before I was supposed to interview the President of Directric Industries, Inc., Pacificador C. Directo, I couldn't sleep. I was bugged by unnerving thoughts about this awesome hunk of a man, whose reputation of having a stern disposition and temperamental bearing haunted me persistently to the last wee hours of the night.

I had known Directo, or "Dick," as his friends fondly call him, only from a distance. What struck me first about the man was that indescribable silent dignity which he seemed to carry about him, blending perfectly with his typical neatly-ironed cream suits, and well-polished shoes. In meetings and conferences, he talked with that slow and deliberate tone, occasionally punctuated with a willful raise of his voice, if only to get his point across. He had a demanding streak in him which could almost be considered an air of arrogance, but in whatever endeavor he was in, he worked hard as a bull. This was clearly evident in the recently concluded "First Metals Industry Show 1979" where, in his capacity as the project's Vice-Chairman, he used up all his energies – and even his brawns when the need arose – to get things done – and fast.

I was afraid to interview the man all right, but work being work, there I was in his office the next day, practically grappling with my crumpled list of questions which all of a sudden seemed preposterous to ask. As usual, he was early for the scheduled appointment, which made me all the more embarrassed and at a loss as to where to start.

The energy crisis is the biggest problem plaguing the whole world at present, but it hardly seemed so when I first popped the question about this to Directo. He gave me that most intriguing smile which kept me wondering whether I asked a very silly question or not.

The long silent look. The deeply-penetrating eyes. The well-combed hair with not a straying strand in sight. All these presented a picture formidable enough to make me run out and forget the interview forever.

It didn't, however. On the contrary, it was the dramatic start of a long hearty conversation, which later turned out to be a most significant revelation for me.

Directo was born on February 18, 1924, in Sta. Maria, Ilocos Sur. During his early days, his interest in electronics was already evident, as shown by his tinkerings with radios and television sets. A few years after finishing high school in 1941, Directo studied at the National Radio School in Manila, where he supported himself through by working as a bus driver at the Manila Electric Company.

"I was a pro in TV repair for a time, " he quipped. What struck me more at this point, however, was how this elegantly-dressed "executive", who was managing a fast-expanding manufacturing firm, could have possibly worked as a driver for three long years, in his earnest pursuit to obtain a Radio Technician's Course.

Directo went to college at the age of 24, a relatively late time for one to pursue a higher education. He chose a course in Mechanical Engineering. Still supporting himself through college, he worked as a General Service Clerk at the Eastern Inspector Bureau. It was during this time when he met his first wife and eventually got married, making him a breadwinner, a student, and later a father, all at the same time.

"I finished college in four years," Directo proudly reminisced. "And to think that I was already married, working full time, and had a full load at school."

An even more outstanding feat is the fact that Directo ranked 10th place in the Board examination for Mechanical Engineers. He reviewed only for two weeks while still working in the mornings.

"I would have been topnotcher if not for one question," Directo revealed. He showed us a photostat copy of the results of his exam, which glimmered with 100's and 80's. Only one set pulled him down, which he attributed to his "over-confidence."

I marvelled at the strength and gift of this character sitting in front of me, who I had the former impression, was born with a silver spoon. Little by little I began to absorb small but significant facets of his personality, eventually easing the tension which silently gripped me ever since.

The tuning point of Directo's career happened in 1956 when he applied as a plant engineer with Reynolds Philippine Corporation (RPC). Instead of being assigned to work in the plant, however, he was asked to work with the Sales Division, a field totally new to the resourceful engineer.

"I had to study it before accepting the job," Directo explained. He found out that some of the sales engineers then had higher pays than the company's top men. He discovered moreover that all of the executives who came to the top came from sales.

With the pros outweighing the odds of taking the job, Directo grabbed the opportunity which drove him to a new life in the field, plying his trade as a salesman. Little did he know that his regular round about town would prove useful to him later on, as he was able to get a feel of the needs of the industry, particularly the engineering raw materials and products which would give one who would dare to venture in entrepreneurship, a "comfortable profit."

For ten years, Directo got to know the tricks of the trade at RPC. It was also within this time that he remarried, after his wife's demise in 1960, who was able to bring him forth five beautiful children.

The idea of establishing a manufacturing firm was then beginning to develop itself in Directo's mind, which was an outcrop of a thought that struck the enterprising engineer.

"When I was still a sales engineer in RPC," Directo narrated, "I was able to influence many individuals who had a minimum of financial resources, into successful enterpreneurship. This, I did, out of my own creative ideas. There came then that bugging idea that if I could do it for other people, why couldn't I do it for myself?"

Such nagging questions brought forth the beginnings of a small manufacturing firm in 1966, which started with electrical gadgets such as plugs and switches.

"We practically came from nothing," Directo said with a sense of accomplishment and pride. "At the beginning, I was the production man, the collector, and the salesman all rolled into one."

"Our shop was just at the back of our former house here in Mandaluyong," he continued. "In 1971, hanggang kalsada na kami." He recalled with amusement how their assembly of coils had to be done in the street right outside their house.

How did the firm get its name, I asked curiously.

Directo explained that he initially wanted to name the new firm "Grace Manufacturing" after his fourth daughter Grace. The Bureau of Commerce would not allow it however, since there were already too many firms registered with such a name, and so would make registration difficult. The Bureau suggested the engineer's family name instead.

"Since our initial products at that time were electrical in nature," Directo said, "I thought of combining my family name and the word "electric." Thus evolved the firms' name Directic Engineering, which was changed into Directric Industries, Inc., in 1973.

Indeed, Directric Industries has come a long way. Today it stands as a formidable monument of Directo's courage and dedication. With a present total work force of 50 laborers and 10 employees, the firm earns an annual gross income of ₱1,758,286.38, making its growth a distinctively impressive one.

Two of Directo's children, Cesar, 25 and Grace, 23 help him in the family business as Sales Manager and Industrial Engineer, respectively. With the firm's expansions, the whole family, except for Cesar who has stayed behind, has moved into their new residence in Bel Air, Makati.

"Modesty aside, we started everything," Directo beamed. "We started the mass production of T.V. antennas in consortium with a 'kumpadre'. We have been originals; we never tried to copy."

To date, the firm's product lines range widely from refrigerator evaporators to car air-conditioners.

They also manufacture blower-type walk-in freezers, propeller fans, refrigeration and air-conditioning coil fins and steam coils, among many others.

There had been plans of expanding to Dasmarinas in Cavite, but the recent oil crisis foiled everything. This was quite unfortunate, since DBP recently approved the firm's loan. With the rise of material costs however, the plan just had to be given up.

"The energy crisis is a real catastrophe," Directo pointed out. "A change of lifestyle is now necessary. Where once before we had a penchant to be very showy, we can't have that anymore now."

The engineer offered three solutions to this worldwide problem: one, a good energy conservation policy, two, a search for alternate sources of energy, and three, a change of lifestyle.

"As of now, my firm has not yet felt the effects of the oil crisis," Directo said. "Later, when people would eventually conserve energy, the production of air-conditioners for one, would be affected."

He further added that efforts should now be concentrated on solar energy usage. Directo particularly referred to the solar water heater which he displayed in the metals exhibit last May.

"This would jibe well with the Filipino habit of preserving and heating their food," the creative man said. "Although this would be expensive at first cost, it would prove cheaper in the long run." The manufacturing firm's facilities incidentally are enough to manufacture such an equipment, but the project is still being studied.

The interview was obviously getting a bit too long as it was almost noontime, and I haven't asked the most important question.

What is the secret of your success?

"Hard work, determination, and most of all, creativity and innovativeness." Directo readily replied, "and one more thing, it is being there at the right time and at the right place."

Simple rules to say, but definitely a hard one to follow. Not if you have the "courage" and "dedication" which Directo was practically born with.

And how would you describe yourself as the President of a fast-growing establishment which may soon rise higher than its brothers?

"I don't know . . . one thing I can say, Directric Industries came from nothing. That is the best evidence of my success and character."

Yes indeed, there can be no clearer description of the man.

The interview was a revelation, and I went home thankful I got to know the stuff of which this man was made of. The tension in my veins has gone completely ever since. **PM**

No one would ever think that a piece of steel with a hole in it could be so important. This applies to specialty steel tubing, which can be defined as: a) small diameter steel tubing manufactured using high grade stainless steel, particularly for conveying volatile, flammable, or noxious fluids and gases at high temperature and pressure; or b) large diameter steel tubing manufactured primarily for structural and mechanical components. As proof of its myriad uses, specialty steel tubing is often utilized in electrical power generation, oil refining and processing, chemical and food processing, textile equipment, air, rail and automotive transportation, farm machinery, construction equipment and defense oriented equipment.

No other mill form of steel, or other metal or material can economically perform the tasks required of specialty tubing. It is made by the seamless method – rotary piercing or extruding a solid cylindrical billet of carbon, alloy or stainless steel – or by the welded method in which flat sheet or strip is formed into a tubular shape and the butted edges welded together.

Specialty tubing is engineered to meet specific end-use requirements, many of which demand special metallurgical, physical and mechanical characteristics. The equipment used to manufacture specialty tubing is expensive and complex. Superior human skills are needed to engineer and produce this tubing. All of these factors, plus extensive quality control procedures demanded by the critical applications of this product, make it expensive. In most cases, specialty tubing cannot be anything less than fail-safe.

The growing sophistication of the automotive industry brought into focus the dire need for inexpensive high-pressure tubing, and it was at about this period that the Bundyweld process was introduced in Australia, with Bundy Corp. initiating a tie-up with Tubemakers of Australia, forming Bundy Tubing Co. (Australia) Pty. Ltd. This company is now manufacturing Bundyweld tubing for the Asian and Pacific Regions.

In the early 70's, Bundy Tubing (Australia) organized a research for expansion in the Southeast Asian market, then settled on the Philippines primarily because the country was the most advanced in its Progressive Car Manufacturing Program. The joint business venture undergone by the company with Pacific Oxygen and Acetylene Co. resulted in Bundy Pacific Tubing (Phils.), Inc., the sole fabricator and distributor of Bundyweld tubes.

Bundy Pacific Tubing (Phils.), Inc. started out as a fabricator of specialty tubing for automotive components, with its introductory services directed towards the then newly introduced Ford Fiera line. With an initial capacity of fabricating 100,000 meters annually, the company now does work on 800,000 meters of specialty tubing per year at its 1-hectare plant in Km. 40, Sta. Rosa, Laguna. The plant houses all of Bundy Pacific's fabrication line, employing 30 factory workers operating in two 8-hr. shifts. The company also employs 15 staff workers who handle marketing, accounting and administrative services. Some of the staff manage the sales office at the POACO Bldg. at Km. 30, MacArthur Highway, Malabon.

Bundy Pacific regularly sends qualified and deserving employees on training programs in the various operational aspects, usually prior to promotions to the next level. This ensures smooth turnover of job responsibilities.

The company maintains a relatively simple management set-up, with Manuel H. Torres as General Manager, Carmelo S. Arada as Marketing Manager and Joselito V. Rogacion as Production Manager.

MANUFACTURING PROCESS

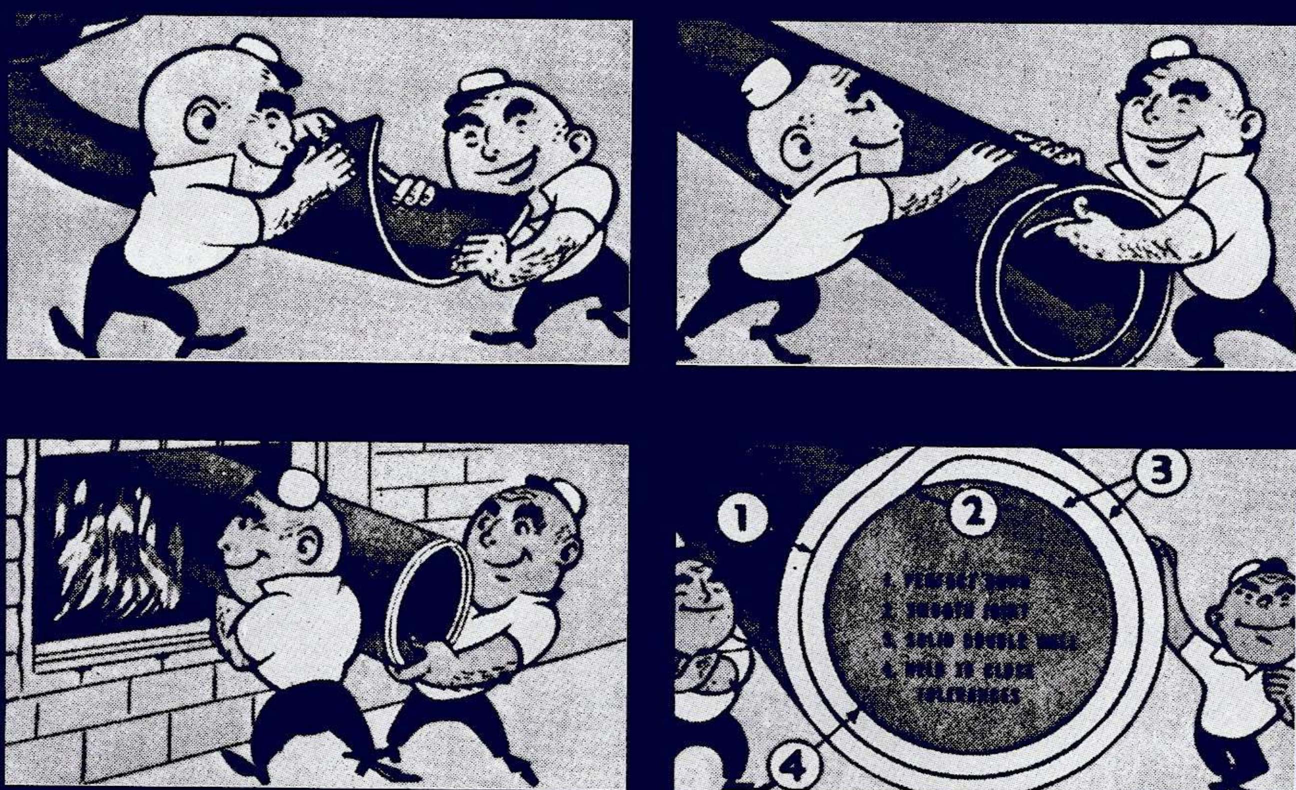
Bundyweld tubing starts as a strip of copper coated steel. It is continuously rolled twice around laterally into tubular form.

Uniform wall thickness and concentricity are assured by the use of close tolerance, cold rolled strip. The double-rolled strip is next passed through a furnace and brazed, then cooled in a reducing atmosphere.

This process results in an extra-sturdy, extra-strong, solid double-walled steel tube, copper-brazed through 360° of wall contact, copper-coated inside and out, scale-free, and held to close dimensions.

Bundyweld has great bursting strength and is easily bent into uniform, accurate bends. It has a built-in resistance to vibration fatigue, which is a critical factor in automotive and refrigeration applications. The tube can be fabricated into a wide variety of shapes, with uniform and accurate wall thickness and concentricity.

Bundyweld tubes meet the following specifications: Standards Association of Australia – AS–1751 (formerly AS-B289); American Society for Testing Materials (ASTM) – A254; and Society of Automotive Engineers (SAE) – J527.



In the annealed condition, Bundyweld has the following properties: 280 MPa (40,000 psi) minimum ultimate tensile strength; 180 MPa (26,000 psi) minimum yield strength; and 25% minimum elongation in 50.8 mm (2"). Mechanical properties of cold drawn tubing depend on the amount of cold reduction. As an example, tubing which has been reduced 20% on outside diameter possesses a minimum ultimate tensile strength of 520 MPa (75,00 psi) and elongation in 50.8 mm (2") of 5% maximum.

Drawn or sunk, Bundyweld can provide greater mechanical properties and busting strengths where needed. It can be supplied hard drawn when higher strength is needed or when the tube is to be machined.

END PRODUCTS

Bundyweld steel tubing may be fabricated into various shapes using ordinary tools. It can be cut by any of the usual machine or manual operations. Cutting edges of the tools should be of high speed steel. Deburring tools similar to those used with non-ferrous tubing are suitable for use with Bundyweld.

Bundy produces the double-walled flare, which is a must for safest carriage of high pressure, for effective resistance to greater wrench torque on fittings, for safety in frequent coupling and uncoupling of fittings, and especially for safety in hydraulic brake lines.

The company also produces diesel fuel injection (DFI) tubing whose durability, fabricability and economy serve as main factors in its widespread use in diesel engines.

Proof of its high resistance to pressure are the three bundyweld tubings which are cold drawn as a composite tube and copper brazed together to produce a single DFI.

Cleaner inside diameter and excellent leakproof qualities of tubings are major considerations for manufacturers of gas stoves and ranges. In this case, bundyweld tubing is used to ensure a smooth, blockage-free flow of gas from the gas cylinder to the burners and ovens.

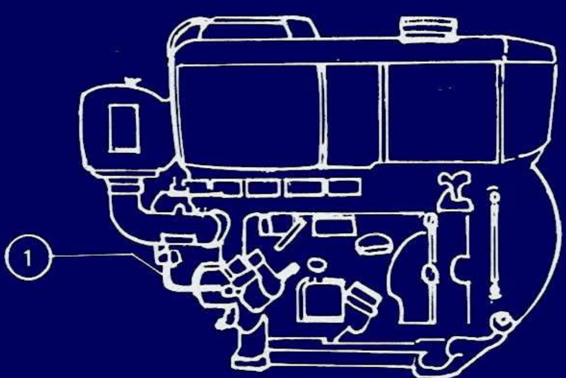
No other tube in the industry is known to have a cleaner inside diameter than bundyweld. It far surpasses the AS 1751 specification of 0.16 grams maximum residue per square meter of internal surface. For refrigeration applications, where specified, tubing is supplied with average cleanliness below 0.03 g/m^2. This is extremely important where possible contamination of systems and blockage of refrigerant flow are major concerns. It is also uniquely bendable to small radii and can be easily fabricated into serpentine coils. Its inside diameter can be expanded to its outside diameter size, making it possible to join without special fittings, and it can be die-reduced down to extremely small inside diameters to accept capillary tubing.

Bundy Pacific is equipped with engineering skills and fabricating facilities to assist in the design, production or fabrication of their customers' tubing parts. The company's engineers can provide information and help set up the precise fabrication equipment. They can also advise on specific requirements to determine exact tube size need, where and how it should be bent, the type of coating suitable, the design and construction of the necessary tooling which the customer may require for his own fabrication.

APPLICATIONS OF BUNDYWELD IN DIESEL ENGINES

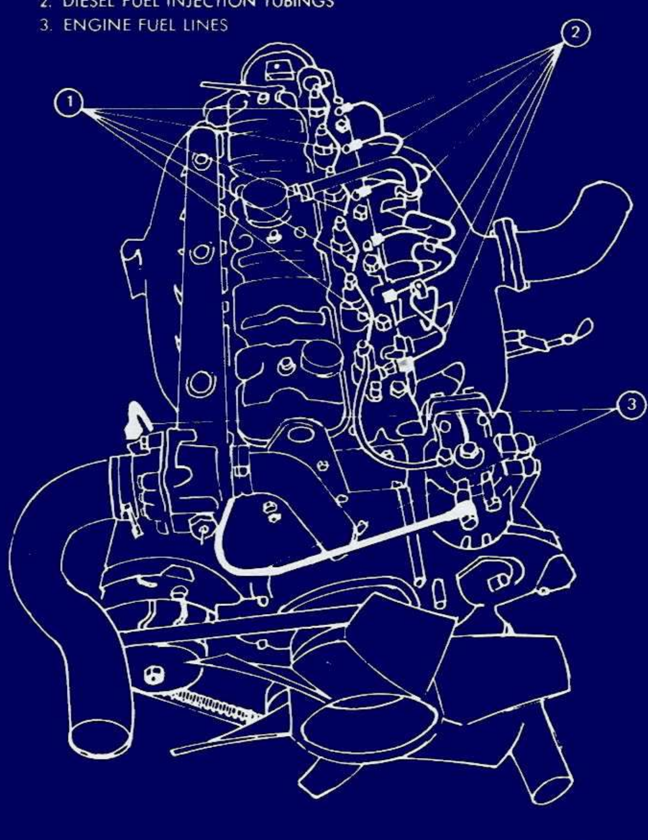
for: AGRICULTURE

1. DIESEL FUEL INJECTION TUBING



for: MOTOR VEHICLES

1. CONNECTING TUBE LINES
2. DIESEL FUEL INJECTION TUBINGS
3. ENGINE FUEL LINES



OTHER PROPERTIES

Corrosion Resistance. The main purpose of the copper on the steel bundyweld tubing is to act as the brazing medium to ensure a strong leak-proof tube. This copper is thin, and cannot be relied upon as a protection against corrosion. It does, however, protect the steel against rusting under dry atmospheric conditions, and if kept covered and dust free is less susceptible to surface deterioration.

Coatings. Many types of coating can be applied to bundyweld tubing in addition to the standard lead: tin (terne) coating offered mainly for automotive applications. This is a "hot dipped terne coating" containing a minimum of 12% tin and a minimum coating weight of 18.3 g/m^2 (0.06 oz/ft^2) on the external surface. Bundyweld has been successfully plated with cadmium, zinc, copper, nickel, chromium and gold. Standard solutions for plating steel can be used in electroplating plain bundyweld steel tubing.

The steel used for bundweld tubings conform to the following requirements as to chemical composition:

Carbon, % = 0.05 to 0.15
Manganese, % = 0.27 to 0.63
Phosphorus, max, % = 0.050
Sulfur, max, % = 0.060

An analysis of each heat is made to determine the percentages of the elements specified. The chemical composition thus determined is reported to the purchaser, and should conform to the requirements specified.

Tensile properties. Bundyweld tubings conform to the following:

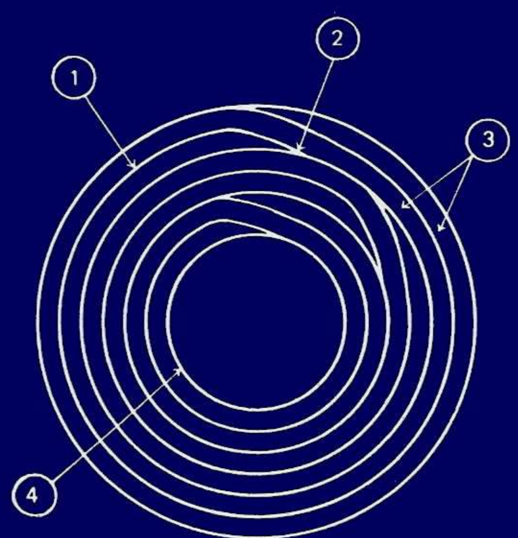
tensile strength, min, psi = 42,000

yield point, min, psi = 28,000

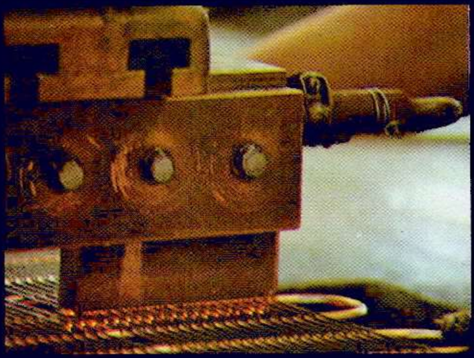
elongation in 2 in., min, per cent = 29

Tubings are tested for combined flattening and bending, where a section of tubing not less than 2½ inches in length stand being flattened between parallel plates until the inside walls are in contact. The flattened section is then bent once through 90° around a pin having a diameter three times the wall thickness of the tubing, and is subsequently straightened once, without cracking or showing flaws.

INSIDE STORY OF BUNDYWELD
DIESEL FUEL INJECTION TUBING



1. PERFECT BOND
2. SMOOTH JOINT
3. THREE SOLID DOUBLE WALLS
4. HELD TO CLOSE TOLERANCES



A flaring test is also be performed on a section of tubing approximately 4 inches in length. This should stand being expanded over a tapered mandrel having a slope of 1 in 10 until the outside diameter at the expanded end is increased 20 per cent without cracking or showing flaws.

Bending properties. To test for this area, a suitable length of tubing is bent around a cylindrical mandrel, through 360°, and should not kink, crack, or develop other flaws. The diameter of the mandrel is as follows:

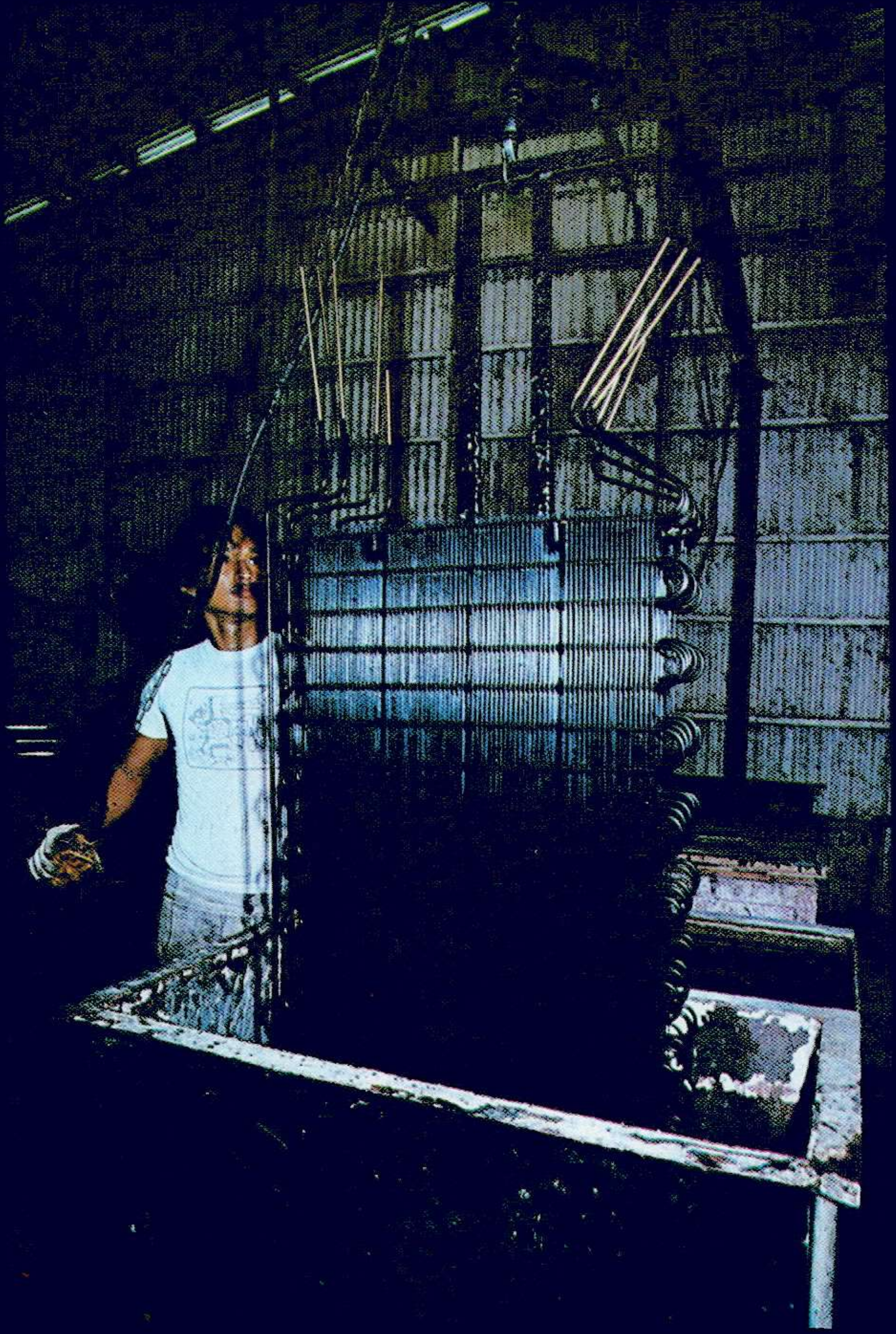
MANDREL DIAMETER
3times tube diameter for 5/16" tube θ
6 times tube diameter for over 5/16" tube θ

Hardness. The tubings posses a Rockwell superficial hardness not exceeding 55 on the 30-T scale.

QUALITY CONTROL

Quality control at Bundy Pacific, as in any other industrial supplies firm, is not taken lightly. The process is primarily undertaken to prevent gas, refrigerant, or automotive fluid leakage, which can be extremely harmful to the appliance or automotive manufacturer as well as the end users.

The quality control process at Bundy Pacific includes four steps:



(Top left) Coiled bundyweld tubes are prepared for zinc plating. (Above) After fabrication and extensive quality control testing, refrigerator condenser assemblies undergo dip painting process.

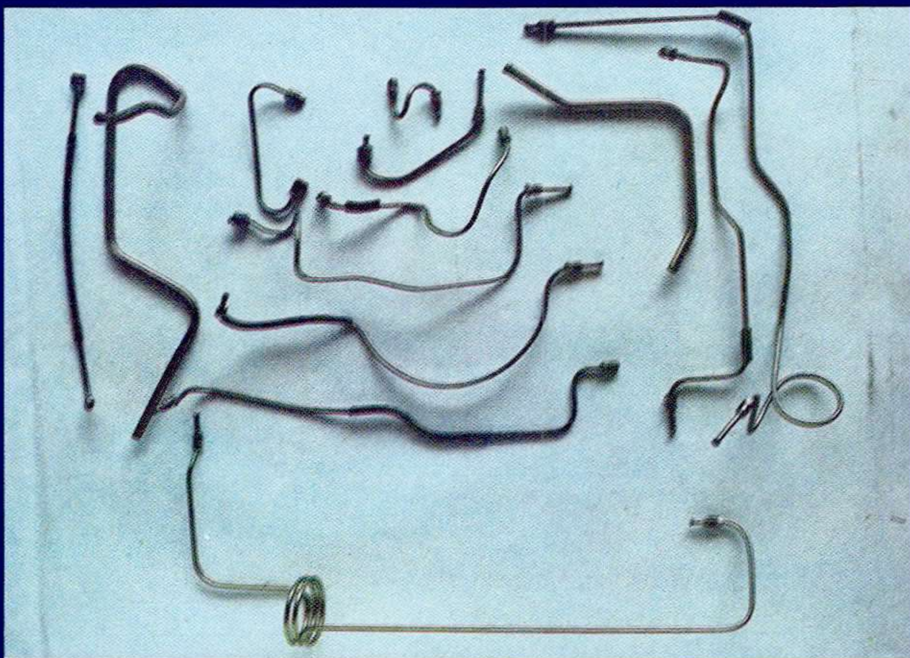
(Top) Corrosion resistance is enhanced by electrolytic zinc coating of bundyweld tubes. (Top right) The tubes are bent to serpentine wire fins for condenser assemblies. These are electric-resistance-welded to assure uniform adhesion while maintaining the desired physical and mechanical properties of the tubes and the finished condensers as a whole.

a. Testing for dimensional tolerance. This is done by checking the tubing against samples, using jigs.

b. Cleanliness test. This involves the passing of solvents through the tubing to test for degree of contamination, and blowing nitrogren through to expel dust.

When a length of tubing is washed internally with redistilled chloroform or redistilled trichlorethylene, the residue remaining upon evaporation of the solvent should not exceed 1.25×10^{-4}g (0.000125 g) per square inch of internal surface. To perform the test, 100 ml of solvent is passed through the tubing and collected. The total length of tubing tested is 40 feet or more (it should not be less), although by ASTM A254 standards this total length may be obtained by washing several separate lengths and pouring the same solvent through each in succession. The solvent is then evaporated in a steam or hot water bath, and dried at 110°C until the vapors are completely removed.

c. Leak test. The tubing is injected with nitrogen at 350 psi, then submerged under water (ends closed). Any tubing which emits air bubbles is summarily rejected.



(Top) Fabrication of tubular components with elaborate designs require special engineering skills to assure adherence to dimensional tolerances. (Bottom) The Bundy Pacific Tubing (Phils.), Inc. building at Km. 40, Sta. Rosa, Laguna houses the fabrication plant.

Each tube should be capable of withstanding, without bursting or leaking, an internal hydrostatic pressure sufficient to subject the material to a minimum fiber stress of 16,000 psi in the case of double-wall, 360° brazed tubing.

An alternative hydrostatic test involves subjecting the tubing under water to an air pressure between 225 and 250 psi, and it should come out free from leaks.

d. Corrosion prevention coatings test. Visual inspection of paints on condenser units are usually carried out after testing the adherence/nonadherence of paint to adhesive tape.

Finished tubes should be reasonably straight and, when so specified, shall have ends free from burrs. Tubes should also be free from rust and injurious defects and should have a workmanlike finish.

FUTURE PLANS

Bundy Pacific Tubing (Phils.), Inc. hopes to realize its expansion program in the near future, to accomodate the growing demand for specialty tubing by the automotive and appliance industries. This will promote flexible capacity to suit any fluctuation in the industries' requirements for such tubings. Aligned with this is the company's proposed apprenticeship program, designed not only on the expansion aspect, but as an added boon to the residents of Sta. Rosa, Laguna.

The company will likewise be involved in continuing product development to explore other uses of Bundyweld tubings, as acclimatized to the Philippine market, primarily on non-traditional applications. Research will also be carried out on the different aspects of quality control to assure continuing adherence to stricter specification requirements of customers. PM

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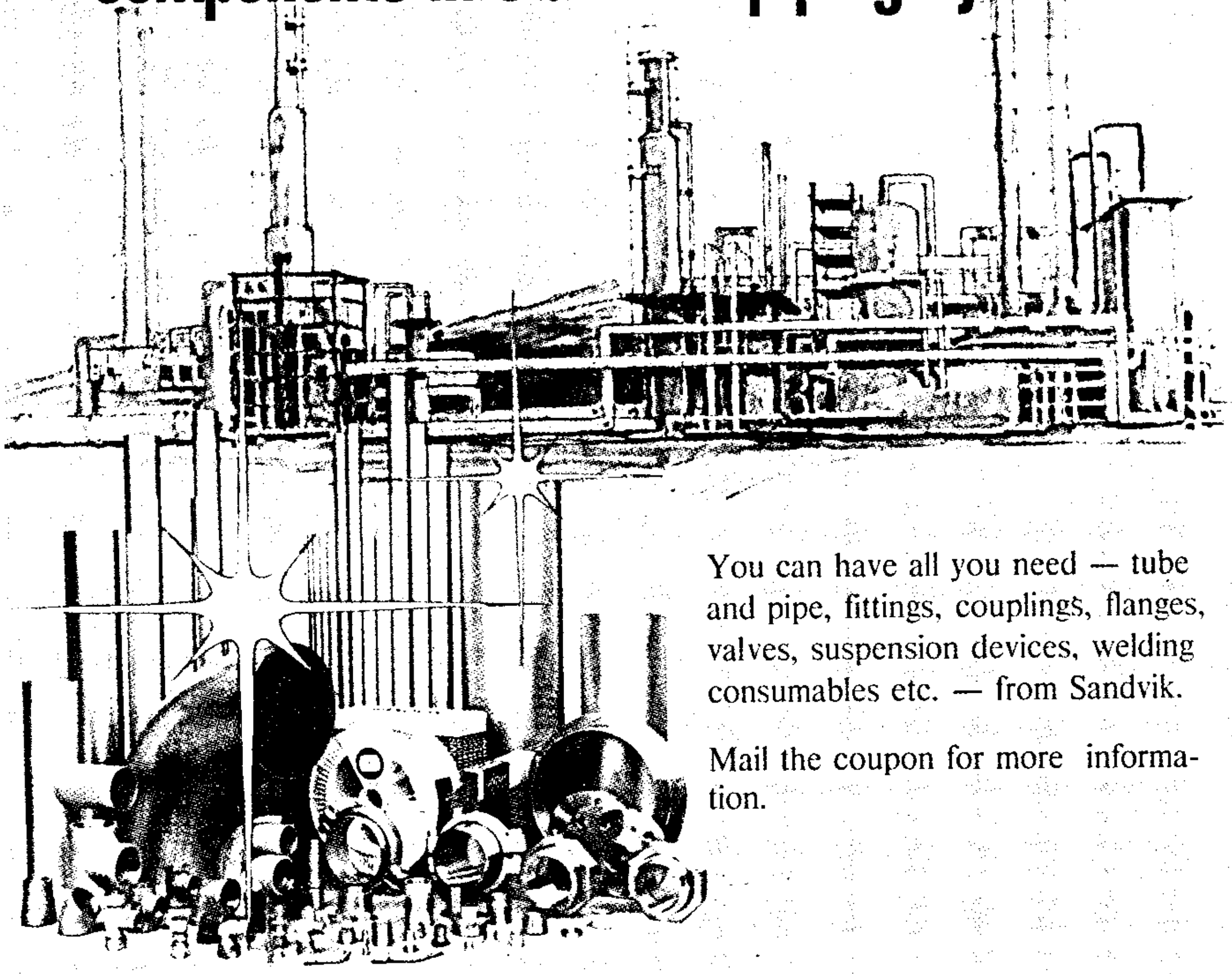

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TIN CAN MANUFACTURERS' ASSOCIATION OF THE PHILIPPINES

From a cottage industry, tin can manufacturing in the Philippines has matured into a self-reliant industry equipped with modern plants and appropriate technology.

Now generating an average annual sales of half a billion pesos, the industry adequately supplies the requirement for quality food-grade cans by the food processors, fish canners, dietetics and milk manufacturers, and other can users, including exporters.

Self-reliance has been the policy of the tin can manufacturers since they formed the Tin Can Manufacturers' Association of the Philippines, Inc. (TCMAPI) six years ago.

The TCMAPI was organized in answer to the government's call of assisting the then Price Control Council in implementing the price control program. Since prices of canned goods, particularly cooking oil and milk, are affected by the price of the containers, the Council called on local can manufacturers to bind themselves, and dialogue with the government as one united voice.

Ten companies heeded this call. The Association was finally incorporated, holding its meeting on September 25, 1975 with Pablo P. Gabriel of Manila Metal Container Corp. serving as president and holding that post up to the present.

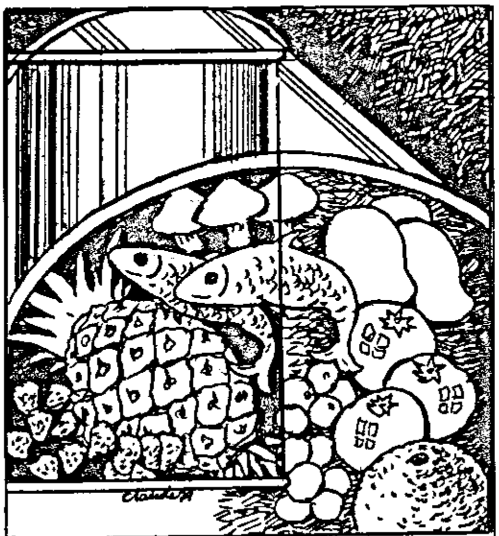
The original incorporators were Pablo P. Gabriel; Alfonso S. Co, Century Container Corp.; Carlos Cruz, Quality Container Corp.; Conrado S. Tiongson, C. S. Tiongson Enterprise; Ramon Chua, Oriental Tin Can & Metal Sheet Mfg. Co., Inc.; Lucio Tan, Rowell Industrial Corp.; Esmeraldo Mendoza, Inland Industries, Inc.; Jose S. Robles, Camara Steel Industries; Ricardo Chua, Consolidated Can Corp.; and Bonifacio Tan, SYS Industrial Corp.

With the primary objective of "service to the Philippine economy", the association has continuously served as a forum for mutual exchange of technology. Through joint action, can manufacturers have sought solutions to whatever problems the industry might encounter.

From the original 10 member-firms, the association now has 25 members:

Azkon Metal Industries
C.S. Tiongson Enterprise
Carnation Philippines, Inc.
Century Container Corp.
Clayton Industrial Corp.
Consolidated Can Corp.
Eastern Metal Industries
Evercan Container Corp.
General Metal Container Corp.
International Container Corp.
Ivan's Enterprise
Manila Metal Container Corp.
Metro Container Corp.
Nice Products
Odeon Container Corp.
Oriental Tin Can & Metal Sheet Mfg. Co.
Philcan Industrial Corp.
Philippine Tin Lithography Co., Inc.
Quality Container Corp.
Reliable Industries
Rowell Industrial Corp.
Ruby Industrial Corp.
Sta. Monica Canning Corp.
SYS Industrial Corp.
Unican Industrial Corp.

Besides the TCMAPI, the can manufacturing industry also consists of independent can makers



who are food processors or canners themselves. Among these are Philippine Packing Corp., Dole Philippines, Philippine Integrated Meat Corporation, Reno Foods, and two other milk processors, Holland Milk Products and Filipro, Inc.

The Tin Can Manufacturers' Association of the Philippines, Inc. was founded on the belief that working for consumers' welfare is the key to growth and stability.

Seminars and workshops are held by the Association to devise ways of effectively raising productivity levels in order to prune down production costs. The aim is to provide can users with cheaper but high quality tin cans which ultimately mean low-priced canned goods for consumers.

Among the Association's notable achievements is the growth attained by the industry from a production level of 80 million cans in 1977 to 200 million cans in 1978. Rationalization of the price of cans is another feat. This does not mean the establishment of a cartel, but rather, prices of cans are based on the ability of manufacturers to reduce production and overhead costs by maximizing plant operation and energy conservation. This is essential, because instead of cut-throat competition, the members succeeded in producing reasonably priced cans.

Another feat achieved by the Association is the lowering of tariffs on imported tinplates through a presidential decree issued last July 12 by President Marcos. Prior to this, the Association periodically made representations with the government for tax and duty-free importation of tinplates to augment the erratic supply of local tinplates.

These accomplishments prove the Association's effectiveness in resolving vital economic issues in the industry.

The Philippine tin can manufacturing industry, like any basic industry, has to select the right technology tailored to the country's economic needs in order to provide consumers with the most practical mode of product packaging.

In a short span of time, the industry acquired the appropriate technology for making three-piece sanitary cans, the most popular container for food, beverages and other products. This modern can making method was adopted because results of experiments and tests have proven its economy, practicality and safety compared with alternate forms of can making. In this respect, the three-piece soldered side seam can-making process answers the needs of Philippine economy and of Filipino consumers for the following reasons:

The economy requires various types and designs of cans in relatively small volumes for processed foods, fish and other seafoods, milk products, and other products packed in cans;

(Left) Mr. Andres Butel, representing the Senden House, receives cheque donated by the TCMAPI from association president Pablo P. Gabriel in the presence of (from left) Mr. Agustin Lao, Mr. Conrado S. Tiongson, and Boy Villavicencio, vice president.

(Right) Dr. Pablo P. Gabriel clarifies a few points during his opening speech at the TCMAPI dinner meeting.

The economy has limited resources, and therefore capital investments should be maximized in procuring the right technology;

Food manufacturers and other can users require superior low-cost packaging methods with the ultimate goal of supplying consumers with low-priced goods; and

Health and safety of consumers must be protected, and thus the chosen technology must produce the safest means of food packaging.

To attain these goals, local tin can manufacturers have acquired and are operating the latest equipment and facilities which are periodically modernized to keep abreast of modern technology. These machines are procured from Switzerland, USA, Germany, and Taiwan.

Still the industry, particularly the Association, is open to new technology in can manufacturing provided its adoption would answer the country's needs in terms of practicality, economy and consumer safety.

In terms of expertise, Filipino technicians regularly train in the US, Germany, Japan and Australia. These Filipino experts blend well with their foreign counterparts: American, German, British, Swiss, Australian, Japanese and Taiwanese who are under the special employ of the local tin can manufacturers.

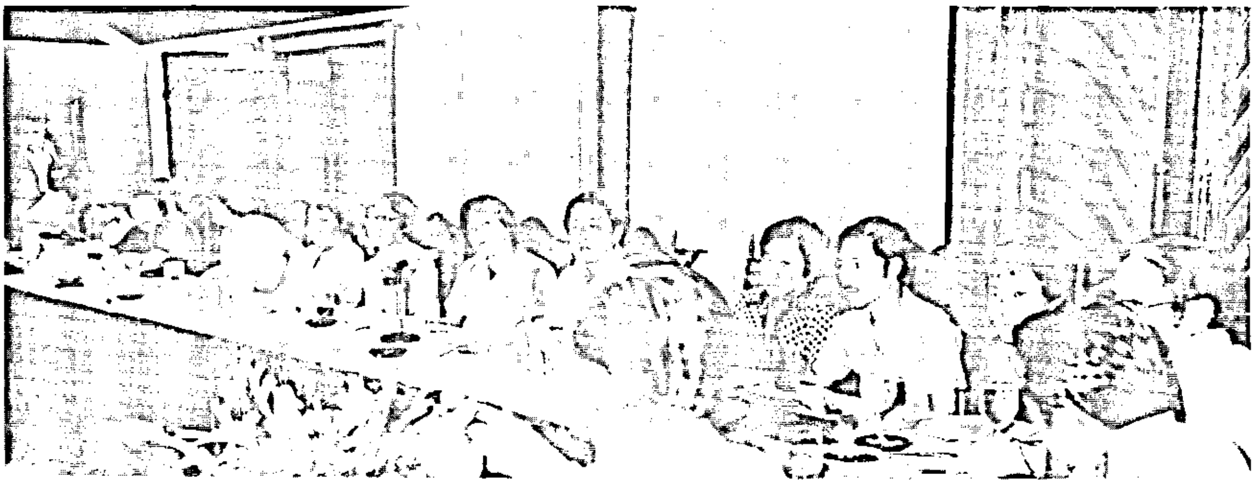
With highly competent men behind efficient machines, thirteen of the twenty-five member firms of TCMAPI are capable of producing high-quality food grade (sanitary) cans, using 38 Soudronic welding equipment which can produce 465.2 million cans at three shifts in 300 days.

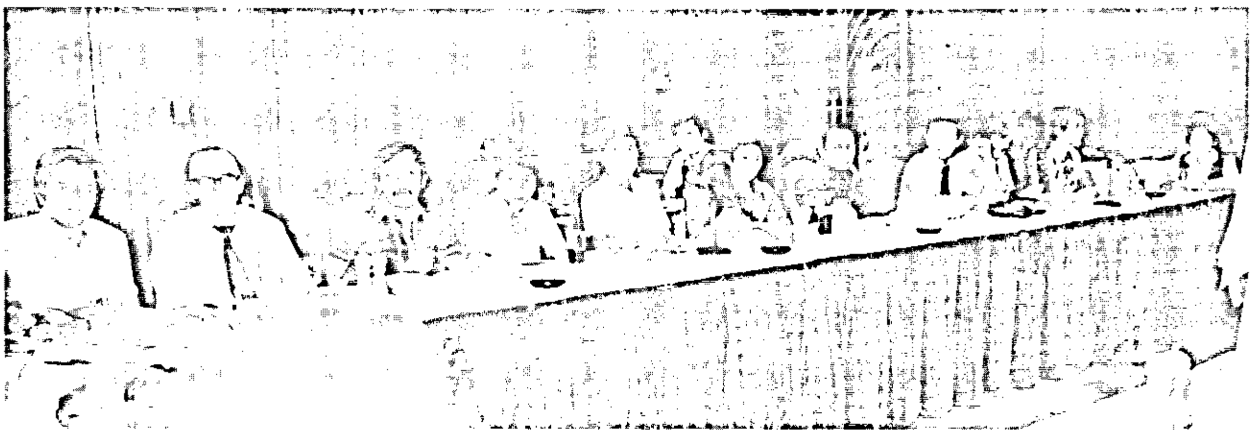
Able leadership has enabled TCMAPI to overcome hardships which have threatened to arrest industry's growth. Right now, the Association is pooling its resources to work out a mechanism by which the perennial problem of tinplate sourcing could be solved once and for all.

Although the country's tinplate supply is stabilizing and its quality improving, the Association is determined to form a purchasing arm for the entire industry. This would give added leverage in procuring low-priced quality tinplates, since bulk buying improves bargaining power.

As an added step to improve the tinplate situation, some members of the Association have applied with the government for the establishment of a bonded manufacturing warehouse. Through the bonded warehouse, tinplates can be imported tax and duty-free for the export sector. The tinplates are re-exported 100 per cent in the form of cans used by food processors.

The Association's leadership has also programmed periodic seminars within the industry and dialogues with consumers on how the industry can plot out ways to further bring down their cost of production. Members of the Association conduct conferences to exchange information on reducing their power consumption as a step towards energy conservation.





TCMAPI members deliberated on current issues and controversies affecting the tin can manufacturing industry during a dinner meeting held at the Silahis International Hotel last 14 June 1979.

Concern for related industries is one motivating factor that contributed to TCMAPI's success. The Association helps related industries to grow and prosper. The food manufacturing industry, for example, profits from the technology of tin can manufacturers through technical assistance programs on proper packaging of processed foods. And by providing high-quality low-priced tin cans, the industry helps make canned food exports more competitive in the world market.

TCMAPI president Pablo P. Gabriel said, "We have sufficient expertise and technical know-how when it comes to tin can making for various uses. We believe that we can produce better quality cans with the type of equipment we are currently using. We have the most modern equipment in Southeast Asia, comparable to any type of equipment in any part of the world."

"Whatever progress we have attained is shared not only by can users but most importantly by Filipino consumers," Gabriel stressed.

OFFICERS OF THE ASSOCIATION (1979-1980)

Pablo P. Gabriel
President
(Manila Metal Container Corp.)

Vitaliano G. Villavicencio
Vice President
(Oriental Tin Can & Metal Sheet Mfg. Co., Inc.)

Alfonso Co
Secretary
(Century Container Corp.)

Conrad S. Tiongson
Treasurer
(C. S. Tiongson Enterprise)

Antonio G. Singian
Public Relations Officer
(Carnation Philippines, Inc.)

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Francis Chua
Philippine Tin Lithography Co., Inc.

Richard Sycip
Consolidated Can Corp. **PM**

technical abstracts

Piezoceramic atomizers break up liquids of all kinds into a very fine mist. The exhibition model shown here creates such a fine mist from water that a considerable time passes before visible drops actually form on the walls of the glass collecting vessel (Siemens press photo).

PIEZOCERAMIC ATOMIZERS

Piezoceramic atomizers are used to break up liquids of all kinds into a very fine mist. However, liquids with viscosities above a certain level are not suitable. The model shown in photo creates such a fine mist from water that a considerable time passes before visible drops actually form on the walls of the glass collecting vessel. The core of the set-up developed by Siemens is a small metal oscillator to which a ceramic disk is cemented. The water is fed via centric holes in the two elements.

With a disk diameter of 17 mm (length of metal body = 14 mm), it was possible to achieve an atomizing margin rate of three liters of water per hour. The oscilating frequency is set to 100 kHz, which produces droplets with a diameter of around 20 um. The lifetime is of the order of 10,000 operating hours. Using lower oscillating frequencies and larger disk diameters, more than three liters per hour can be atomized.

Two features in particular, the small size of the compound oscillator and the fineness of the mist, have attracted the attention of manufacturers from a variety of fields. For instance, an inhaling apparatus based on this technique for the generation of medical aerosols is already available. Automobile makers also have the intention of testing piezoceramic atomizers in carburetors. *Siemens.*

AUTOMATIC IMPRINTED IDENTIFICATION OF SLABS

A device that automates the imprinting of identification codes on the top or rear end surface of the sizzling chunk of slab as it comes off the continuous casting shop has been developed by Kawasaki Steel Corp. Called the Automatic Hot Spray Marker, the machine uses a special stencil made of inflammable material, and sprays an inorganic, heat-proof paint through this stencil to impress a mark which is clearly readable from 10 meters (33 feet) away. The mark will neither peel off nor fade out from the slab surface even after more than a year's exposure to wind and rain in the open yard.

With a microcomputer or sequential circuits built into an operational control console for data processing, sequencing, monitoring and other control purposes, the device saves manpower and eliminates both work hazards and marking errors.

The device is also applicable, after minor modifications, to the marking of continuously cast blooms, and the commercial feasibility of such extended use is now being tested, with an early probability of success. *Kawasaki Steel Corporation.*

SOLVING PROBLEMS IN JOINING AND BRAZING

Clad metals are often specified for joining dissimilar metals. Copper does not solder well to aluminum, but adding a clad metal transition spacer allows the joint to be made by conventional methods. In brazing stainless steel, copper clad steel eliminates surface precleaning and fluxing and makes control of hydrogen atmospheres less stringent.

Clad metal transition spacers, consisting of a clad combination of the two metals being joined, can solve two major welding problems. They are: a) joining of dissimilar metals where welding, brazing or soldering are the preferred methods; and b) solving a potentail corrosion problem by eliminating the crevice between dissimilar metals. The latter is particularly applicable to the auto industry, where increased use of aluminum in basically steel cars make them potentially one huge galvanic cell.

Since transition spacers must be designed for each specific application, they are not off-the shelf items. So far, tests show that various combinations of steel, aluminum and copper are viable, although applications involving tubing are in service already. Metal thickness and cladding ratios can be varied to meet specific requirements. *Materials Engineering, February 1978.*

PROFITABLE SHORT-RUN STAMPINGS

Short production runs on large stamping presses can be uneconomical due to the unproductive time taken to change over and set up dies. This was the primary consideration in the design of the Minster Die-Namic process, a quick die change system with interchangeable tooling.

Some significant benefits derived from the system are:
a) reduced tooling costs with savings of up to 60% for Die-namic dies as opposed to conventional dies; b) die change time cut from 1½ days on a conventional transfer line to less than 30 minutes for a complete run change, including transfer finger bars and blank feeding chutes; c) die storage for 72 different workpieces in a compact rack system near the press; d) blanks are fed automatically from chutes instead of manually; e) short runs are now economical without extensive cost of conventional transfer die set-up times; f) greater production scheduling flexibility with the ability to make quick adjustments to meet tight delivery dates; and g) material savings of about 80% as the parts produced are made from scrap blanks coming off conventional transfer die operations. *Sheet Metal Industries, October 1978.*

INFLUENCE OF TINPLATE VARIABLES ON D AND I CANMAKING

Tin-coated steel has proved to be an excellent material for the manufacture of drawn and ironed (D and I) containers. Material variables which were studied as part of an investigation into the influence on the D and I process included steel-temper, steel surface topography and tin-coating thickness.

During the draw-redraw operations the steel surface is greatly deformed and the original surface roughness is increased because of grain tilting. The subsequent ironing steps tend to smooth this surface roughness by filling in the valleys and thus produce a smooth wall container. Tin is distributed during these operations, by being wiped from the tops of peaks and pushed into the valleys. Ironing further segregates tin to the valleys and creates smooth areas that have very little tin remaining.

Ironing loads have been shown to be dependent upon tin coating weight. Variations in coating thickness from heavy tin down to some critical level cause a slight increase in the ironing load. Below this critical level friction forces increase rapidly as the tin has lost its ability to act as a solid lubricant and the possibility of galling has increased. *Sheet Metal Industries, October 1978.*

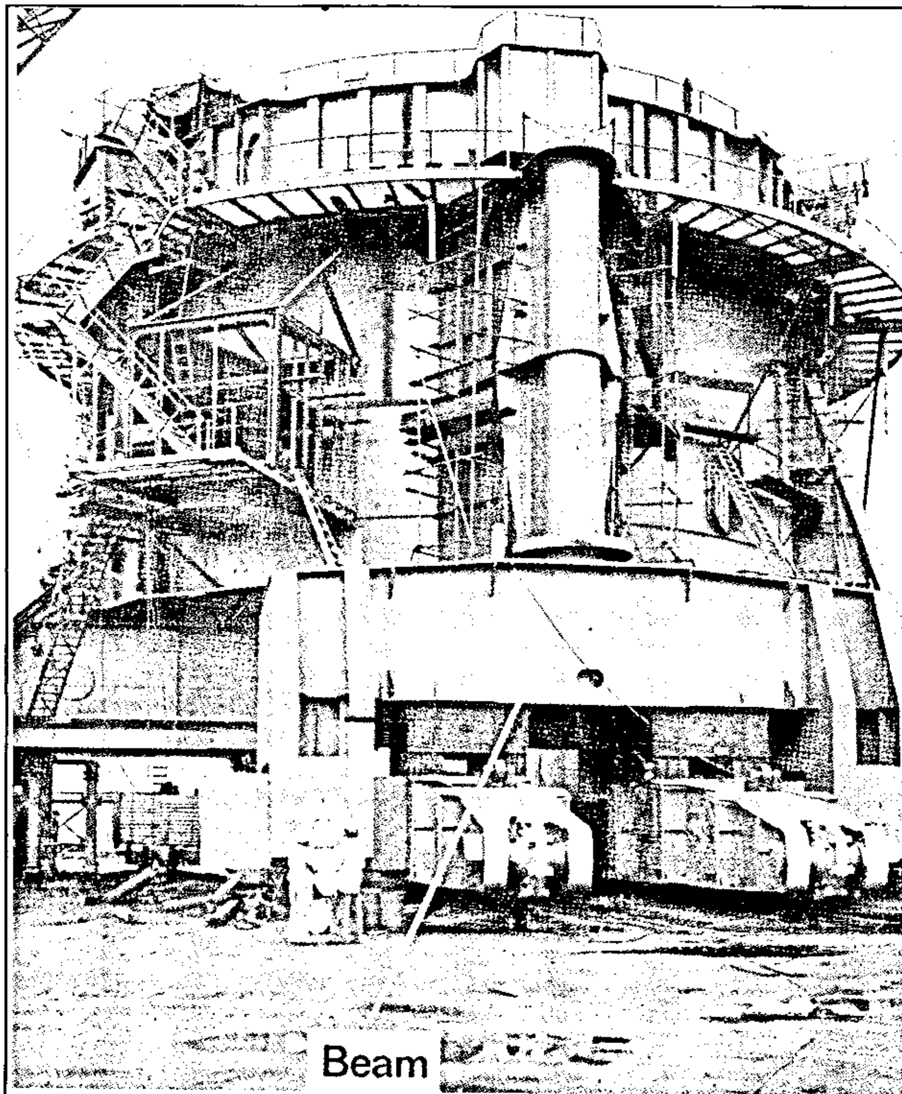
RESEARCH ON TINPLATE AND ELECTROCHEMISTRY

One of the important areas of research currently being followed in the field of tinplate and electrochemistry is the study of the passivation of tinplate and the subsequent analysis of the passivation film in order to examine its effect on the performance of lacquer films applied afterwards. Use has been made of a specially built-in rig embodying a rotating cathode treatment cell which can simulate many of the operating conditions of a commercial tinplate line. The flow-melting stage of manufacture, in which the tin coating on the steel is momentarily melted so that the matt finish changes to the familiar reflective material, is then carried out on a separate apparatus. The passivation process itself is then studied in a second design of rotating cathode cell which permits sequential filling with different treatment solutions. In this new method, the passivation film is characterized by measuring how much chromium dissolves during an anodic oxidation treatment, the remaining chromium being assessed by dissolution in boiling sodium hydroxide.

There is a requirement, particularly in the electronics industry, for a deposition process for tin which does not need an applied current. Development has therefore continued as regards a solution for the autocatalytic deposition of tin. In the current study, Sn^{2+} ions are reduced to tin by Ti 3+ ions at an activated surface and hence deposited as an even layer. The advange of such a process over electrodeposition is that even non-conducting substrates such as plastics may be coated and intricate shapes can be more evenly covered. *International Tin Research Council, Annual Report 1977.*

DEVELOPMENTS IN PUNCHING PRESSES

The recently introduced Norton-SMV press is able to cope with difficult material variations without affecting output, and also offers batch production at speeds significantly higher than those which may be achieved with open front presses. Furthermore, the tools do not require expensive monitoring systems, and the operators do not need to be highly trained.



Welded yoke-beam construction of a 240,000 m^3 bucket wheel excavator.

Designated as the FCP series, the new presses are fitted with a quick die change system incorporating hydraulically operated pivoted clamps, motorised slide adjustment with digital readout, and hydraulic locking of the pitman screw, making them particularly suitable for the manufacture of small and medium as well as large batches.

Press frames are of one-piece cast iron construction which can be fitted with suitably sized legs to alter the bolster height where necessary. Cast iron is well known for its ability to dampen shock and vibration caused by punching or blanking operations. A pneumatic clutch is currently fitted, but it is proposed to fit a hydraulic clutch and brake unit which will result in quieter operation. *Sheet Metal Industries, October 1978.*

WELDING OF BUCKET WHEEL EXCAVATORS

In the past 10 years, welding techniques have been developed for the production of giant bucket wheel excavators. Bolted joints have virtually disappeared, having been replaced by welded joints. Even on the erection site the connection of elements is carried out by welding.

Because of the great weight of steel structurals for excavators, care must be taken in considering which of the weldable steels to DIN 17000 or SEW 089-70 with varying nominal strengths is the most suitable for structural use. It is necessary to determine whether or not high tensile strength, fine grain steels have advantages in comparison with structural steel such as St 52-3. The experience gained with the particularly good weldability of low sulphur steels has provided considerable encouragement for the realization of the fully welded structures of giant excavators.

To keep the structural weights of excavators down to acceptable levels, the welded joints must be of high quality. The quality of the welded joints, as well as permissible operating stresses for excavator structures, depends on the basic material, the type of weld seam specified in the design, and the quality of the produced weld seam. *Welding Journal, February 1979.*

COAL CONVERSION THROUGH HYDROGENATION

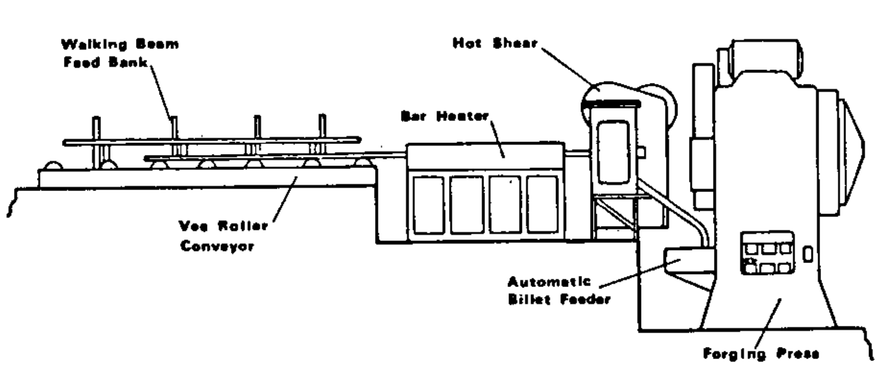
Kawasaki Steel Corp. is pressing forward on its research into coal conversion by having on stream at its Mizushima, Okayama Pref. Works an eight-ton per day pilot plant that turns steam coal and other non-metallurgical coal into what it calls "recon coal" — the primary coal extract suitable for use in blast furnace cokemaking. The pilot plant uses the hydrogenation process for coal conversion, whereby a slurry of ground and dried non-metallurgical coal is partially dissolved in a solvent that is pumped back from the downtream recovery unit. The addition of hydrogen at high temperature and under high pressure re-composes the mixture's molecular structure. Bitumen, which makes up the recon coal, is extracted from the resultant hydrogenated liquid, as it passes through distillation, ash control and other treatment steps.

Manufactured that way, the coal is in a solid state at normal room temperature. It looks no different from other metallurgical or non-metallurgical coals on the surface, although it is slightly more brittle and prone to crumble into pieces. What makes it different from other coals are two distinctive features. These are its high fluidity and ability to more readily enhance the coking characteristics of non-coking or weakly coking coal, or char, when blended with the latter and baked in the coke oven.

These properties make the recon coal appear largely as a significant source of cost savings in the process of cokemaking, and are suggestive of its role in coal liquefaction. Similar cost benefits are also anticipated when an agglomerated mixture of recon coal and non-metallurgical coal or char is baked in the shaft-type coking furnace and converted into formcoke, another substitute for more expensive metallurgical coal. *Kawasaki Steel Corp., February 1979.*

SEMI-AUTOMATIC FORGING LINE WITH HOT SHEAR

Since cold-sheared billets are cut remote from the forging process, it is difficult to monitor and change the cut volume to suit the various die conditions and accommodate the changing section of the bar stock. The very remoteness of the shearing facility relative to the ultimate forging process brings many problems: identification of steel, quality control to ensure crack-free forging uses, an expensive system of moving billets and the general difficulties in stock control.



The semi-automatic forging line with hot shear comprises a vertical forging press on the right with billet feeder fed with hot slugs cut on a shear at the exit of a bar heater.

One way of controlling these problems is by the use of the semi-automatic forging line, which is essentially a series of proven pieces of machinery linked together. Basically, the process comprises a vertical forging press equipped with automatic billet feeder which is fed with hot slugs cut on a shear at the exit of a bar heater. This line is simply the next stage towards more efficient and more acceptable units of machinery for the modern forge.

Further automation can be introduced to the basic forging line in the shape of automatic beam transfer equipment. In this case the hot sheared slug is delivered straight into the loading section inside the window of the press. Toes on the transfer beams engage the billet and move it in a square lift action to the first and subsequent die stations. The billet is flattened, moulded, finished and trimmed as it progresses across the dies to exit as a finished forging directed to the collecting bin and as flash to another. Careful die design and positive ejection are essential for trouble-free operation. *Metallurgia, January 1979.*

THE METAL FORMING MACHINE INDUSTRY OF JAPAN

The metal forming machine is considered the "mother" of the machinery industry. Together with the metal construction machine, it is considered as basic capital goods. The application of this machine has resulted in good material yield and proved suitable in economical and mass production of uniform precision products. The basic machine occupies a large weight in the mass production industries such as the automotive, electric equipment, and precision instrument industries.

The Japanese metal forming machine industry has been continuing constant efforts to develop new plasticity processing technology, noise and vibration measures, safety measures, automation and energy conservation and diverse production facilities. A national project is now being promoted to develop a complex but highly effective production system. This makes it possible to carry out consistent molding, processing and assembling of machinery parts materials of various shapes, measurements and weight.

In the practical application of the metal plasticity processing method, recent advances have made it possible to broaden the application scope of the powder plastic method and the cold forging system. *Digest of Japanese Industry & Technology, No. 131 1978.*

RECRYSTALLIZATION IN HEAVILY DEFORMED METALS

In the electron microscope the structure of metal deformed at ambient temperature to strains in the range 1.0 to 3.0 appear very messy; in the optical microscope the dominant feature is the elongated or flattened grain shape. Simple formal transformations may be found to convert one texture into another, but there is a great multiplicity of transformation that can describe any given pair of textures; where recrystallization is involved none of them is likely to imply a mechanism.

A consideration of the difference between the structure of heavily deformed and moderately deformed metals, and of the relationship between structure and recrystallization, has been given in recent study to show something of the complexity that a connective theory between recrystallization and deformation textures must encompass. It was also shown that the microstructural and compositional details of each system need to be recognized separately and considered in detail, in any explanation of the development of the annealing textures from the associated deformation structure.

The contribution of competitive grain growth to texture development, which starts well before recystallization is complete, is an important one. It is not subject simply to considerations of the relationship between a growing grain and the deformed matrix, and is thus a further complication to the formal theories relating the deformed and annealed structures. *Metals Forum, September 1978.*

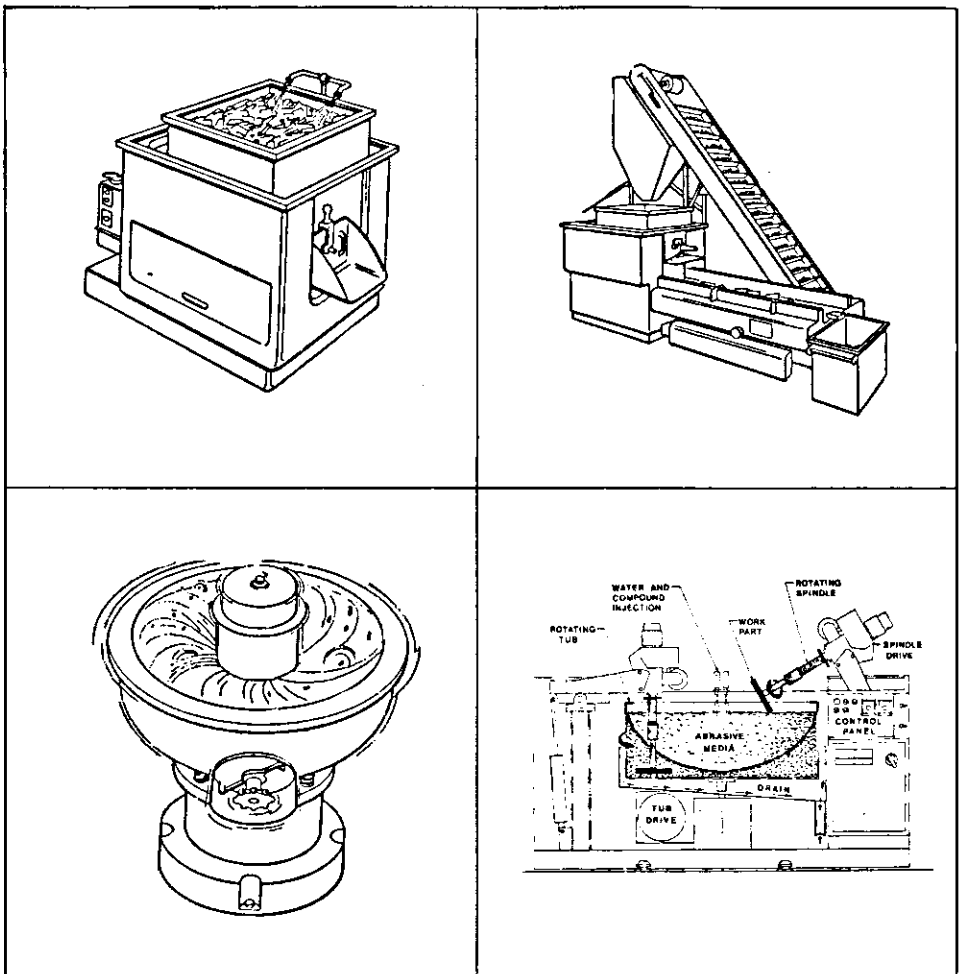
MASS FINISHING

Mass finishing is a process of deburring, edge and corner radiusing, and surface finishing a quantity of components in bulk by mechanical means. Improvement of surface includes removal of rust and scale, reduction of surface profile in micro inches RMS or AA, and generating suitable surface textures for decorative reasons or subsequent paint or chemical coatings. At present, there is an increasing effort being made to develop mechanical finishing into a technology. Mass finishing, being one of the most important groups of mechanical finishing methods, is probably developing faster than other techniques. An understanding of the different types of machinery available, the range of consumable materials, and the basic process parameters will enable an engineer to find an effective and economical means of deburring, radiusing, and surface finishing a substantial proportion of his components.

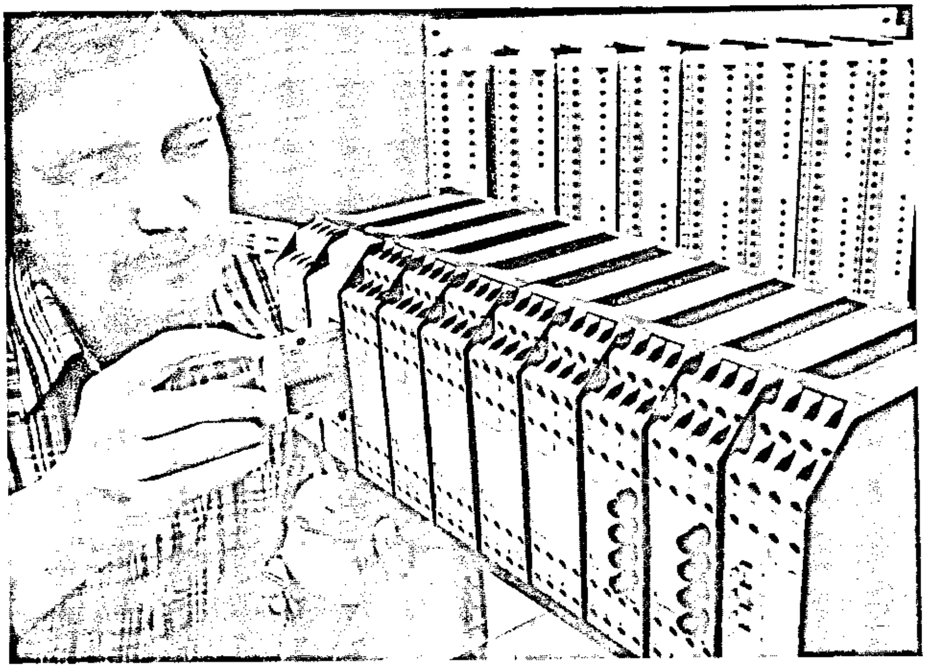
Conventional barrel tumbling was the original mass finishing technique. However, the process is usually very time-consuming and space-consuming. In place of this, vibratory deburring equipment has become the most common and accepted mass finishing technique in use today. The initial advantages of vibratory equipment were that they were faster and more convenient than tumbling barrels, and they also had the capability of getting more action in recesses of components.

These processes were followed by centrifugal barrel finishing, which uses a variety of abrasive media, compound and water to deburr and surface finish a wide range of components. Centrifugal action results in very fast, highly controllable finishing operations, together with the capability of imparting very high compressive stresses in the surface of components.

Spindle machines are just coming of age, and these comprise a circular, rotating tub which holds loose abrasive media, and a rotary spindle to which the part is fixtured. The workpiece mounted on the spindle is immersed into the rapidly moving abrasive slurry, causing the abrasive to flow swiftly over rough edges and over the surface of components. *Metal Finishing, July 1978.*



Clockwise, from top left, a vibratory tub, automatic vibratory unit, vibratory bowl, and two-spindle finishing concept.



User-oriented automatic system with microprocessor for simple and complex industrial processes (Siemens press photo).

THE JAPANESE MACHINE TOOL INDUSTRY

The rapid advance in the development of machine tools has brought about continual changes in the types and their applications. Where before a major part of machine tool production was taken by the ordinary lathe, the trend today is for an increase in ratio of special purpose machines.

Other miscellaneous machines (including NC machines) make a fast increasing category. Among these, NC machines represent a pre-dominant 70 per cent. A new trend in miscellaneous machines is the rise in the number of machine tools utilizing electric-discharge, electrochemical erosion, and ultrasonic energy for forming, grinding and milling operations.

Moreover, the "machine systems" approach in the design of machine tools, made possible by the adoption of electric control technology, has stimulated the development of new machine tools. This has resulted in a broadening of the variety in types and sizes of machine tools available in the domestic market. In relation to this, the industry is planning to start a joint research effort with related manufacturing industries, such as process control equipment, conveyors and moving equipment, industrial, and tools.
Digest of Japanese Industry and Technology, No. 131 1978.

A USER-ORIENTED AUTOMATION SYSTEM

Modern semiconductor technology permits the use of economically efficient automation equipment extending from contactors and relays at the lower end of the automation scale to process computers at the top. To this end, Siemens has developed the Simatic S5 user-oriented programmable automation system which operates with bit processors on one hand and microprocessors on the other, for easier control of simple and complex industrial processes. The system is distinguished by short reaction times, easy programming, and simple handling. It not only performs monitoring, control and logging operations, but also closed-loop control functions as well.

The system was broken down into four coordinated and mutually compatible types of units, in order to optimize economic efficiency. This applies to the programming units, which enable programming to be depicted on visual display units or screens in the form of control system flow charts, ladder diagrams or nmemotics.

The system can operate with input and output voltages of up to 220V without additional modules, making it possible to switch direct from contactor to electronic circuitry.
Siemens.

A NOVEL SHAKE-OUT DRUM

The shake-out drum with interchangeable drum lining made of wear-proof, perforated segment plates, produced by Didion Manufacturing Co., USA, is now manufactured for the European, African and Middle East markets.

An outstanding feature of this Universal Separator TR 1200/1500 shake-out drum is that while the sand and the castings are turned by the revolving movement of the drum, the sand falls through the perforations of the lining segments into a chamber between the lining and the drum casing. Here, separated from the castings, the sand is moved on by means of spirally arranged sand guide beads and is conveyed on the used sand return belt. The castings are also transported through the drum by means of spirally arranged guide ribs on the inside of the lining. By altering the drum speed and modifying the spiral guide ribs, the shake-out drum can be adapted to the operating conditions of the foundry concerned.

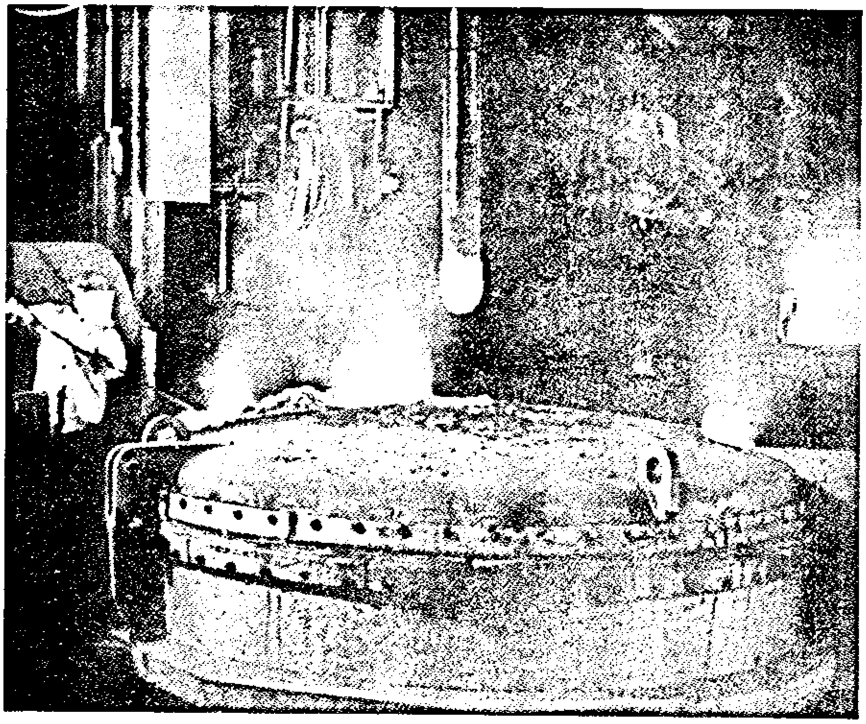
Advantages offered by the shake-out drum include good separation of sand and castings, homogenization of the used sand, low power requirement, low wear of the assembly, optimum dealing with dust and mist, and lower noise level than in vibrating shake-out equipment. The shake-out drum can be utilized in combination with all types of cold setting moulding sands. *NOWEA Press Information, GIFA '79.*

ENGINEERING ASSISTANCE FROM KAWASAKI

The Construction & Development Corp. of the Phils. (CDCP) has awarded a contract to Kawasaki Steel Corp. for technical assistance and support services in the design and engineering of a 160 m (0.10 mile) long pier. This is part of the dock facilities which CDCP is currently constructing in Batangas for Luzon Stevedoring Corporation. This assistance involves the on-site application of the interlocked steel pipe piling (ISPP) method, and is packaged with the supply of 982 metric tons of pipe piles and 415 metric tons of sheet piles plus auxiliary supplies, which go into the pier.

ISPP is an engineering method which brings multiple benefits when applied to the construction of foundations in poor soil, such as loose sand and soft clay layers found in the Batangas shoreline. It walls off an excavation site with a string of pipe piles driven either in a row or in a circular, oval, rectangular or other enclosing arrangement. To form a watertight wall, each pipe pile which is fabricated from large diameter spiral weld pipe has a pair of small diameter electric-resistance-weld tubes welded to its outer wall, with a slit in the tube's wall used for interlocking every two adjoining pipe piles. An enclosure carved out by pipe piles driven in an encircling array serves as a temporary cofferdam while excavation work goes on.

By its high section moduli, the wall of interlocked pipe pile offers strong resistance to lateral forces and has a high vertical bearing capacity, thereby ensuring the ease and safety of work inside it and saving both time and manpower. *Kawasaki Steel Corporation.*



Argon gas and calcium or magnesium compounds are injected through the lance into the molten steel to reduce sulfur levels.

HYDROGEN PRODUCTION BY ELECTROLYSIS

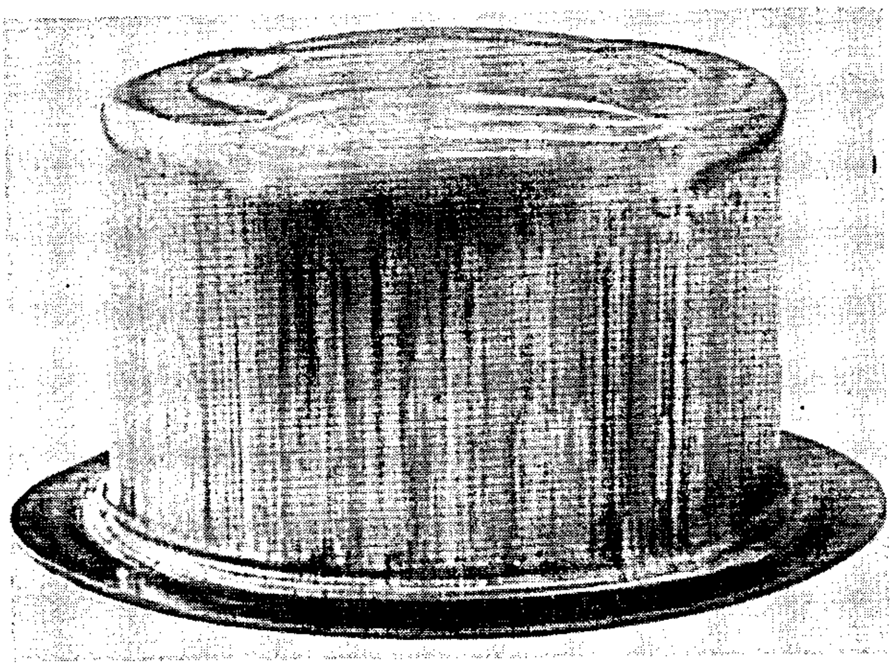
Greater interest is now being shown in electrolysis due mainly to the constant decrease in quantity of fossil hydrocarbons, and this is with respect to the proposal of using hydrogen as a possible energy source in the future. Hydrogen produced by electrolysis is expensive because, in the electrolytic cells in use today, considerably more electricity per kilogram of gas is used than theoretically necessary. The energy losses occur primarily during charge transfer through the electrolytic double layer at the boundary between electrode and electrolyte. These losses are dependent primarily on the material used for the electrodes and also, to a large extent, on temperature and current density.

Studies to improve the efficiency of electrolysis are being carried out at the Brown Boveri Research Center at Dattwill and at the Central Research Laboratory in Heidelberg, with electrochemists and solid-state physicists working jointly. New types of electrode material are being synthesized and their electrochemical properties studied in experimental cells. The results of these investigations provide information on what effects the crystalline structure and chemical composition of the electrode material have on electric losses, and with this knowledge enable the researchers to find new and better materials.

Various electrolytic cells with solid electrolytes are also being investigated. The application of ion-conducting polymer membranes is very promising for high current densities and would offer distinct possibilities for the economic production of hydrogen, if more effective electrodes could be developed. *Iron and Steel Engineer, February 1979.*

IMPROVING PROPERTIES OF STEEL BY REMELTING

Notable property improvements of steel are obtained by vacuum arc remelting and other secondary remelting processes. For example, vacuum arc remelting enchances transverse ductility, fracture toughness and fatigue resistance. Another example is electroslag remelted steel which has considerably better transverse ductility than electric furnace steels. It is important to remember that not all steelmaking processes are applicable nor are they used to produce all the major grades of steel. Generally, the secondary remelting processes tend to be used more often on more costly, high performance steels. Simple air melting or air melting followed by vacuum remelting (VR) or argon-oxygen decarburization (AOD) is used on steels with less demanding applications. Vacuum refining or degassing of air melted (AM) steels removes dissolved gases, principally oxygen, hydrogen and nitrogen. The resulting steel is cleaner and more uniform than a simple air-melted electric furnace steel.



Pressing showing effects of lubrication breakdown.

impact here would vary substantially in different parts of the world.

A consensus is growing among executives and researchers throughout the world that the best in current iron and steelmaking technologies and processes will not be replaced or made obsolete by any revolutionary breakthroughs in the near medium-range future. By the mid-1980's, new technology to improve electric furnaces will be available for full utilization. There are three major advances which must be considered together:

- Ultra high power - the electric power input to the furnace is tripled.
- Water-cooled furnace walls are put in to increase refractory life.
- Oxygen and fuel are injected through burners to increase heat release in the furnace.

The cumulative effect of these improvements is an increase in productivity of about 45% and a decrease in heat time of about 30% over present electric furnaces. *Iron and Steel Engineer, February 1979.*

Other processes include AM + AOD for effective decarburization, vacuum induction melting for close composition control, vacuum arc remelting for cleaner steels, electroslag remelting for tougher steel, calcium argon blowing to reduce sulfur, and electron beam melting which results in extremely low carbon levels and considerable reduction on the amounts of other impurities. *Materials Engineering, February 1978.*

ADVANTAGES OF AUSTEMPERING

Apart from the conventional two-stage heat treatment process of achieving an ' tempering, austempering provides another means of achieving high-strength characteristics of parts. Austempering also offers advantages as regards operational factors, such as quality and expenses.

Depending on the material and dimensions, higher durability values and lower danger of embrittlement of the parts are achieved with austempering as compared with equally stable quenched and tempered parts. Moreover, the danger of warpage and quenching crack are lower because the difference between the hardening temperature and the quenching bath temperature is smaller by as much as 350°C.

The omission of the tempering furnace in favor of a hot salt bath does not only reduce the amount of space required for the plant and, in most cases, the product throughput times as well, but it also decreases the energy consumption of the entire plant, i.e. the production costs. *NOWEA Press Information, Thermprocess '79, J. Aichelin Industrieofenbau.*

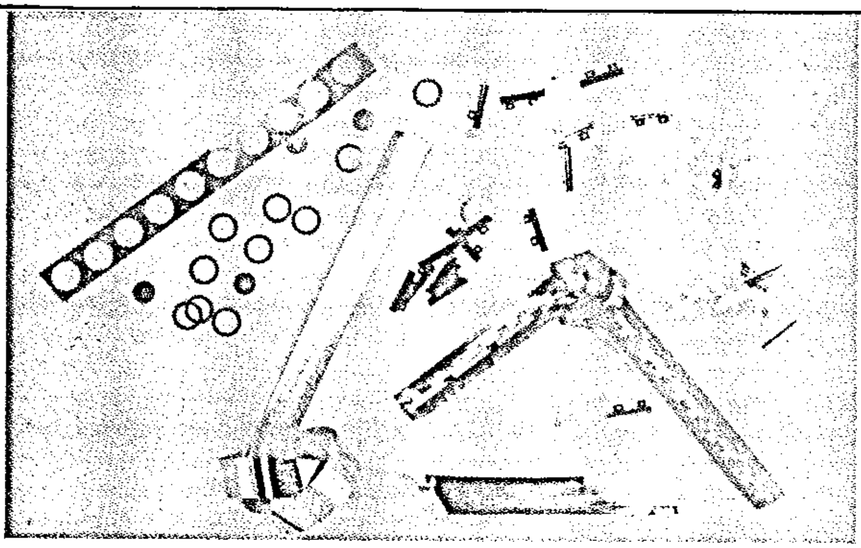
STEEL TECHNOLOGY FOR THE 1980's

A projection of steel technology in the world for the next decade shows that the shifts in the share of world steel production in the mid and late 1980's are not too pronounced, except for the rather large percentage increase for the developing countries which pick up all the relative declines in the other areas. The demand for added production is a function of many economic factors — certainly including future petroleum availability and future oil prices. The

LUBRICATION IN SHEET METAL FORMING

Application of lubricants to blanks immediately before pressing takes many forms. These include the time-honored piece of rag, the roller coater and the Turks-head brush. Properly used, i.e. without excess lubricant, the roller coater is probably the best method of providing selective and well-defined lubrication to a particular blank area. This is particularly so with the thicker lubricants, and use of suitable perforated sheet on top of the lubricant tray can help to restrict the quantity applied. Other methods include passing blanks through mangle-type devices, essentially a separate operation or, with smaller work, blanks are frequently rubbed over foam rubber pads or blocks impregnated with lubricant.

Many of the components that can be added to a lubricant to enhance its pressing performance can lead to problems either on removal or from corrosion when pressings are stored. Also, problems can arise when lubricants which are satisfactory on steel are applied to electro-zinc or tin-zinc-coated sheet.



Ductile METGLAS foils and preforms.

Materials now under development by Pyrene Chemical Services Ltd. have the potential to fill the technology gap in this area. The target has been to give enhanced corrosion resistance over normal temporary protectives applied to steel sheet, and to provide improved press performance. Additionally, the materials have the capability of being applied at full mill speed during the later stages of cold reduction. *Sheet Metal Industries, December 1978.*

METGLAS BRAZING FOIL

Homogeneous, ductile foils of nickel based brazing filler metal compositions have been produced by liquid metal quenching. The foils have a metallic glass, rather than a crystalline, structure. They are 100% dense, and are more easily handled than powders, contain no organic binders and can be bent to comply with complex joint geometries or punched to exact joint shapes.

Metglas, or metallic glasses, are so called because of their unconventional glass-like structure. They are derived from rapidly quenched metal-alloys of the BNi composition, which result in a flexible ductile ribbon having an amorphous or glassy structure. From shear and tensile strength data, metallic glass braze foil joint strengths are comparable to that of other commercially available brazing materials. Extensive tests on brazing properties of metallic glass have shown that brazed joints are characterized by almost complete diffusion of the metalloid elements. *Welding Journal, July 1978.*

THE CORRECT USE OF RADIATION THERMOMETERS

Contact-free temperature measurement with radiation thermometers is an efficient and proven method in cases where conventional methods cannot be used for technical or physical reasons. It is based on the measurement of the infra-red radiation emitted by all bodies and requires observation of the laws of radiation physics. External interference factors often present an additional problem and suitable measures must be taken for their elimination. A practical solution – determination of the drying temperature of an emulsion under bright radiators – can be used to analyse the individual interference factors of radiation measurement. *NOWEA Press Information, Thermprocess '79, Heimann GmbH.*

CORROSION-RESISTANT ZINC-COATED STEEL SHEET

The primary objective of coating steel with zinc is to provide protection against corrosion, therefore it is quite logical to try to improve the corrosion resistance of galvanized sheets, even if only to a slight degree. Researches with this objective in view have been ongoing for some- me time throughout the world.

Presented in outline on this research are the production and features of NKFZ, a "high-corrosion-resistant, composite zinc-coated steel sheet," which NKK (Japan) recently developed. NKFZ is a composite zinc-coated steel in which very small amounts of Co and Cr are co-deposited in the coating. It has a corrosion resistance claimed to be twice as high as ordinary galvanized steel sheet. This can be produced in conventional electrogalvanizing lines.

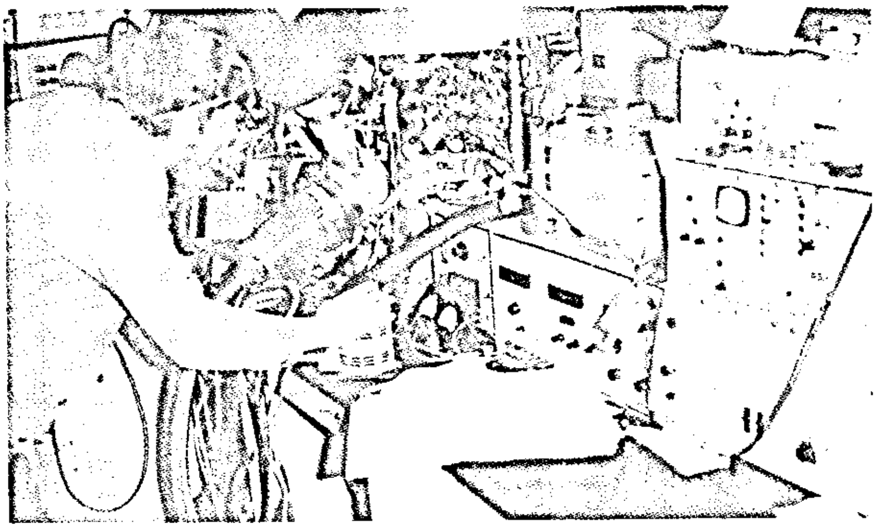
With this product, properties of paint adhesion and corrosion resistance through the paint films is the same or more than that of ordinary galvanized steel sheets. As it is processed by electrogalvanizing, a wide selection of base metals is possible and there is no deterioration in mechanical properties. One-side plating is easy to carry out. Workability and weldability of the coated layer are the same as those of electrogalvanized steel sheets. Also, this product can be applied to all fields where conventional galvanized steels are used. *Sheet Metal Industries, December 1978.*

FACTORS AFFECTING THE USE OF COPPER AND COPPER ALLOY ELECTRICAL CONDUCTORS

As each extra capacity is added to electrical networks, it becomes necessary to know that each component in that addition will withstand throughout its life the electromagnetic and thermal stresses placed upon it by short circuits, which may occur beyond the controlling apparatus in that particular point in the system.

The continuous (thermal) current rating has now been firmly established on an "as tested" basis. The question which needs definition is the upper temperature limit of operation to be permitted under defined conditions of operation. It is this point which raises a problem, since specified requirements range over wide limits. As the "worst case" conditions will tend to arise when currents are a maximum, it is generally considered that the low voltage networks up to a thousand volts represent the most arduous conditions.

It is also necessary to consider the effective jointing and termination of copper conductors having regard to the new metric dimensions for the conductors themselves, and also to the bolts which may be used to hold the conductors together at the joints. *Coppermetals Review, Summer 1978.*



Dr. Nils E. Erickson, chairman of E42.04 on ESCA, adjusts the specimen heater current on an ESCA spectrometer, at the national Bureau of Standards, while looking in the window of the specimen chamber.

ELECTRON SPECTROSCOPY FOR CHEMICAL ANALYSIS

ESCA, or electron spectroscopy for chemical analysis, is one of the more common of the "new" techniques used for surface analysis. The process involves photo energies which are characteristic of x-ray energies, i.e., more than or almost 100 electron volts (ev), thus excluding the field of ultraviolet photoelectron spectroscopy.

The electrons of primary interest are the no-energy-loss electron produced via a photoelectric process between an X-ray with energy E_X and electrons in the sample with binding energy E_B. The emitted electrons have a kinetic energy E_K, given by

$$E_K = E_X - E_B - E_{sp},$$

where E_{sp} is an instrumental constant normally called the spectrometer work function.

There are a number of commercially available ESCA systems in the market. All these systems use electrostatic analyzers and a number of different designs are also available. Many systems are multipurpose and are capable of producing not only ESCA spectra, but also Auger, low-energy electron diffraction (LEED), secondary ion mass spectrometry (SIMS), and other types of data. Data-handling features can range from a simple recorder output to highly automated, computer-controlled systems. *ASTM Standardization News, February 1978.* **PM**

8th PRIVATE SECTOR AND MIRDC WORKSHOP SEMINAR HELD

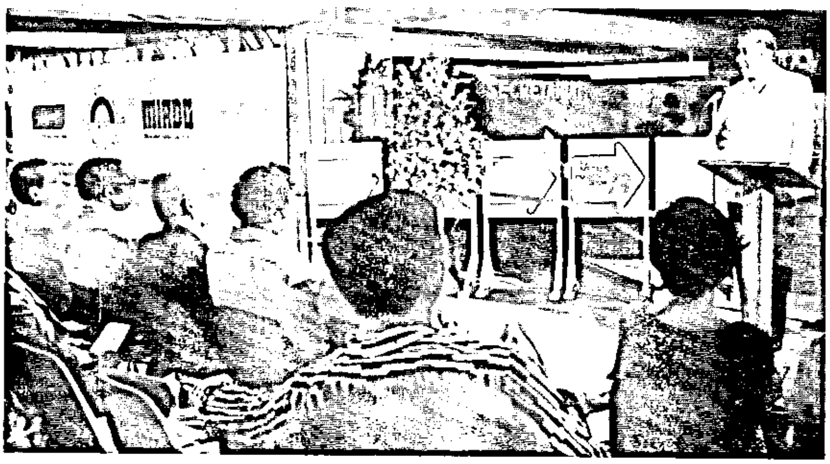
The 8th Private Sector and MIRDC Workshop Seminar was held last May 18-19, 1979 at the Hotel Intercontinental Manila with the theme "Domestic Industrial Machinery, Equipment and Metal Products Manufacturing."

Guest Speaker Industry Minister Vicente T. Paterno urged the various sectors in the metals industry to unite in promoting the growth as well as individual interests of small and medium sized firms. His keynote address was directed towards entrepreneurs as well as established businesses who participated in the First Metals Industry Show, the opening of which was made to coincide with the workshop seminar.

Technical papers relevant to the theme were presented to the three workshop sectors (primary metals, metalcasting and metalworking) by the following:

For the primary metals sector, Dr. Felipe P. Calderon, division manager for research and development, National Steel Corp.; Manolo M. Quiray, marketing services manager, Phelps Dodge Phils., Inc.; Philippe P. Borthayre, general manager, Armco Marsteel Alloy Corp.; and Benjamin T. Damian, asst. executive director for technical operations, MIRDC.

For the metalcasting sector, Alfredo R. Liwanag, technical services manager, AG & P; Napoleon O. Dickson, manpower development officer, SILCOR Management Corp. (represented by Cesar R. Leal); Orlando M. Simbajon, technical dept. manager, Foundry Division, EEI; and Narciso P. Buenaventura, vice president for appliance manufacturing, DMG, Inc.



Industry Minister Vicente T. Paterno delivers the keynote address during the joint opening of the 8th Private Sector and MIRDC Workshop Seminar and the First Metals Industry Show, held at the QUAD Car Park, Makati, Metro Manila.

For the metalworking sector, Raul M. Consunji, president of Machine Tools Mfg. Co. of the Philippines., Inc.; Henry Yee, manager for manufacturing, planning and control of Philacor; Oscar C. Guevarra, vice president for manufacturing & engineering, Philippine Electric Corp.; Henry L. Bobis, general supervisor for production engineering, General Motors Phils. Mfg., Corp. (represented by Alfredo G. Magpayo); and Alfredo L. Blanco, general manufacturing manager of Asian Transmission Corp.

"FIRST METALS INDUSTRY SHOW" LAUNCHED

An industrial exhibition showcasing the current status of the local metal industry, as well as efforts directed towards full industrialization, was held last May 18-27 at the 6th level, Quad Car Park, Makati Commercial Center. The exhibit was designed to focus mainly on the industrial capability of the country in the field of metals.

After the keynote address of Industry Minister Vicente T. Paterno (featured in this issue's editorial), the exhibition was formally opened by the cutting of the ceremonial ribbon by Mrs. Socorro P. Paterno.

The companies represented in the exhibition included manufacturers from all capacity levels – cottage, small, medium and large-scale – involved in the manufacturing of metals, mainly primary iron and steel producers, metalcasters, ferrous and non-ferrous manufacturers, metalworking firms, and other manufacturing concerns.

The Society of Manufacturing Engineers, Manila Chapter 165 were originators of the idea behind the "First Metals Industry Show" which was primarily supported by the MIRDC, in cooperation with the Metalworking Industries Association of the Phils., the Philippine Foundry Society, the Philippine Instrumentation and Controls Society, the Philippine Iron and Steel Institute, the Fiberglass Reinforced Plastics Association of the Phils., and the Makati Commercial Corp.

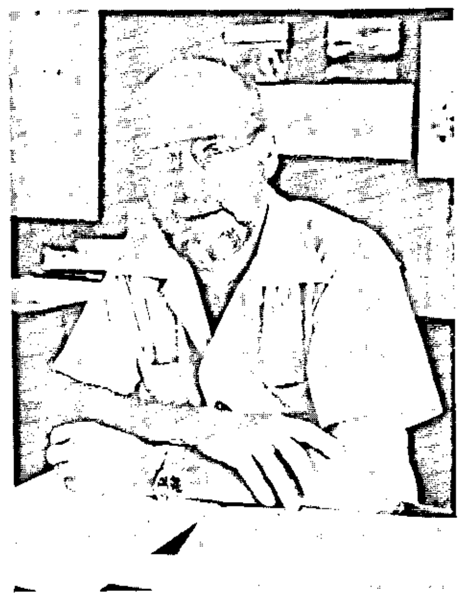
PROVINCIAL SEMINARS SLATED

A series of 3-day technical seminars/dialogues in Iloilo, Cebu and Davao will be held at the end of September and early October, with the objective of updating technical know-how and information dissemination on engineering and technological developments.

To be presented are: lectures designed to provide new engineers, foundry foremen and leadmen with basic technical background on foundry quality control with emphasis on the need for better quality castings; a perspective of the basic principles, applications, theories and practices involved in heat treatment; an insight into the proper selection and procedures required in basic manufacturing operations; and introduction into the principles and methods of basic metalworking and measuring.

A dialogue on the last day of seminar in each venue will serve as an interaction between private enterprises and government representatives on matters affecting the metals and allied engineering industries. The dialogues will be participated in by Dr. Antonio V. Arizabal, Executive Director, MIRDC; Atty. Jose G. Bautista, Jr., Asst. Exec. Director for Administration; and Mr. Benjamin T. Damian, Asst. Exec. Director for Technical Operations.

Lecturers will be composed of: Jose Sason, manager, Metal-casting and Treatment Dept.; Marcelo Villanueva, head of the Materials Technology & Research Dept.; Antonio Lazo, senior foundry engineer; Toribio Jamolin, senior metrology engineer; Tagumpay Cruz, supervising mechanical metallurgist; Eduardo Lacbay, heat treatment engineer; and the MIRDC German Technical Advisory Group.



Horst Witt

NEW GERMAN PROJECT MANAGER

MIRDC has a new project manager for the German Advisory Group, in the person of multi-lingual Horst Albert Walter Witt. Prior to his appointment with the MIRDC, he has served as project manager under the Federal Republic of Germany technical cooperation project in Small Scale Industry Promotion in Lima, Peru.

Born in Berlin on July 1, 1923, Witt underwent his primary and secondary education in Berlin/Neukolln and served as trainee at the Engineering School Beuth and the Heinkel factory from 1940 to 1941. He was subsequently drafted into military service in the Luftwaffe, surviving wounds suffered in 1945 only to be held as a prisoner of war in France. When World War II ended, Witt immediately continued his studies attending the Berlin Technical University, succeeding in the final examination as Diplom.—Ingeneur, eventually undertaking specialized training on propulsion and aerodynamics at the College of Aeronautics, England; and obtained a diploma in business management from the Harzburg College.

Witt first worked as a research and design engineer at Daimler-Benz A. G. in Stuttgart, has lectured on instrumentation and its application in the construction of piston engines at Cairo University, served as department head at the Heluan Aricraft Engines Factory 135 in Heluan, Egypt, and was project manager on a Federal Republic of Germany technical assistance project at the Instituto Technico Peruano-Aleman.

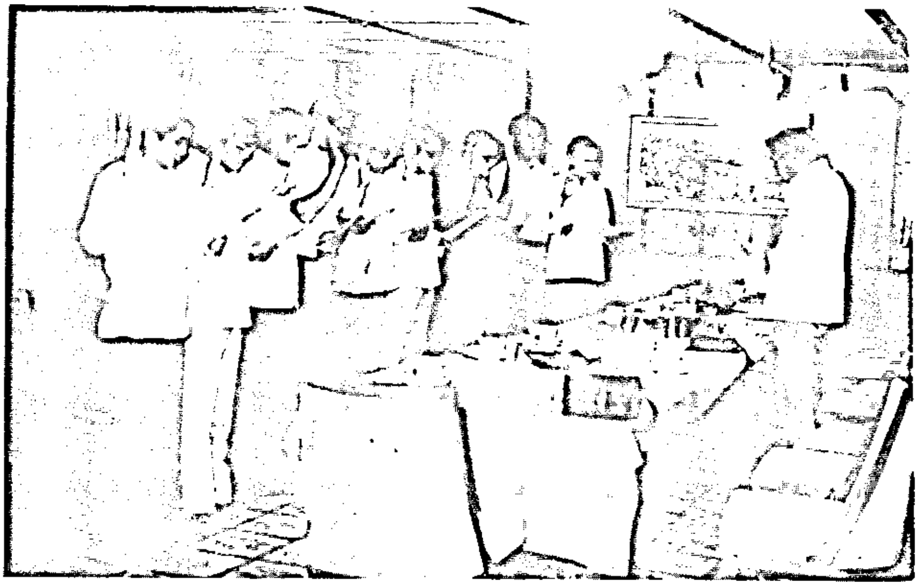
Aside from his extensive work experience, Witt holds patents on a rotating heat exchanger, measuring instrument for flowing media, and the rocket engine. He speaks German, English, French and Spanish fluently.

PATERNO INDUCTS MIAP BOARD

Industry Minister Vicente T. Paterno inducted into office the first Board of Directors (FY 1978-1979) of the Metalworking Industries Association of the Philippines (MIAP) last March 20 at the Green Room, Central Bank Bldg., Roxas Blvd.

The MIAP officers are composed of Raul M. Consunji, president; Bienvenido Juan, vice president; Leonardo B. Santiago, secretary; Tomas Uy, treasurer; Francisco Recto, PRO; John Wong, Benjamin Ma. Aycardo, Pacificador Directo, Ramon Cura, Simplicio Capule and Emilio Cuyugan, directors.

The association was primarily organized to serve as an important vehicle in attaining horizontal integration of the industries; promote sharing of expertise and machinery; and acquisition of feedback on industry data, particularly with regard to its market.



Induction of officers of the Metalworking Industries Association of the Philippines with Minister Vicente T. Paterno at the Green Room, Central Bank Bldg., last 20 March 1979.

SEMINARS

Two seminars lasting through the whole quarter of April to June were conducted simultaneously, both being related courses. These seminars on "Basic Turning" and "Basic Metalworking and Measuring" were held from April 27 to June 2 at the MIRDC Pilot Plant III, NSDB Compound, Bicutan, Taguig, Metro Manila.

Topics covered on basic turning included theory and practice ranging from components influencing machining processes to the more advanced study on internal taper turning. On basic metalworking and measuring, the course covered the area ranging from forces at the wedge to threads and tread cutting. Evaluations were done in both courses to gauge the participants' achievements on theory, measuring and practice.

MIRDC resource speakers were composed of the members of the German Technical Advisory Group, namely Johann Gerle, Heinz Kirschner, Heinz Winkler and Reinhold Zimmerman, in cooperation with the MIRDC technical staff composed of Joel Geronimo, Oliver de Guzman, Dennis Dein, Jimmy Diaz, Leonardo Roque, Alejandro Tolentino, Allan Masocol, Valentin Cacho and Ernesto Samson.

A "Quality Control Testing and Inspection" seminar was held last June 4 to 8 at the MIRDC Seminar Room, 5th Flr. Ortigas Bldg., Ortigas Ave., Pasig, covering topics on mechanical testing, non-destructive testing and metallographic testing, with actual demonstrations conducted at the MIRDC Laboratories Bldg., NSDB Compound, Bicutan, Taguig.

The course was designed for people directly involved with quality control, specifically in mechanical and non-destructive testing and metallographic examination, with the objective of providing new engineers, foremen and technicians with basic technical background on testing and inspection.

Resource speakers were Tagumpay P. Cruz, supervising mechanical metallurgist, Wilfredo L. Balmores, testing and inspection engineer, Emiliano O. Amparo, mechanical metallurgist, and Fidelino E. Adriano Jr., physical metallurgist.

"Design of Plastic Injection Molds" was the subject of the last seminar for the second quarter of the year, and this was conducted at the MIRDC Seminar Room last June 18-22. Among the topics covered were introduction to plastic materials, description of commonly used injection moulding machines, elementary and intermediate mould design, multi-daylight moulds, and runner-less moulds.

Resource speakers were Emmanuel V. Nolasco, design engineering head, and Elias Libutague, design engineer.

ARRIVALS/DEPARTURES

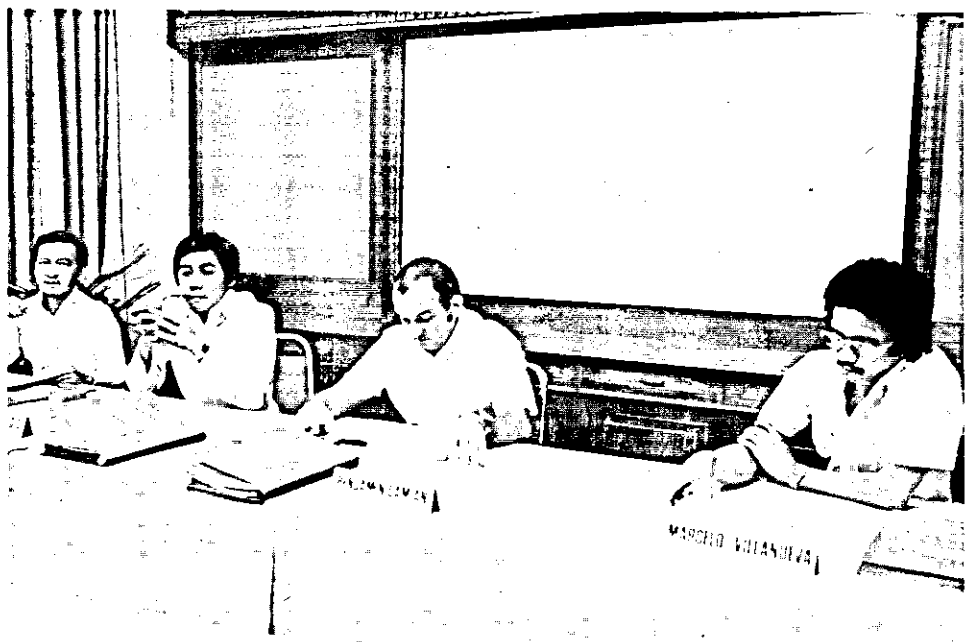
Isagani Blasco, toolmaker III, left last April 3, 1979 under the UNDP Programme to undertake training on die casting and plastic making. Antonio Lazo, senior foundry engineer, Arturo Corral, junior foundry engineer, and Mario Forbes, molder II left several weeks after to undertake training on modular cast iron production in Netherlands, under the Netherlands-Yugoslavia-MIRDC technical assistance project. They were followed on May 24 by Feliciano Dungca, junior engineer, Aristeo Mercado, welder III and Salvador de Paz, welder II, who went to Austria under the Austrian-MIRDC technical assistance project to undertake extensive training on welding technology. Junior engineer Rene Balangue left for Finland last June 1, to undergo training on scanning electro microscopy under the UNDP Programme.

The arrivals for the current quarter included: Daniel Banaag, Melquiades Llanto and Eduardo Diaz, tool makers, having undertaken training on general tool manufacture and machine tool reconditioning and pedagogy in West Germany under the MIRDC-FRG technical assistance program; Nilo Fontanos, tool maker I and Mario Patricio, master tool maker, after extensive training on copy milling and model making, machine tool design, and molding technology in Texas, USA with Eleno Dotig, pattern maker, who trained on molding technology in England, under the auspices of the UNDP Programme.

THE 8th MIRDC & PRIVATE SECTOR WORKSHOP SEMINAR

1

1. Rogelio Avenido, representing Manolo M. Quiray of Phelps Dodge Phils., Inc., delivers a technical paper on "Copper Standards for Electrical Wire and Cable" to the primary metals sector with Ruben Pinaroc of National Steel Corporation (representing Dr. Felipe P. Calderon) looking on.



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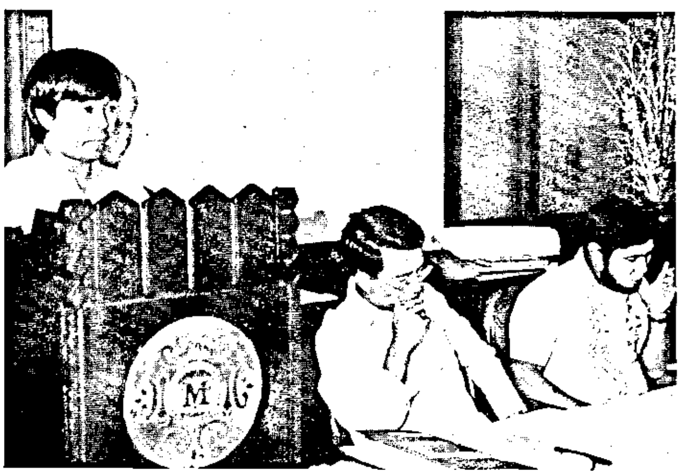
2. Still on primary metals, the "Manufacture of Carbon and Alloyed Hot-Rolled Bars" was effectively expounded by Benito M. Mauricio, Technical Manager, and Philippe B. Borthayre, General Manager of Armco-Marsteel Alloy Corp., with (left) Crisanto P. Laset (moderator), Vice President — Marketing, International Pipe Industries Corp. and (right) Marcelo B. Villanueva (co-moderator), head of the Materials Testing & Research Dept., MIRDC.



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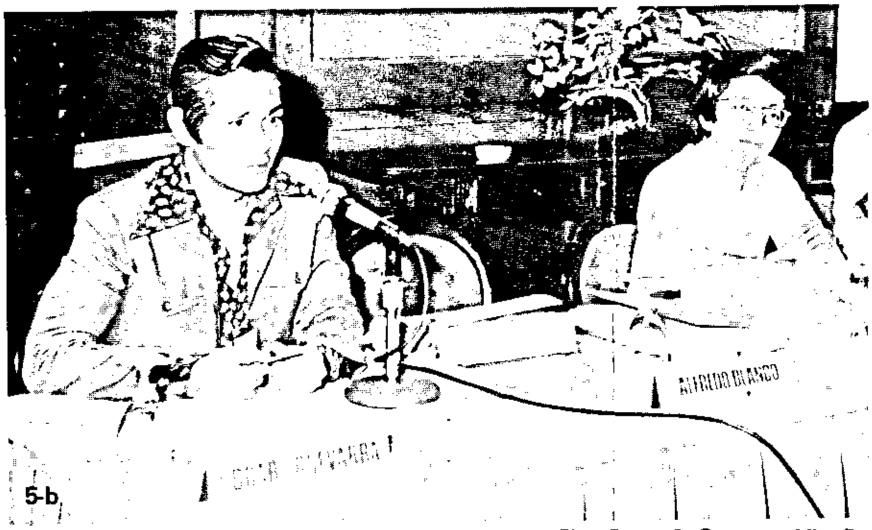
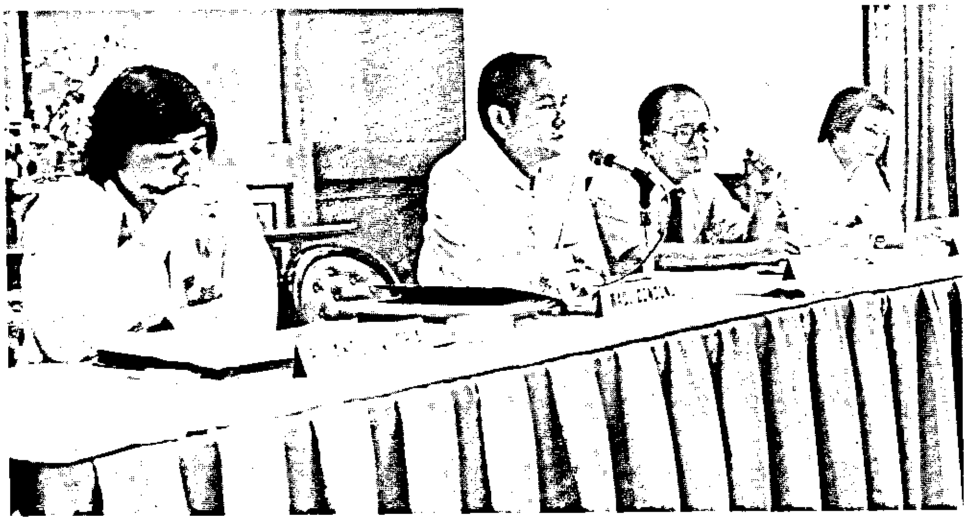
3. Alfredo R. Liwanag, Technical Manager of Atlantic, Gulf & Pacific Co. of Manila, Inc. speaks on "Ductile Iron Castings for Industrial Machinery," while Herman T. Laurel (moderator), Vice President-Marketing of Tri-Star Metal Industries and Cesar R. Leal (representing Napoleon O. Dickson) of Silcor Management Corp. look on.

4. Artemio Salomes of San Miguel Creusot-Loire gives the metal casting sector participants some insight into the "Production of Malleable Pipe Fittings," with Orlando Simbajon, Technical Dept. Manager, Foundry Division, Engineering Equipment, Inc. and Narciso P. Buenaventura, Vice President-Appliance Manufacturing, DMG, Inc. listening in.

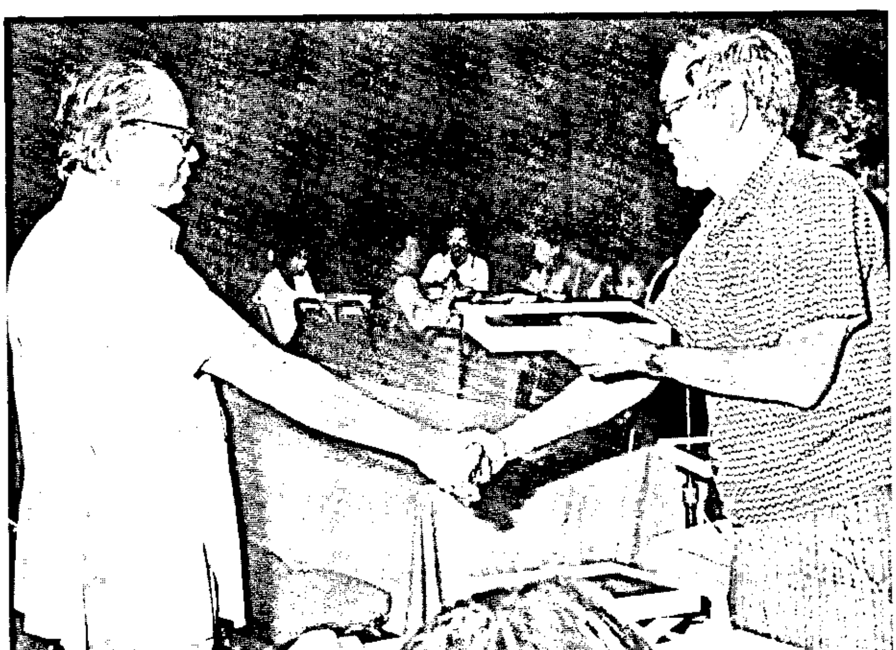
5a. Other speakers for the metalworking sector included Alfredo L. Blanco, General Manufacturing Manager of Asian Transmission Corp., who expounded on "Part Manufacturing for Automotive Transmission."



5b. Oscar C. Guevarra, Vice-President - Manufacturing and Engineering, Philippine Electric Corp. who spoke on "Power Transformer Manufacturing," and Alfredo G. Magpayo (representing Henry L. Bobis) of General Motors Phils. Mfg. Corp., who explained "The Art of Gear Manufacturing".



6. Raul M. Consunji, President of Machine Tools Mfg. Co. of the Phil., answers questions from the metalworking sector on the "Fabrication of Jigs and Fixtures" in the company of Rolando T. Viloria (co-moderator), head of the Mechanical Workshops Department, MIRDC, Pacificador C. Director (moderator), President & General Manager of Directric Industries, Inc., and Henry Yee, Manager for Manufacturing, Planning & Control, Philippine Appliance Corp.



7. Highlighting the workshop seminar was the awarding of plaques of appreciation to moderators, co-moderators and speakers. Shown here is Pacificador C. Directo, President & General Manager of Directric Industries, Inc. receiving his plaque from MIRDC Board Member Raul M. Consunji.

domestic prices

TABLE I
DOMESTIC RETAIL METAL PRICES
(In Philippine Pesos)
APRIL-JUNE, 1979

ITEMS	UNIT	PRICE
G. I. Roofing Sheets		
Corrugated, Gauge #26 x 32"	Linear ft.	6.10
Corrugated, Gauge #31 x 32"	Linear ft.	3.80
Plain, Gauge #26 x 36"	Linear ft.	6.10
Aluminum Sheets (1100 Alloy)		
0.016 x 36 x 8'	sheet	60.70
0.017 x 36 x 8'	sheet	71.10
0.024 x 36 x 8'	sheet	88.75
0.027 x 36 x 8'	sheet	99.75
0.032 x 36 x 8'	sheet	117.45
Square Bars, 20'		
3/8" x 3/8"	each	14.50 – 15.00
1/2" x 1/2"	each	20.00 – 22.00
5/8" x 5/8"	each	37.00 – 38.00
1" x 1"	–	unquoted
Round Bars, 20'		
1/4" (5mm)	each	6.50 – 7.00
3/4" (std.)	each	42.00 – 43.00
3/8" (9mm)	each	13.00 – 13.50
1/2" (11mm)	each	21.00 – 22.00
5/8" (14mm)	each	30.00 – 32.00
1" (std.)	–	–

TABLE I
DOMESTIC RETAIL METAL PRICES
(In Philippine Pesos)
APRIL-JUNE, 1979

ITEMS	UNIT	PRICE
Angle Bars 20′		
1/8′ x 3/4″	each	22.00 – 23.00
1/7″ x 1″	each	28.00 – 30.00
3/16″ x 1″	each	36.00 – 38.00
1/4″ x 1″	each	47.00 – 48.00
3/8″ x 3″	–	–
Flat Bars, (mm size) 20′		
1/8″ x 3/8″	each	10.00 – 12.00
1/8″ x 1/2″	each	11.00 – 12.00
3/16″ x 1″	each	25.00 – 26.00
1/4″ x 1/2″	each	19.00 – 25.00
1/2″ x 1-1/4″	each	–
Galvanized Iron Pipes (orginary) 20′		
1/2″	each	39.00 – 40.00
3/4″	each	56.00 – 58.00
1″	each	80.00 – 82.00
1-1/2″	each	135.00 – 140.00
2″	each	170.00 – 175.00
Black Iron Pipes, 20″	each	41.00 – 42.00
1/4″	each	41.00 – 42.00
1/2″	each	35.00 – 36.00
1″	each	60.00 – 65.00
1-1/2″	each	115.00 – 120.00
2″	each	140.00 – 150.00

Source *Bureau of Domestic Trade*
Department of Trade
Quezon City

TABLE II
JAPAN MONTHLY AVERAGE PRICE
(In US$ per MT unless otherwise indicated)

IRON AND STEEL	APRIL	MAY	JUNE
Round bar, 9mm	295.79	292.89	280.98
16-25mm	300.68	298.19	286.93
Flat Bar, 6 x 50mm	336.87	335.49	323.35
Equal Angle, 6 x 50mm	306.18	302.38	290.83
10 x 90mm	313.98	311.09	299.19
Channel, 6 x 65 x 125mm	319.26	316.52	303.84
H-shape, 9/14 x 250 x 1.6mm	399.39	391.68	374.68
Hot-rolled sheet (3 x 6), 1.6mm	415.89	414.15	398.06
Cold-rolled sheet (3 x 6), 1.2mm	454.98	453.86	436.71
Medium Plate, 3.2 x 3 x 6	403.38	402.14	389.14
Plate 6 x 4 x 8	392.82	393.62	381.33
9 x 4 x 8	389.29	390.125	375.38
Gas Pipe (black), 15A (1/2 inch((per kg)	0.455	0.452	0.433
Water Pipe (white), 15A (1/2 inch) (per kg)	0.648	0.642	0.616
Galvanized Sheet			
(Plain), 0.30mm	554,64	549.51	527.17
(corrugated), 0.25mm (per sheet)	1.744	1.73	1.66
Wire Rod, 5.5mm	93.31	92.39	88.64
Round Nail, 100mm (4 inches)	408.234	483.49	477.59
Iron Wire No. 8	508.234	440.89	417.24
Annealed Iron Wire No. 7	463.24	471.48	437.08
Barbed Wire, No. 14	645.56	593.91	614.25
Tinplate, 90L (0.257mm)	562.35	584.07	533.86
Wire Rope JIS (per 200mm)			
1st grade, zinc coated (24 x 6)			
10mm	1.99	1.97	1.89
20mm	511.76	506.74	486.14
NON-FERROUS METALS (per kg)			
Electro copper	2,092.79	2,054.85	1,921.50
Electro zinc	846	888.33	874.52
Electro lead	1,226.57	1,289.73	1,347.68
Tin	15,818.25	16,015.81	14,617.65
Antimony	3,505.62	3,765.69	4,095.75
Nickel	6,479.10	7,438.40	7,507.65
Selenium	53,992.50	53,463.50	51,290.00
Bismuth	11,268.00	11,157.60	10,704.00
Cadmium	9,413.48	9,321.25	8,944.30
Mercury	313,001.57	334,728.00	346,394.82
Aluminum	1,527.05	1,594.98	1,597.38

Source: Japan Metal Bulletin

index to advertisers

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Industrial Engineering	:	*January-April 1979*
Instrument & Apparatus News	:	*January-February 1979*
Instruments & Control Systems	:	*January-February 1979*
Ironmaking & Steelmaking	:	*Vol. VI Nos. 1 & 2 1979*
Journal of Metals	:	*January-March 1979*
Machine Design	:	*January-March 1979*
Mechanical Engineering	:	*January-March 1979*
Metal Bulletin	:	*January-May 1979*
Metal Finishing	:	*January-February 1979*
Metallurgical Transactions	:	*January-February 1979*
Metal Technology	:	*January-April 1979*
Modern Casting	:	*January-April 1979*
Modern Materials Handling	:	*January-February 1979*
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Phil. Development	:	*January-March 1979*
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Product Engineering	:	*January-April 1979*
Transactions of the Iron & Steel Institute of Japan	:	*January-March 1979*
Welding Journal	:	*January-March 1979*

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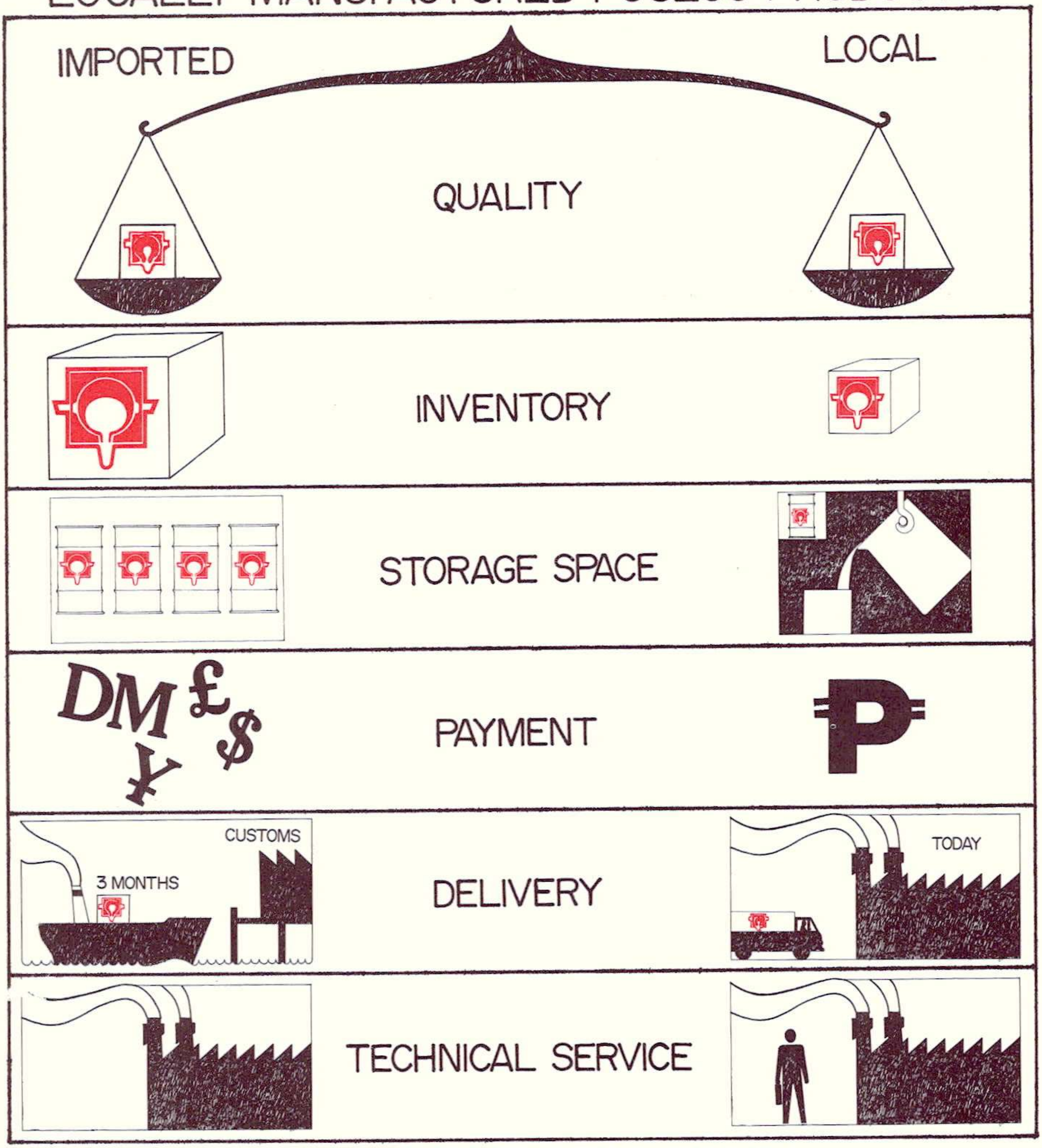

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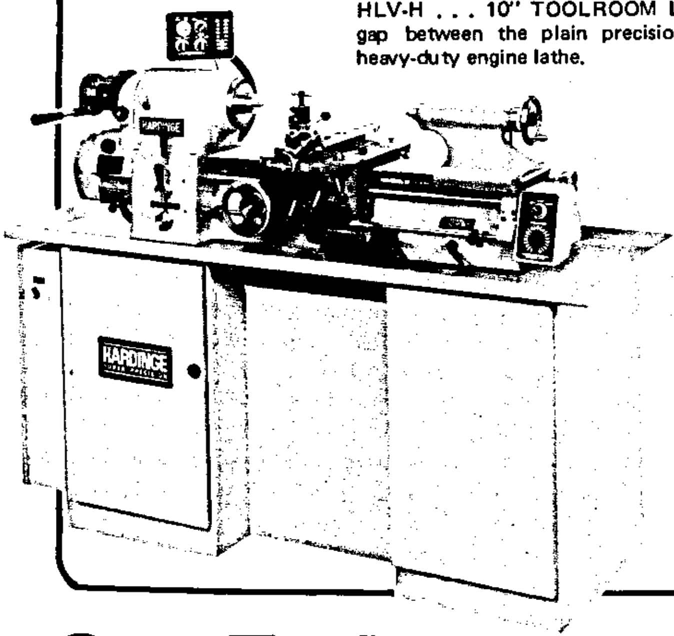

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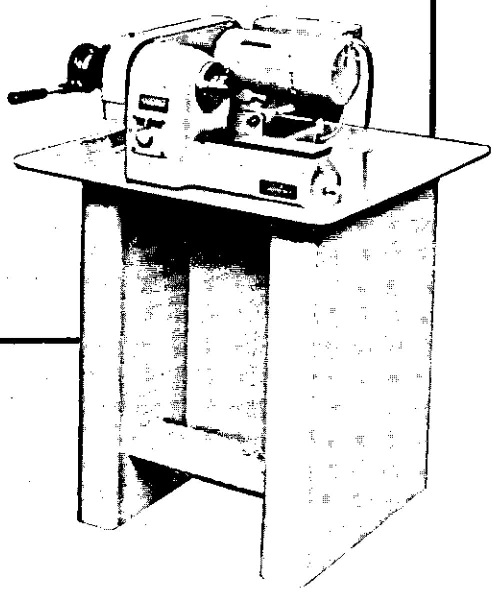

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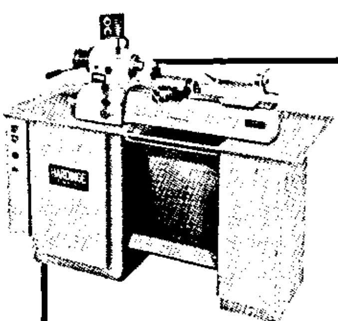

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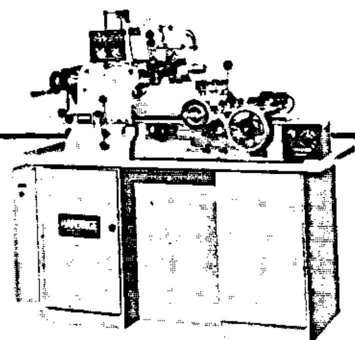

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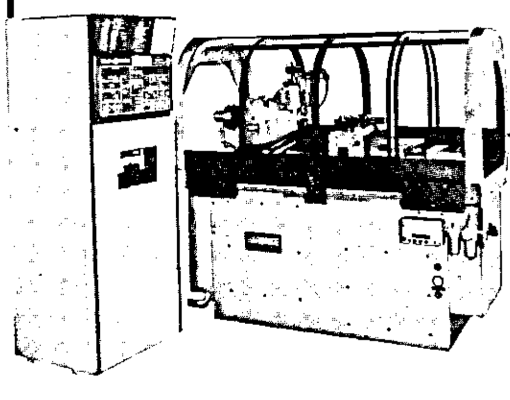

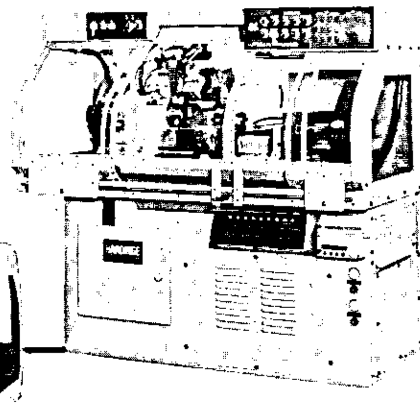

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PHILIPPINE metals

ISSN 0115-117 • VOL. IX NO. 3 • JULY – SEPTEMBER, 1979

editorial staff

On the cover:

Photo shows body dropping of an ISUZU jeepney at the General Motors Pilipinas assembly plant.

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The industrial world has yet to catch up on its energy savings programs, as well as develop the zero defect concept in all products, to be able to forge a path towards effective and economical modernization. This will involve on one aspect the use of higher strength but lighter materials of construction. Rare earths are now being utilized in increasing quantities throughout the world to achieve these objectives.

"Advantages of the Use of Rare Earths in Steel," by William G. Wilson, clarifies the following points: decrease in the number of inclusions present and globularizing the remaining ones; modification of alumina; improvements in transverse impacts; formability, ductility in the through-thickness direction, impact resistance of the heat affected zone, and hot workability of stainless steels; reduction of under bead cracking; and prevention of hydrogen delayed cracking by reduction of the sulfur content of steel.

In another development, "High Speed Casting of Billets," by Markus Schmid and Dieter Rubensdorffer, describes a totally new two-stage mould, which makes it possible to increase casting speed considerably without affecting the operating reliability of the plant. The multi-stage (MS) mould is designed for high-speed casting of billets with cross sections up to 160 x 160mm. These sections attain a relatively high stability of shape after leaving the mould. The mould allows safe casting speeds up to 5m/min., depending on the section. The design features an 800 mm long primary section and a secondary section comprising four 300 mm long copper plates. The latter has been designed to ensure optimum backing and cooling of the billet, and limit the additional mechanical stress on the strand to a minimum. The casting strand can be cooled either by direct water spray, in which case the water cooled parts cease to serve as supporting surfaces, or by indirect cooling, which is limited by the amount of possible heat dissipation.

In continuous casting in which molten steel is teemed from a ladle into a tundish, air oxidation of the liquid steel in turbulent flows must be prevented in order to obtain high quality steel. To accomplish this, two different-diameter nozzles peculiar to a rotary nozzle are selectively used to pour molten steel through the full-open nozzle. Sakamoto, et all, expounds on this operation in "An Automatic Pouring System for Continuous Casting," dwelling primarily on the NKK rotary nozzle which has a number of distinct advantages, including: reduction in amount and frequency of ladle preparation by increasing the operating rate of the slide nozzle equipment; maximum safety by eliminating dangerous jobs near molten steel; full automation with pushbutton control, doing away with hard labor and undesirable working environment; maintenance of molten steel at high temperature; and cost reduction of refractory materials by increase in operating rate.

Dr. Eckart E. Goette, in "Handling and Shipping of Midrex Iron," reviews the means by which direct reduced iron (DRI) should be treated prior to shipping. Throughout the years, Midrex plants have acquired extensive experience in handling, storage and shipping of DRI. In order to overcome the general rule that DRI is best kept dry, and keeping in mind the aim of marketing DRI to a wide variety of non-captive users, Midrex has developed the specialized processes of "Chemaire" and hot discharge/hot briquetting. The Chemaire corrosion inhibiting process consists essentially of saturating the DRI with a dilute water solution of a corrosion inhibiting chemical, followed by drying and controlled passivation against oxidation The chemical employed is compatible with standard EAF melting practices, and does not contaminate the steel or liberate any volatiles during melting of the DRI. The treatment enables wetted DRI to be buried beneath dry DRI in a bulk pile without occurrence of any significant corrosion or re-oxidation or heating within the pile.

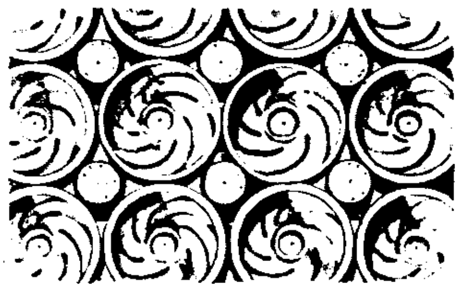
"What Does the User Look for the Design of a Casting? " Generally, says authors Donald J. Stauffer and H. R. Bancroft, it is "the most of the best for the least." To clarify this point, castings have been classified into two main categories: decorative and functional. With decorative castings, the main things the user desires are style and appearance, surface finish and texture, color, strength and durability, cost, and ease of manufacturing and assembly. For functional castings, desired properties are light weight, cost or value, metallurgy, cleanliness inside and out, ease of machining, and satisfaction of design parameters.

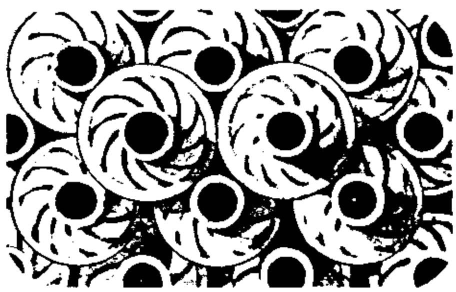
Werner Deppert concludes in this issue his article on "Rationalization with Pneumatics." The first topic on this final portion involves pneumatic operation of tipping mechanisms, which greatly simplifies the operation. Another field of discussion is singling, feeding and transferring of a workpiece, which can be facilitated with the installation of two pneumatic cylinders to control a gripping system. The last discussion deals with the use of pneumatics in putting valuable goods in a safe place.

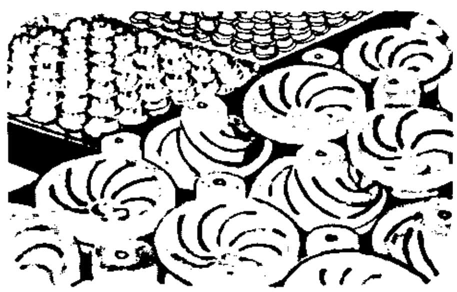
The "Cover Story" is on General Motors Pilipinas, Inc. (GMPI), a joint venture between General Motors Overseas Distribution Corporation and Isuzu Motors Limited of Japan. It produces and sells motor vehicles, transmissions, and other automotive parts, among them the ever popular Gemini, Rekord, Ascona and Manta. After having gone through two corporate transitions since its establishment in 1972, GMPI today continues to exert efforts in furthering the gains and achievements it has made in the past years. Having taken a good look at GMPI facilities and capabilitites, it seems certain that the company will succeed in its current motto: "Serving the people better through better transportation."

Our "Men in the Metals Industry" feature for September is Robert A. Cushman, the charming, debonair and witty Executive Vice President and General Manager of Armco-Marsteel Alloy Corporation. Cushman's refreshing good looks seldom belies his iron will, which has been instrumental in getting him from the bottom of the work scale to the top executive post he now occupies. He is currently director of the American Chamber of Commerce (Phils.), member of the Filipino-Italian Association, member of the board of trustees of Brent School (Baguio), and has served as director of the Philippine Iron and Steel Institute (PISI). Despite his hectic schedule the staff managed to get him interviewed, and the resulting write-up shows why the interview has been dubbed by the writer as "very interesting."

"In the Limelight" for this quarter is the Philippine Instrumentation and Controls Society (PICS), established in 1977 to structure the various instrumentation and control activities in the country. With a current membership of 294 firms and individuals, the Society stands as the crystallization of a unified voice of professionals, scientists and technologists interested in the design, manufacture, use and servicing of industrial instrumentation and controls, the target of which is to propel this fibre of industry towards its growth and development.







HIGH SPEED CASTING OF BILLETS

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SEAISI Supplementary Journal, February 1979.

Any increase in the casting speed of plants of conventional design and operating method enhances the breakout hazard and can seriously impair the availability and economic efficiency of the plant because of this[1].

This paper describes a newly developed two-stage mould, which makes it possible to increase the casting speed considerably without affecting the operating reliability of the plant.

Application field of the multi-stage mould (MS mould)

The MS mould is designed for the high-speed casting of billets, i.e. cross-sections up to 160 x 160 mm. These sections have a relatively high stability of shape after leaving the mould. The MS mould should allow safe casting speeds of up to 5 m/min, depending on the section.

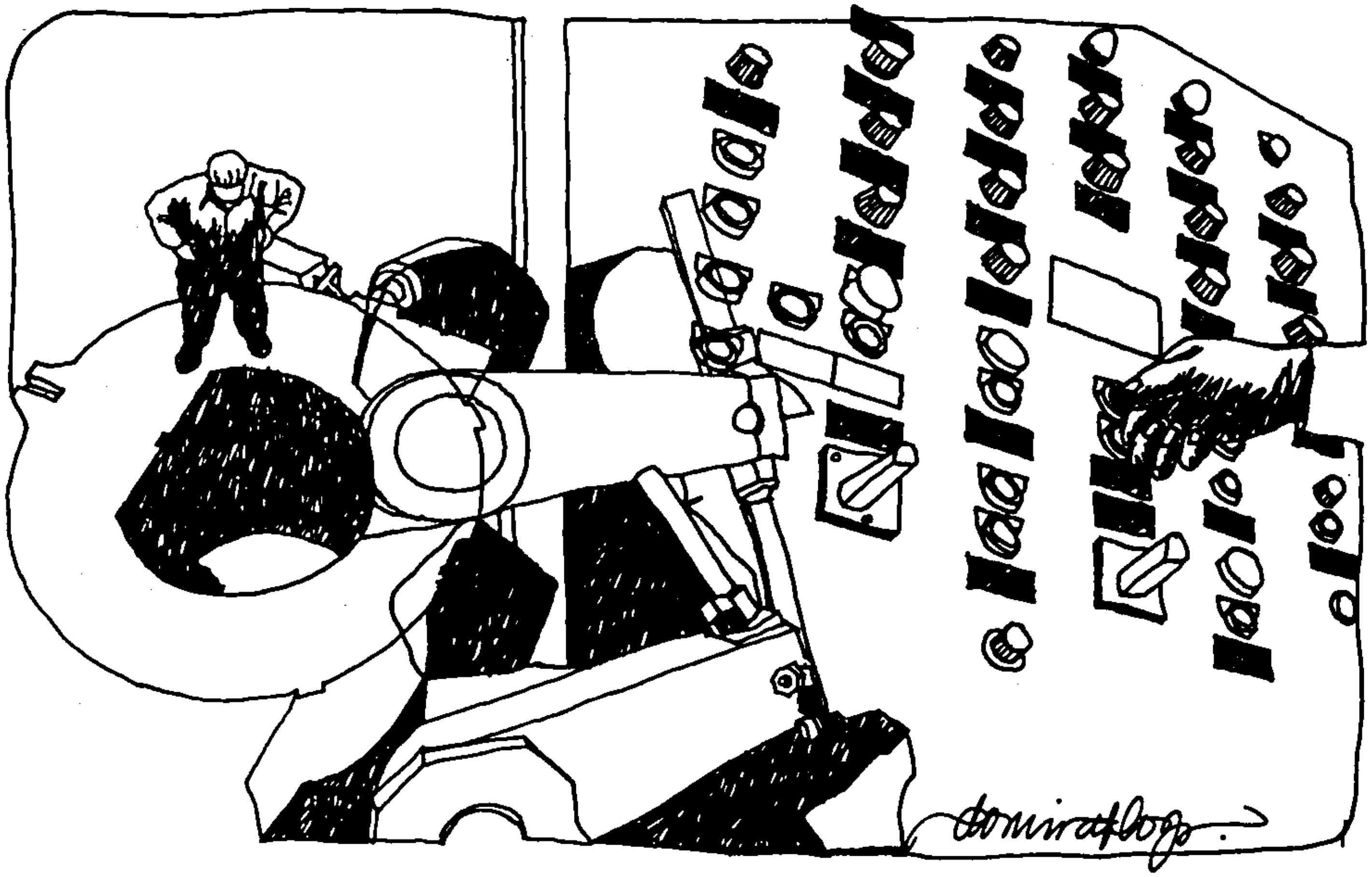
Basic ideas which have led to the development of the MS mould

2.1 High-speed casting tests with conventional moulds

As part of the development work, 101 x 101 mm billets have been cast with an 800 mm long tube mould with attached foot rollers and an optimum secondary cooling arrangement at casting speeds of up to 5 m/min. The tests were carried out on the 4-strand billet caster with 4 m casting radius at Stahlwerke Rochling-Burbach GmbH, Volklingen/Saar, Federal Republic of Germany. These tests have shown a substantial increase in the breakout rate at casting speeds of about 3.5 m/min or higher, despite optimum conditions with respect to personnel, steel making process, automatic steel level control, etc. Measurements have indicated a shell thickness of 6 to 7 mm at a speed of 4.3 m/min at the mould outlet. With such thin shells, the smallest irregularity as for example a poorly developed or non-centered casting strand, frequently leads to breakouts. Hence, in order to enable the safe use of high casting speeds under normal production conditions, it was obviously necessary either to change the mould length or to improve the cooling and backing directly under the mould.

2.2 Mould length vs. casting speed

The interrelationship between mould length, heat flux density, casting speed, friction and backing effect has been discussed in various papers[1,2,3,4,5]. It should be borne in mind, though, that the mould length adopted for a production caster always represents a compromise between the various contradictory requirements. Although it is certainly possible to determine a theoretically optimum mould length and shape by means of various assumptions, these will always apply only to a limited production range. A change in each individual production parameter, such as steel grade, casting temperature, casting speed, etc. would require, in fact, a different mould length and a different mould taper. In view of the residence time and the stresses in the shell as it leaves the mould, higher casting speeds require longer moulds. However, considering the experience gained in operation until now and the fact that practical aspects, such as dimensional accuracy, fabrication, stability of shape, etc. are generally decisive factors in the selection of the mould length, as well as the fact that, with longer moulds, the slightest deviations from the theoretically correct shape make such a mould poorer than one that is theoretically too short, the normal mould length has been maintained. The key to the reliable high-speed casting of billets seems to be a cooling and back-up device located directly under the mould.



Consequently, instead of lengthening the mould, the solution adopted was to divide it into two cooling sections. The first part consisting of a conventional tubular or plate mould, with the second part made up of an attached cooling and supporting unit.

Design and operation of the MS mould

The MS mould consists of an 800 mm long primary section and an attached 300 mm long secondary section.

Primary Section

The primary section is a conventional conical tubular or plate mould of a maximum length of 800 mm.

Secondary Section

The secondary section, which consists essentially of four cooling plates 300 mm long, is designed to ensure an optimum backing and cooling of the billet and should limit the additional mechanical stress on the strand to a minimum. The casting strand can be cooled either by direct water spray, in which case the water cooled parts cease to serve as supporting surfaces, or by indirect cooling, which is limited, in turn, by the amount of possible heat dissipation.

Similarly to the considerations involved in the determination of the mould length, here again it is obviously possible to theorize on the design of the secondary section; however, the proper solution — considering a design appropriate for steelworks — can be found only by a comprehensive series of tests.

Therefore, over 7000 strands of billet sizes 84 mm, 101 mm, 122 mm and 140 mm square have been cast during recent years on six different continuous casting plants using nine different secondary mould sections. The tests involved stationary and mobile cooling elements, cooling elements made of various materials, directly and indirectly cooled plates as well as plates which consisted of separate cooling and supporting sections.

Some of the secondary sections employed at Rochling-Burbach had closed plate cooling, while others had plates cooled from the outside with spray nozzles. A series of tests involving about 3000 strands demonstrated that the latter design is superior in terms of productivity, operating reliability and maintenance.

DETAIL STUDY OF COOLING EFFECT

Friction between plates and strand

As the MS mould is specially designed for the casting of billets, it is not necessary to equate the contact pressure of the plates to the theoretically available ferrostatic counterpressure. Depending on the size, good test results were obtained with contact pressures of the cooling plates varying between 20% and 60% of the ferrostatic force. Contact pressures of 30% of the ferrostatic force result already in a stress decrease in the order of 45% at the critical points near the corners, with friction forces between the plates and the strand in the range of 400 to 1000 N and additional tensile stresses in the strand shell of 12 to 18 N/cm^2 (which can be neglected) being developed in the process. The decisive aspect is that, as a result of the mobility of the plates, these contact pressures and stresses can be determined only by the springs and that unfavourable production cases, such as rhombic strands and the like, cannot cause a jamming of the casting strand.

Schematic comparison of the long mould, the MS mould and the normal mould

A 1100 mm long mould, a 1100 mm long MS mould (800 mm primary and 3000 mm secondary section), and an 800 mm long mould with subsequent spray cooling are compared schematically in Figure 1. The diagram shows the solidification constant, the shell thickness and the tension in the corner areas of the cross-section as a function of the distance from the bath level. It is evident that the short mould with subsequent intensive spray cooling 1000 mm under the bath level results in the thickest shell; however, a high tension is present in the strand shell 700 mm under the bath level after the exit from the mould.

With the MS mould, on account of the smaller cooling capacity of the cooling plates, the shell is somewhat thinner after 1000 mm but there is no critical tension 700 mm under the bath level and there is already a decrease in tension when the strand leaves the secondary section of the mould. With the 1100 mm long one-piece mould, as a result of the smaller cooling effect in the bottom part of the mould, the tension in the strand shell is about the same as that recorded at the outlet of the shorter mould. This diagram indicates a smooth transition from the mould to the unsupported strand with the MS mould and this gives a higher operational reliability.

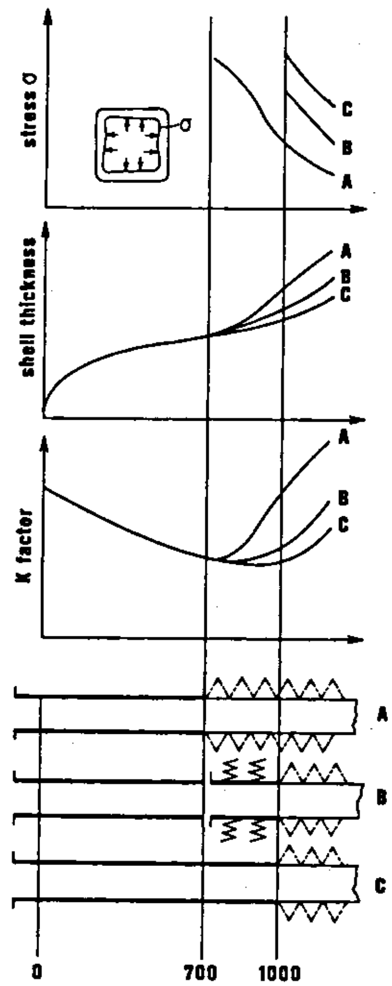


Figure 1
K factor, shell thickness bending stress in the strand shell
A 800 mm long mould
B 1100 mm MS mould
800 mm long primary part
300 mm long secondary part
C 1100 mm long mould

Mechanical design and method of operation of the secondary section

The four cooling plates are screwed individually to the bottom mould flange and can be replaced separately, if required. The copper plates are cooled by means of spray nozzles on the sides facing away from the strand; the special arrangement and the spray pattern of the spray nozzles ensures also a secondary cooling of the strand

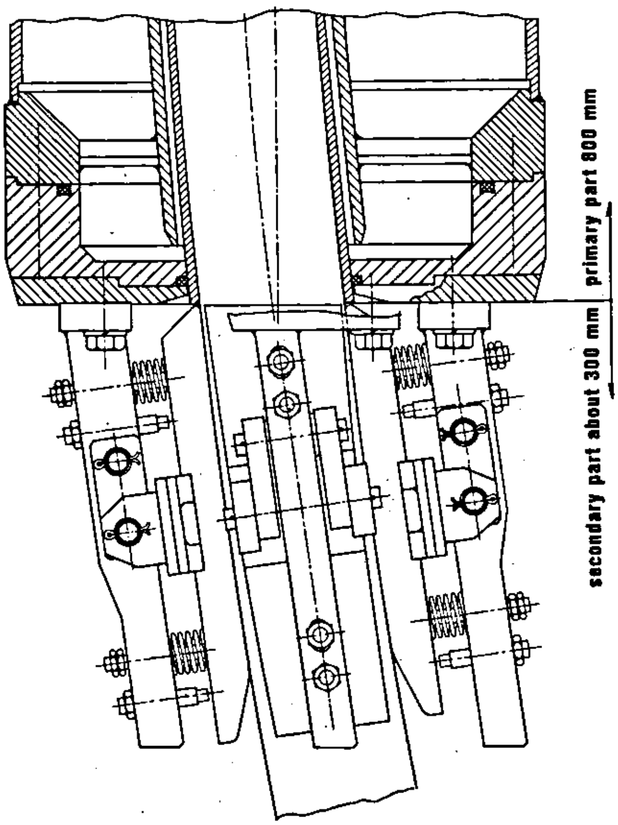


Figure 2. MS mould, view secondary part

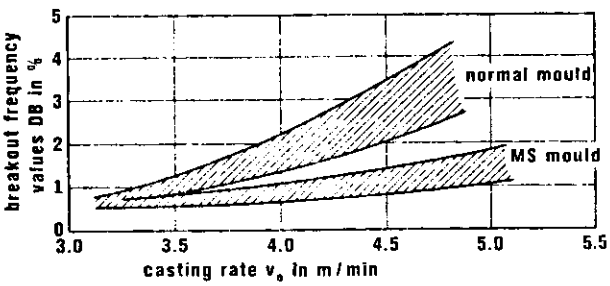


Figure 3. Comparison breakout frequency normal mould/MS mould. Casting product 101 mm square

edges. The gap between the primary and the secondary section of the mould is about 1 mm wide. The individual copper plates converge conically downwards, so that the billet corners become increasingly uncovered as the strand progresses (see Figure 2).

Operating Data

Figure 3 shows the breakout frequency as a function of the casting speed in casting operations with and without an MS mould. This figure refers to a billet size of 101 x 101 mm, a casting radius of 4 m, a mould primary section length of 800 mm and a mould secondary section length of 300 mm. The diagram reveals the clear superiority of the MS mould at casting speeds over 3.5 m/sec. Furthermore it has been established that in spite of the high casting speeds the occurrence of surface cracks in harder steel grades does not increase. This is because of the large area cooling plates producing gentler cooling than that obtained by the extremely concentrated cooling in the spraying range of fan jet nozzles.

Abrasion

The adjustment of the cooling plates enable each individual plate to move at least 5 mm against the strand. As a result of the low contact pressure of the plates, the measured abrasion after 1000 charges was less than 1 mm.

Adjustment

Due to the mobility of the cooling plates there are no special adjustment requirements. The plates are adjusted prior to their attachment to the primary mould. A template is provided as an adjustment aid.

Detail study of the secondary section

For a casting strand which is no longer supported in any way after the mould and, under normal friction conditions in the mould, the mechanical stress in the strand shell due to the ferrostatic pressure generally reaches a maximum level at the outlet from the mould and decreases inordinately with increasing solidification constants and strand lengths. The application of a strong secondary cooling effect results, in fact, in a considerable reduction in stress after a short time; however, the dangerous area immediately after the mould outlet is not eliminated in this way, regardless of the subsequent cooling intensity. This can lead – at extremely high casting speeds – to breakouts. If one abandons the idea of a longer mould, the only remaining solution is to provide an additional support, which reduces the peak stress while still ensuring a sufficient cooling intensity. This requirement was satisfied by means of rollers, crosspieces, skids etc. in conjunction with spray nozzles.

The tests showed, however, relatively large-area plates to be the most suitable for this purpose, as these plates ensure not only the required supporting and cooling effects but at the same time cover the strand surface so completely that the breakout hazard is largely reduced by this feature alone. Moreover, plates are easier to service in case of an actual breakout.

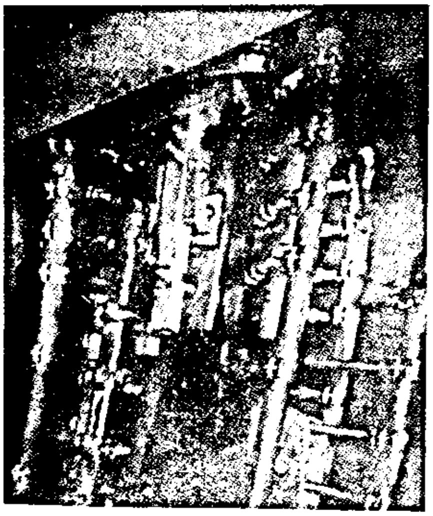


Fig. 4. View Showing secondary section of MS mould.

Cooling effect and fastening of the cooling plates

The cooling plates, which ensure the primary cooling of the casting strand, are made of copper, matched to the curvature of the strand, freely suspended to allow movement in all directions and spring loaded against the strand (figure 4). The cooling capacity which can be attained with such plates is of the order of 1400 kW/m². This is less than the values which can be reached by spray nozzles in the water spray area but more than the cooling capacity in the bottom part of the mould. Consequently, from the point of view of cooling efficiency, it is better to provide cooling plates matched to the casting strand geometry than to lengthen the moulds. The secondary cooling in the edge areas results in an additional cooling effect, which is of importance for the prevention of edge breakouts.

Summary

The considerations involved in raising the casting speed of billet machines were reviewed and the realization of a multistage (MS) mould described. Design features of a 2-stage mould with 800 mm long primary section and a secondary section comprising four 300 mm long copper plates were elaborated. Extensive high-speed casting tests were run on Rochling-Burbach's Concast billet caster with the 101 x 101 mm section both with and without the 2-stage mould. These tests verified the superiority of the 2-stage design. As a result, 3 of the caster's 4 strands are now operated with MS moulds; the fourth strand is used as a spare and for adaptation to the converter cycle for a normal sequence cast of 10 heats.

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AN AUTOMATIC POURING SYSTEM FOR CONTINUOUS CASTING

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In continuous casting in which molten steel is teemed from a ladle into a tundish, air oxidation of the liquid steel in turbulent flows must be prevented in order to obtain high quality steel. To accomplish this, two different-diameter nozzles peculiar to a Rotary Nozzle are selectively used to pour molten steel through the full-open nozzle.

In the initial stages of pouring, when the molten steel temperature drops, and a buildup of solidified metal must be precluded, the larger diameter nozzle is used to fill the tundish for a limited period of time. A shift is then made to the small diameter nozzle, which feeds the tundish from the ladle in amounts sufficient to make up for the lowering of the tundish steel level.

If the tundish steel level is lowered under that which is allowable a shift is made to the large diameter nozzle.

In order to automate these operations, the tundish is provided with a position detector for the molten steel level, and a synchronous oscillator is mounted on the driving motor shaft of the Rotary Nozzle to detect the position of nozzle bores. Thus the nozzle is automatically switched from one with small diameter to the larger one to keep the molten steel level in the tundish constant through the combined action of this apparatus.

INTRODUCTION

NKK's Ohgishima project was organized in 1969 in order to rationalize the ironmaking operations and facilities at its Keihin Works. The new works began commercial operation on November 13, 1976, following the inaugural kindling of the No. 1 blast furnace.

A large number of new techniques and processes have been introduced in this project and the new works has been operating satisfactorily since its inception. Of the many prominent features of the Ohgishima Works, the method of automatic pouring using the NKK Rotary Nozzle will be dealt with in this paper. The NKK Rotary Nozzle has already been adopted in various parts of the world and has proved instrumental in stabilization of operations, quality improvement and labor saving.

GENERAL INFORMATION FOR THE OHGISHIMA WORKS

i) Of the total area of about 5,530,000 sq. m of the Ohgishima Works, an area of about 520,000 sq. m. is devoted to steel-making and the planned capacity of steelmaking at the end of the second phase of the Ohgishima project is six million tons of crude steel.

ii) Steel is used in the production of various items including sheets, plates, tubes and bars.

iii) The planned annual output of the first phase of the project is three million tons of crude steel. Of this, 1,200,000 tons is used in ingot-making and 1,800,000 tons in continuous casting.

iv) When the No. 2 blast furnace is completed, the Ohgishima Works will have a capacity of six million tons per year of crude steel. The steelmaking system at the Ohgishima Works is planned so that the greater part of its crude steel output will be continuously cast.

"*Nippon Kokan Technical Report,*" *No.25 September 1978.*

v) One of the two 250 ton LD converters operates with the No. 1 blast furnace. Two of three 250 ton LD converters will operate when the No. 2 blast furnace is completed. The converter is 12 m in height and 7.8 m in diameter and has a shell volume of 478 m^3 and an inner brickwork volume of 231 m^3.

vi) The main specifications of the continuous casting equipment are given in Table I.

vii) The ingot-making facilities include 14 ladles (with the No. 1 blast furnace in operation) each having a maximum volume of 290 tons. Bottom pouring is employed in the so-called comb-shape ingot-making yard and ingots mainly intended for use in the manufacture of sheets, plates and seamless pipes are produced.

The steelmaking facilities of the Ohgishima Works have been briefly described. Needless to say, the NKK Rotary Nozzles have been incorporated into the pouring equipment since inception.

Table I Specification of Continuous Caster.

	No. 1 slab caster (for plate grade slab casting)	No. 2 slab caster (for strip grade slab casting)
Machine builder	Concast-Sumitomo Heavy Industries	USSR-Kobe Steel
Slab format	234 x 1,600 –2,250 mm (Design capacity 300 x 2,300 mm)	204 x 900 –1,500 mm 204 x 1,250 –1,850 mm (Design capacity 250 x 1,850 mm)
Type	Vertical mold Progressive bending caster	Curved mold caster with Curvilinear straightener
Casting speed	max. 1.0 m/min (at 250 thickness)	max 2.0 m/min (at 200 mm thickness) max 1.6 m/min (at 250 mm thickness)
Length of machine (metallurgical length)	about 20 m	about 30 m
Distance between strands	6,500 mm	6,500 mm

FEATURES OF THE ROTARY NOZZLE

The slide nozzle is generally more advantageous in several ways when compared to the conventional stopper system.

i) The amount and frequency of ladle preparation can be reduced by increasing the operating rate of the slide nozzle equipment.

ii) The dangerous jobs near molten steel like stopper installation are not required by the slide nozzle so that the safety of workers and working conditions can be improved.

iii) Hard labor and an undesirable working environment can be eliminated, as the slide nozzle allows the pouring operation through remote, pushbutton control.

iv) As the stopper is not used, the molten steel in the ladle can be maintained at a high temperature for a long time.

v) The cost of the refractory materials can be reduced by increasing the operating rate.

The NKK Rotary Nozzle is still more advantageous than other slide nozzles in many ways (see Figure 1).

i) The Rotary Nozzle, which makes a rotary motion, has a sliding stroke of 3.14 times as long as that of the slide nozzle which moves linearly even when the cross section does not differ in area from one nozzle to the other. Furthermore, the rotary nozzle is designed to prevent the displacement of its two refractory plates during sliding so that there is no danger of molten steel leakage.

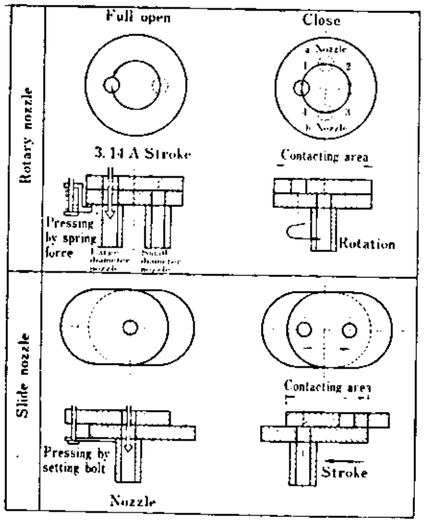
ii) As the refractory plates are fastened by a spring, there is little danger of uneven fastening, although the accuracy of refractory plate setting may be somewhat difficult.

iii) As the rotary nozzle is electrically driven, the hydraulic unit, hoses and cylinder which are indispensable to the slide nozzle can be dispensed with so that the frequency of trouble can be reduced accordingly.

iv) Other nozzles have only one hole, while the rotary nozzle equipment has two nozzles or more of differing hole diameter. As a result, full open pouring can be controlled by making selective use of its nozzles of different hole diameter. In other words, the rotary nozzle does not give rise to an umbrella-shaped stream of molten steel as in partial open pouring so that steel oxidation by air is reduced.

v) The slide nozzle slides on one side of its hole, while the rotary nozzle moves on both sides of its hole. This prevents the rapid wear of the nozzle edge and contact area of the refractory plate which is unavoidable with the slide nozzle.

Fig. 1 Mechanism of NKK type rotary nozzle



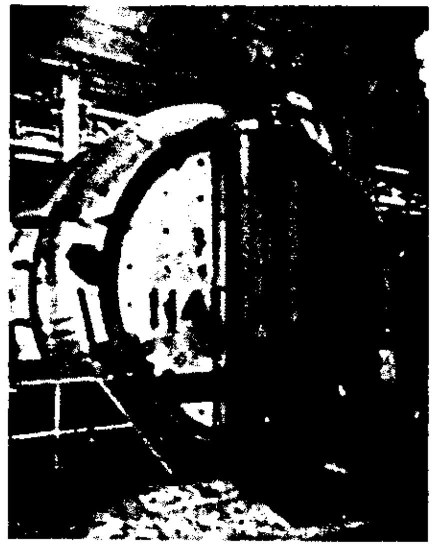


Photo 1 NKK type rotary nozzle attached on ladle.

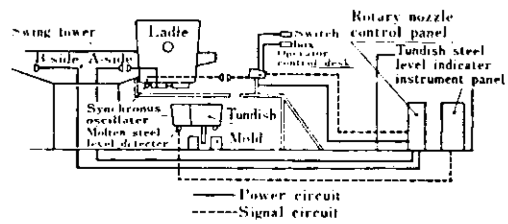


Fig. 2 Automatic ladle pouring system of NKK type rotary nozzle.

THE AUTOMATIC POURING SYSTEM OF THE NKK ROTARY NOZZLE

NECESSITY OF AUTOMATION

The automatic pouring system has been developed in order to make mainly the following three improvements:

i) As the ladle operator is fully occupied in pouring for a long time in fully continuous casting, it is necessary to reduce the period of restraint of the ladle operator in order to save labor. By allowing the ladle operator to attend to more than one job during pouring, the employment of workers in continuous casting can be rationalized.

ii) The volume of molten steel should be within certain limits so as to maintain the molten steel in the tundish within a certain temperature range.

iii) It is necessary to maintain the level of molten steel in the tundish within certain limits whenever possible so as to stabilize the level of molten steel in molds.

The NKK Rotary Nozzle includes the improvements listed above. In other words, full open pouring was in principle employed through use of nozzles of differing hole diameter so as to prevent the oxidation of molten steel by eliminating the umbrella-shaped stream of molten steel seen in partial open pouring. The NKK rotary nozzle in place is shown in Photo 1.

SYSTEM DESCRIPTION

The automatic pouring system of NKK comprises the following three components:

a) Rotary Nozzle
b) Tundish level indicator
c) Control device

These components of the automatic pouring system are shown in Figure 2.

Rotary Nozzle

An oscillator which generates a pulse synchronous with the rotation of the Rotary Nozzle is installed over the end of the shaft of the electric motor which drives the Rotary Nozzle.

Tundish Level Indicator

It is necessary to generate control signals at two points to maintain control of the level of molten steel in the tundish and the level detector may be a spiral vortex detector, load cell or a thermocouple. In the automatic pouring system of NKK the load cell type detector is used.

Control Device

The control device consists of six nozzle angle adjusters (O through 360°) and a control circuit which selects the proper nozzle angle adjuster according to a signal from the steel level indicator.

AUTOMATIC POURING SYSTEM

In the development of the NKK Rotary Nozzle partial open pouring was not taken into consideration from the outset but efforts were made to abide by the principle of full open pouring by making selective use of nozzle holes of differing diameter. As full open pouring is effective in the prevention of a turbulent steel flow which is the cause of oxidation by air, it is indispensable to obtaining quality steel.

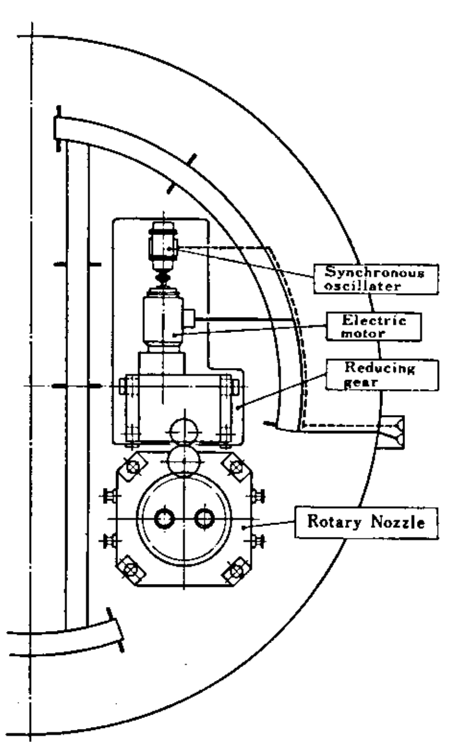


Fig. 3 Rotary nozzle unit.

Basically, pouring is started by filling the tundish in a brief period by making use of the nozzle of a larger hole diameter so as to prevent a decrease of the molten steel temperature and the deposition of solidified steel. Use is then made of the nozzle of a smaller hole diameter to make good a drop in the tundish steel level. As the steel level fluctuates to some extent during the use of the smaller nozzle, the nozzle is closed only when the tolerance limit is exceeded and pouring is automatically switched from the smaller nozzle hole to the larger one at the middle of the pouring period when the steel supply begins to become short on account of a decrease in static steel pressure and nozzle clogging.

This unique method of pouring is feasible only with the multiple-hole Rotary Nozzle and the Rotary Nozzle can be caused to alternately slide to the right and left relative to another nozzle hole.

The opening and closing of the nozzle is entirely controlled by a signal from the tundish steel level indicator.

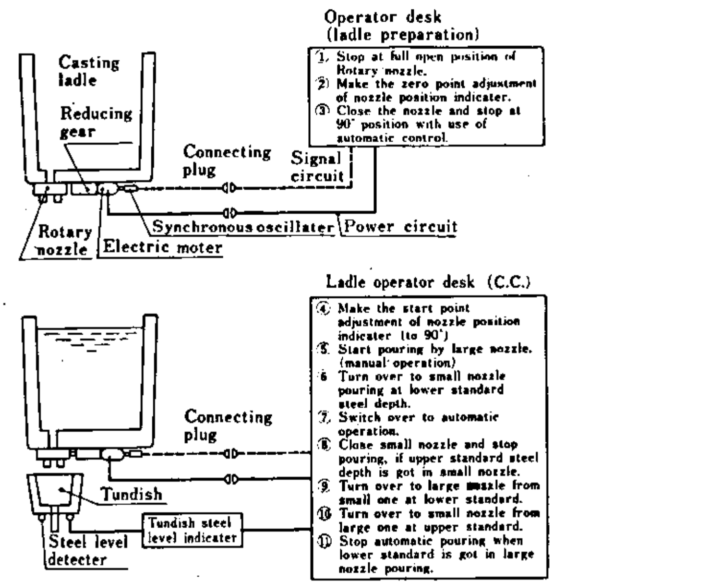


Fig. 4 Operation of automatic ladle pouring system by rotary nozzle.

OPERATING PROCEDURE AND FLOW OF AUTOMATIC OPERATION

The operation in the ladle yard is illustrated in the upper part of Figure 4.

i) The Rotary Nozzle system (Figure 3) rotates through 360 degrees and also slides back and forth. As this nozzle makes the so-called endless motion, it does not come to a mechanical stop in the full or partial open pouring position. In the NKK Rotary Nozzle system an angle of 360 degrees is divided into four so as to fully open the nozzle at the angles of O and 180 degrees and to fully close it at the angles of 90 and 270 degrees.

ii) The Rotary Nozzle cassette is installed and adjusted so that the nozzle is fully opened at the angle of 0 degree and is automatically stopped at an angle of 90 degrees.

iii) The ladle which is filled with molten steel is carried to the continuous casting yard. On arrival of the ladle at the yard, the following operations take place:

a) The nozzle position indicator on the control panel is set to 90 degrees before start of pouring.

b) One operator takes care of the set-up and visual inspection of the equipment until the tundish is filled to a specified level, but all the subsequent operations are unattended.

c) As the smaller bore nozzle is selected in this stage so as to make good a drop in the tundish steel level, signals 3 and 4 indicated in Figure 5 are hardly generated.

d) The larger bore nozzle is designed to have a slightly larger inner diameter than actually needed to cope with nozzle clogging near the end of pouring. Unless the nozzle is clogged pouring is switched from the larger bore nozzle to the smaller one by signal H.

e) On arrival of signal L during large bore nozzle operation the system prepares for completion of the pouring cycle. At this point the operation is switched from automatic to manual so as to check the interior of the tundish and the flow of slag and the cycle of pouring is completed.

RESULTS OF COMMERCIAL OPERATION

In the steelmaking shop of the Ohgishima Works molten steel pouring from the ladle into the tundish is accomplished entirely by the automatic ladle pouring system using the NKK Rotary Nozzle. The performance of this system will be briefly dealt with in this section.

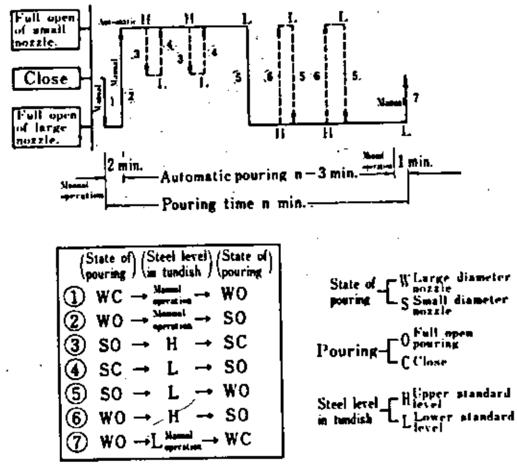


Fig. 5 Flowchart of automatic ladle pouring system.

RESULTS OF COMMERCIAL OPERATION

In the steelmaking shop of the Ohgishima Works molten steel pouring from the ladle into the tundish is accomplished entirely by the automatic ladle pouring system using the NKK Rotary Nozzle. The performance of this system will be briefly dealt with in this section.

AUTOMATIC POURING

The tundish steel level and the time chart for automatic ladle pouring in continuous casting are shown in Figure 6.

Figure 6 shows a case where two heats are poured in fully continuous casting by full open pouring. In pouring one heat the operation is continued for about 60 minutes. In this case the upper limit H of the tundish steel level is 640 mm and the lower limit L, 480 mm. The data indicated in Figure 6 clearly illustrate that the tundish steel level is well controlled and that the automatic nozzle selection is quite satisfactory.

The latter half of the pouring cycle of the first heat, the flow of the ladle slag, ladle replacement, the beginning of the pouring cycle of the second heat and the confirmation of stable Rotary Nozzle operation which takes place in a sequence in a period of about 18 minutes are attended by an operator for caution's sake. In the case shown in figure 6, H and L in pouring the

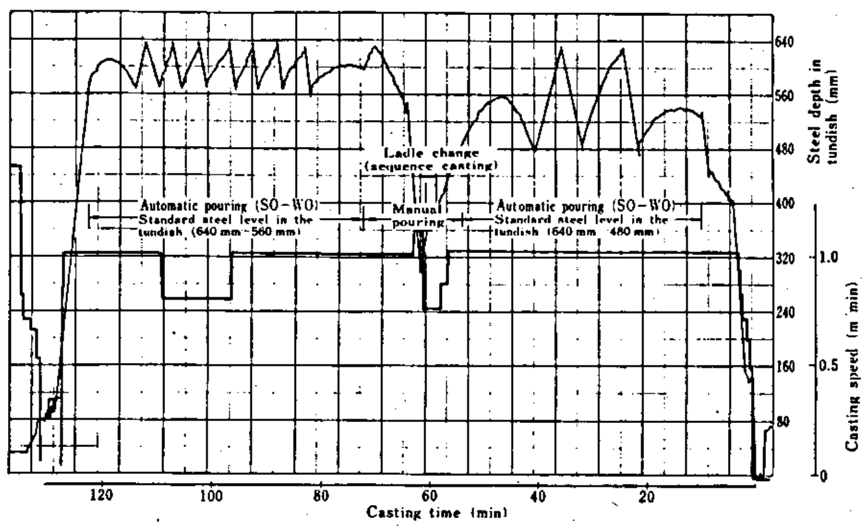
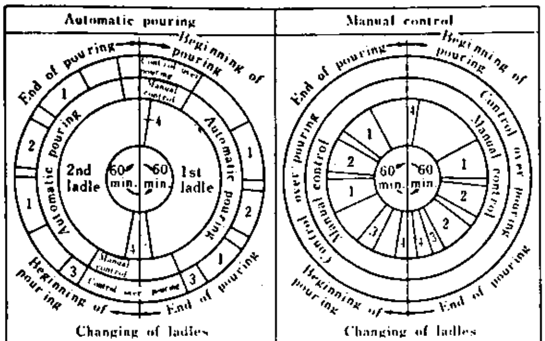


Fig. 6 Timechart of automatic ladle pouring in continuously continuous casting.

Table II Man Hour Saving of Pouring Operator In Continuously Continuous Casting.



	Automatic pouring		Manual control	
Rotary nozzle operator	Control over pouring	30 min.	Control over pouring	120 min.
	Other jobs 1·2·3	58 min.		
Assistant worker	Assistant at the start of pouring	12 min.	Other jobs 1·2·3·4	70 min.
Total		100 min.		190 min.
Ratio of labor saving		190 100	190 47.4%	

Nozzle bore diameter		Pouring stream of molten steel just after the nozzle
50mmφ	Full open pouring	
70mmφ	Partial open pouring (70% open)	

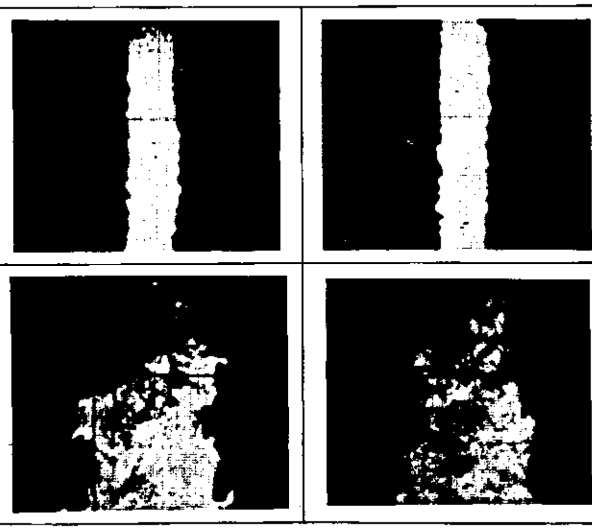


Photo 3 Stream of full open pouring and partial open pouring.

second heat are 640 and 560 mm respectively. Switching between the large and small bore nozzles is repeated many times so as to increase the stability of pouring operation.

The time chart clearly indicates the high operational stability achieved by the automatic control technique and the excellent performance of the rotary nozzle over a long operational period of about 120 minutes.

LABOR SAVING EFFECTED BY AUTOMATIC POURING

The cycle of pouring molten steel from the ladle into the tundish is automated, although a part of the pouring operation near its beginning and end still is attended.

Accordingly, the Rotary Nozzle operator can leave his position while pouring continues automatically.

As a result, not only can the operator be freed the high-tension duty of pouring in a very hot environment while carefully watching the tundish steel level so as to keep it constant, but can take care of other jobs like the following:

i) Sampling and sample shipment to laboratory 7 minutes/time x 4 times
ii) Preparatory work including TD heat insulator transportation 10 minutes/time x 2 times
iii) Receiving of the second ladle and returning of the ladle in fully continuous casting 5 minutes/time x 2 times

The effect of automatic pouring in terms of manpower saved is shown in Table II. The total working hours of the Rotary Nozzle operator and his assistant can be reduced by 47% from 190 minutes to 100 minutes.

IMPROVEMENT IN THE POURING TECHNIQUE

Pictures which were taken by high-speed cinematography of the stream of molten steel right under the full open and partial open nozzles in continuous casting are shown in Photo 3. This photo compares the stream of molten steel from the full open nozzle (50 mm in hole diameter) with that from the partial open nozzle (70 mm in hole diameter). The top of the stream is nearly equal in diameter to the nozzle in both cases, but the stream of molten steel under the partial open nozzle is remarkably disturbed, whereas the stream under the full open nozzle is not disturbed at all. The stream under the partial open nozzle spreads 10 degrees or more to one side from its axial line. This spread is the cause of air inclusion and oxidation of molten steel. In point of fact, Arnulf Diener underlines the importance of the stream of molten steel in pouring in his study concerning the relationship between molten steel steam disturbances and air inclusion. It is important to obtain a normal stream of molten steel by means of full open pouring to obtain quality slabs. In this respect the Rotary Nozzle is instrumental.

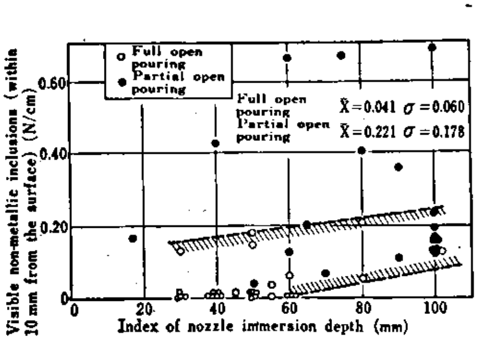


Fig. 7 Number of sub-surface inclusions in the slab.

QUALITY IMPROVEMENT

Sub-Surface Non-Metallic Inclusions In The Slab

As has already been pointed out, the degree of oxidation of molten steel greatly differs from partial open pouring to full open pouring. To simulate this condition, the number of Al_2O_3 inclusions ranging in size over 200u resulting from oxidation of molten steel by air was compared in continuously cast slabs for sheets.

The comparison is shown in Figure 7. This study illustrated that the number of inclusions after partial open pouring was about 5 times as large as that obtained by full open pouring (in spite of sealing) and that the variability of the number of inclusions in partial open pouring was about 3 times as high as that in full open pouring.

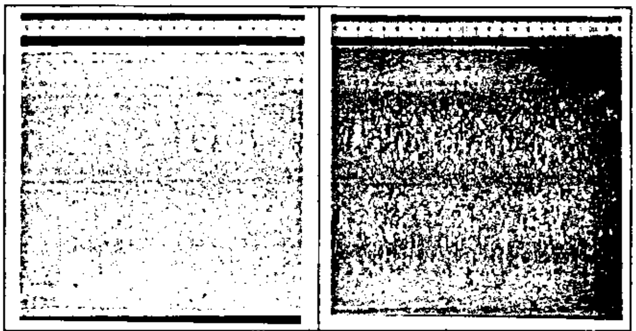
Non-Metallic Inclusions In The Slab

The difference in segregation of inclusions at one-fourth the thickness of slab between partial open pouring and full open pouring was determined by subjecting continuously cast slabs for sheets to a corrosion test. The macrographs of slabs obtained in this test are shown in Photo 4.

In the slabs obtained by partial open pouring many coarse inclusions which are an oxidation product are segregated in a band in the neighborhood of one-fourth the thickness of the slab, whereas the number of inclusions segregating near one-fourth the thickness of the slab is remarkably reduced in the slabs made by full open pouring, because the oxidation of molten steel is significantly inhibited by the latter pouring method.

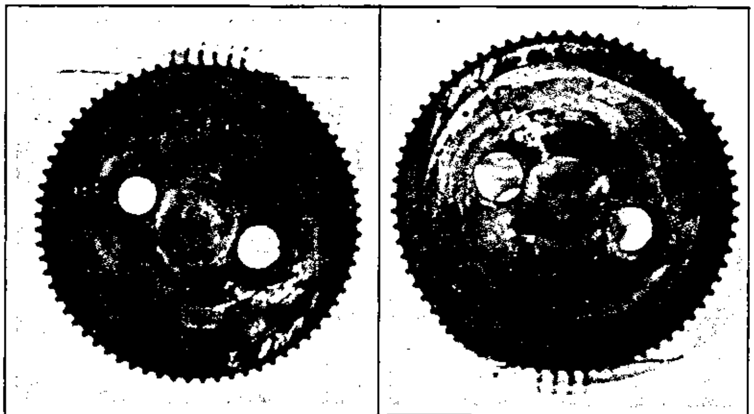
DAMAGE TO THE REFRACTORY OF THE ROTARY NOZZLE

As the pouring operation is carried on by fully opening and closing the nozzle, the wearing effect of the fully open pouring on the nozzle hole edge is far less remarkable than that of partial open pouring, as shown in Photo 5. Full open pouring therefore also helps decrease the wear on the nozzle.



Partial open pouring (nozzle diameter 70mm) 70% open	Full open pouring (nozzle diameter 50mm)

Photo 4 Macro-structure of the slab (full open cast and partial open cast).



Full open pouring (no erosion on the fringe of nozzle bore)	Partial open pouring (large amount of erosion on the fringe)

Photo 5 Erosions of slide plate after pouring.

CONCLUSIONS

At the Ohgishima steelmaking shop of Keihin Works of NKK an automatic pouring system using newly developed NKK Rotary Nozzle equipment was adopted and its commercial operation began in March 1977.

This automatic pouring system was a project which had been pursued since the inception of the Ohgishima Works plan and was improved in many ways after the continuous casting hot line was completed on November 16, 1976. As a result of the implementation of this project, the following have been achieved:

Improvement in the Pouring Technique

a) Full open pouring is carried out by selectively using nozzles of differing hole diameter which is one of the prominent features of the Rotary Nozzle equipment. As a result, the desired pouring rate can be attained without forming the deleterious umbrella-shaped stream of molten steel and the oxidation of molten steel can also be prevented.

b) Full open pouring does little damage to the nozzle hole edge of the slide plate so that the life of the Rotary Nozzle can be extended.

c) As the molten steel in the tundish can be maintained at a constant level, the variations in discharge from the tundish nozzle can be reduced with the result that mold level control can be stabilized.

Quality Improvement

As a result of a significant reduction in the oxidation of molten steel by air between the ladle and the tundish, the following effects have been obtained.

a) The number of slag inclusions of Al-killed steel slabs for cold rolling has been reduced to about one-fifth.

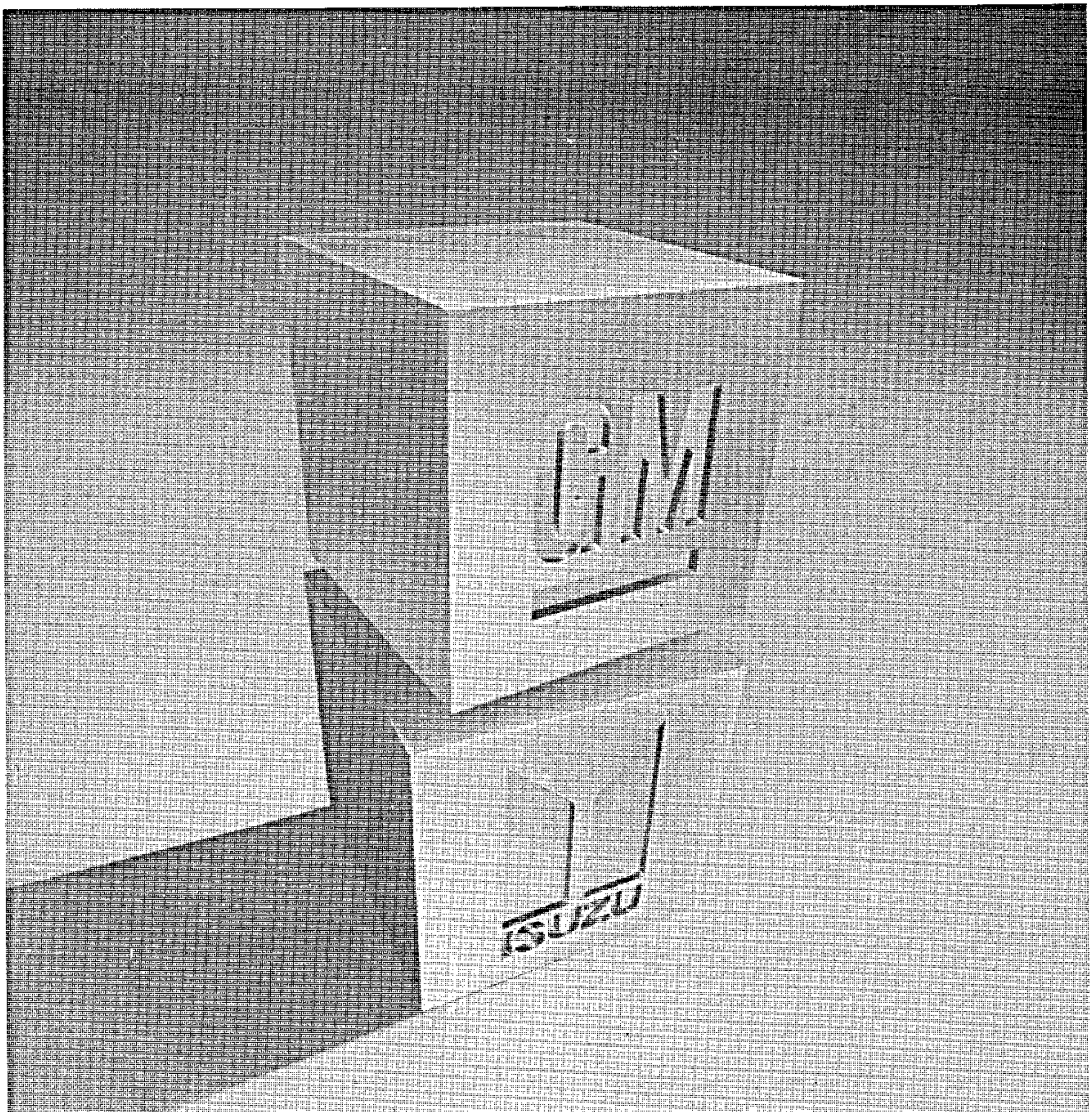
b) The number of coarse inclusions in the slab have been reduced.

c) The yield of the first and premium grade cold-rolled sheets has been significantly increased.

Labor Saving and Diversification of the Operator's Job

The automatic pouring system allows the operator to not only watch the tundish steel level and take care of the pouring operation but also perform other incidental jobs such as the collection and shipping of ladle samples and preparation of materials including the heat insulator. Since the adoption of the automatic pouring system the operator's job has been diversified and his working hours per job have been significantly reduced.

The full open pouring method (On-Off pouring) does not disturb the stream of molten steel, resulting in little air being included in the molten steel, few inclusions are produced and quality variations are minimized. PM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ADVANTAGES OF THE USE OF RARE EARTHS IN STEEL

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INTRODUCTION

Prior to the 50's there had been a very limited use for rare earths (RE) in steel.[1] Early in that decade the demand for superior impact ductility arose in such products as cast tank armor. Additions of concentrated RE's in the form of mischmetal were used to improve the impact properties of these products.[2] At the same time there arose an increased need for high temperature resistant alloys for components in some of the early generation jet engines. Some of the materials used for these applications were types 308, 309, and 310 stainless. These steels were difficult to hot work, and it was found that the use of mischmetal would dramatically improve the hot workability of these alloys.[3]

Although results from the use of mischmetal in both instances were encouraging, there was a lack of reproducibility. At that time, there was no simple, accurate method of chemical analysis for cerium and the possibility of any kind of a control system was absent. Coupled with this the demand for RE declined, due partly to a decrease in demand for ordnance products with high ductility, and partly to the fact that stainless steel producers learned to correctly balance chromium and nickel content and control the heating practices, thus achieving adequate hot workability.

About 1960, the determination of cerium by X-ray fluorescence was developed. It was a fast, accurate, inexpensive method for determining cerium. It provided a quantitative tool for developing a systematic approach to the use of RE's.

From the early 60's to the present time, the use of RE in steel has increased dramatically. There is now a worldwide acceptance of the benefits that can be obtained through their use.

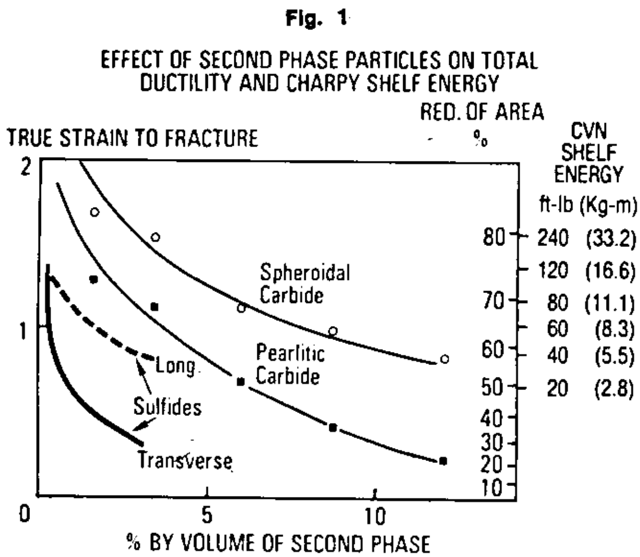
X-ray fluorescence is still the best way to determine cerium in steel. The equipment necessary for this determination, however, is now universally available throughout the steel industry. The analysis requires a proper target and proper excitation.

The objective of this paper is to show the relationship between cerium – as measure of RE content – and certain mechanical properties that can be enhanced through its use.

BASIC INFORMATION

Relationship Between Shape and Volume of Second Phase Particles and Steel Ductility

Gladman has shown that the ductility of steel, as measured by true strain to fracture which can be translated into percent reduction of area or Charpy V-Notch (CVN) shelf energy, is related to the size and the shape of the inclusions and the carbides in that steel.[4] Gladman's disclosures are demonstrated in Fig. 1. It shows the effect of the shape of inclusions by plotting true strain versus second phase content for steels tested both in the longitudinal direction and in the transverse direction. When steels are tested in the longitudinal direction the stresses look at the smallest cross section of elongated inclusions, but when steels are tested in the transverse direction, the stresses look at the elongated inclusions. Therefore, it is desirable to reduce the number of inclusions and control their shape so that they are globular and have the minimum adverse effect on ductility in both lateral directions, transverse and through-thickness direction.



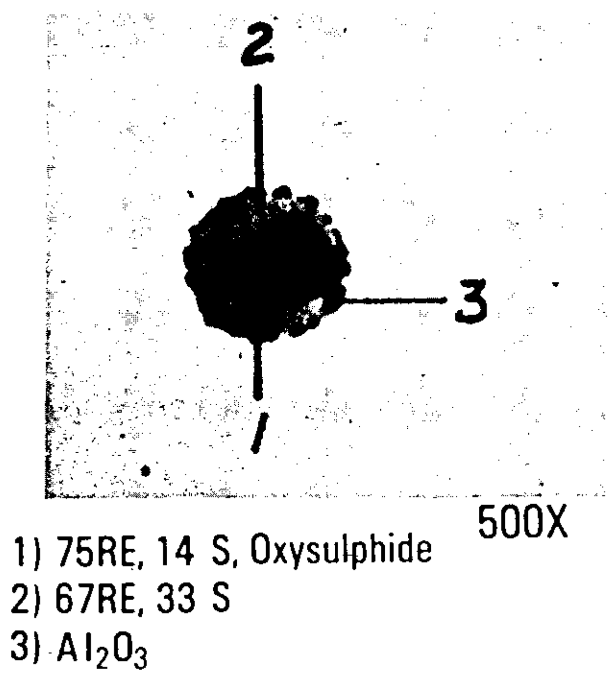


Fig. 2—Typical RE oxysulfide $(RE)_2O_2S$—RE sulfide $(RE)_xS_y$ inclusions found in a steel containing 0.02% RE and 0.025% aluminum

It is important to note that the shape and number of carbides remaining in the steel can overshadow the effect of sulfide inclusions in lowering ductility. Gladman's curves would indicate that even with no sulfide inclusions, a great number of elongated plate-like carbides would reduce the ductility to low levels.

In order to obtain maximum ductility in steel recent developments have emphasized procedures resulting in low volume fractions of inclusions of the proper shape, as well as low carbon contents in the steel.

INCLUSION DATA

Since cerium is about one-half of the RE content in mischmetal or RE silicide, it has become customary to assume that the total RE residual in steel is approximately two times the measured cerium content. In this report that system of computing the RE content will be used.

1) Sulfides With RE/S Ratio Greater Than Three
Fig. 2 shows a typical inclusion found in a steel when there has been prior aluminum deoxidation before the RE addition. Inclusions then contain a core of RE oxysulfides surrounded by rare earth sulfides. The particular inclusion shown also carries a little alumina on its periphery but that is not necessarily typical.[5]

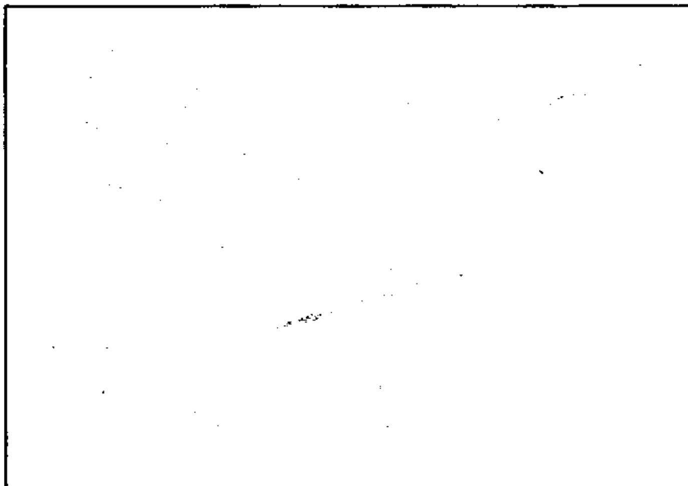
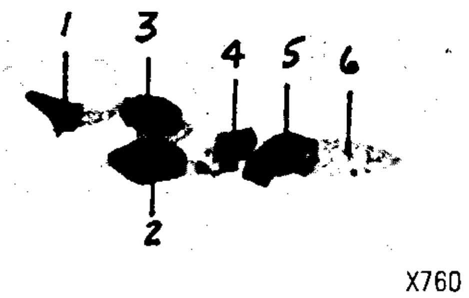


Fig. 3—Under polarized light, typical MnS inclusion is black. Below it is a rare earth-modified MnS inclusion, which has a trace of yellow. It is also shorter, indicating that it is less plastic than pure MnS inclusions. Steel contains 0.016% rare earths. 4,000×



1) 63 RE_2O_3, 27 Al_2O_3, 4 FeO, 2 CaO
2) 14 RE_2O_3, 79 Al_2O_3, 2 FeO, 1 CaO, 1 MgO
3) 64 RE_2O_3, 27 Al_2O_3, 4 FeO, 1 CaO
4) 64 RE_2O_3, 28 Al_2O_3, 5 FeO, 2 CaO
5) 15 RE_2O_3, 77 Al_2O_3, 3 FeO, 1 CaO, 1 MgO
6) 61 Mn, 33 S, 3 Fe

Fig. 4—Typical (RE) Al_xO_y inclusions in a manganese sulfide matrix found in a steel containing 0.020% RE and 0.025% aluminum.

2) Sulfides With RE/S Ratio Less Than Three

Fig. 3 shows the rolled out shape of manganese sulfides which persist when the RE/S ratio is less than three.[5] It can be shown that the particular sulfide plate in the center (with a little light rim around it) has been modified with only three to five percent RE. This RE modified managanese sulfide is thicker and shorter than the unmodified manganese sulfide plates. Such minor modifications with RE can reduce the length of manganese sulfide stringers by approximately two-thirds. Even this reduction in length will improve transverse and through-thickness properties.

3) Al_2O_3 Modification With RE

Figure 4 shows the modification of alumina that can occur when RE's are present in steel. With as little as 0.01% RE in the steel, there is a small amount of RE in the alumina and the compound (RE) $Al_{11}O_{18}$ is formed, (areas two and five in Fig. 4).[5] As the RE content of the steel increases, the RE modification of alumina becomes larger until the RE content becomes the major (64%) component of the inclusion (such as area numbers one, three and four). These are stoichiometrically (RE) AlO_3. With such alumina modifications there is a reduction in number of alumina clusters, and all alumina containing inclusions will vanish when the RE content exceeds approximately 0.03%. There are many potential applications for even these minor modifications of alumina.

EFFECT ON TRANSVERSE IMPACTS

Improvement in Transverse Impacts With RE (Laboratory)

The relation shown by Luyckx between RE/S ratio and CVN shelf energy became a landmark of information in the early application of RE's to improve the transverse impacts in wrought steel.[6] This relationship is shown in Fig. 5. Later work has questioned the shape of the curve after it reaches the maximum. There is still debate as to whether it drops off as abruptly as indicated.

With respect to the inclusions found, Luyckx determined that when the RE/S ratio is greater than three, all of the inclusions contained in the steel are globular and no manganese sulfides exist. If less than the optimum RE/S level is obtained, the inclusion population includes

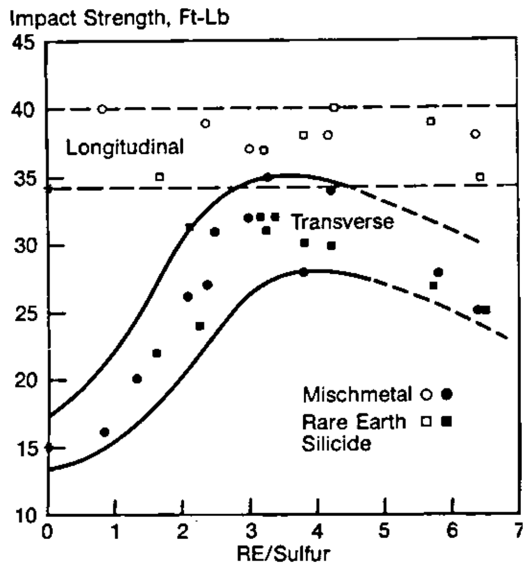


Fig. 5—Longitudinal and transverse impact strengths (Charpy V-Notch) are improved appreciably by rare earth additions, particularly when RE/S ratios are between 3 and 4. Asterisks indicate reference impact strengths, longitudinal and transverse, for the same steel without rare earth additions

the RE modified aluminas, some fully globular sulfides and also shortened RE modified manganese sulfides (still capable of contributing to ductility). For optimum ductility, steelmakers have tried to achieve RE/S ratios of at least 3 to 1.

Additional Laboratory Investigations on Steels With Varying RE/S Ratios

Recently, Oakwood et al.[7] have confirmed Luyckx's basic relationship between RE/S ratio and impact energy. Fig. 6 shows the room temperature impact values for Oakwood's steels, the CVN energy values in some cases exceeding the capacity of his impact testing machine. There is one maverick pair of values here at an RE/S = 6 for both finishing temperatures. This steel had the highest carbon level of any of the steels investigated. This demonstrates that (as Gladman proposed) the presence of excessive carbides of the wrong morphology can adversely affect ductility, even though the sulfide inclusions are of the proper shape.

Improvement in Transverse Impacts With the RE (Plant Trials)

Data so far shown are based on laboratory melted and laboratory rolled steels. Fig. 7, however, is for a commercial heat of HY-80 steel with ingot mold additions of mischmetal.[8] Again, increasing RE content developed increases in shelf energy. HY-80 is a 2½ nickel steel used by the U.S. Navy in shipbuilding. The same relationship between shelf energy and RE/S ratio can be seen – and is just one of many examples of the plant data confirming the laboratory work.

COMPARISON OF METHODS OF OBTAINING HIGH SHELF ENERGY

Reducing the Sulfur Content of the Steel (Laboratory Study)

The relationship between sulfur content and shelf energy in laboratory melts with and without RE's has been demonstrated by Kosazu (Fig. 8).[9] Kosazu's data shows that only at sulfur levels of less than 0.004% can RE free steel absorb the same impact energy as can RE containing steel.

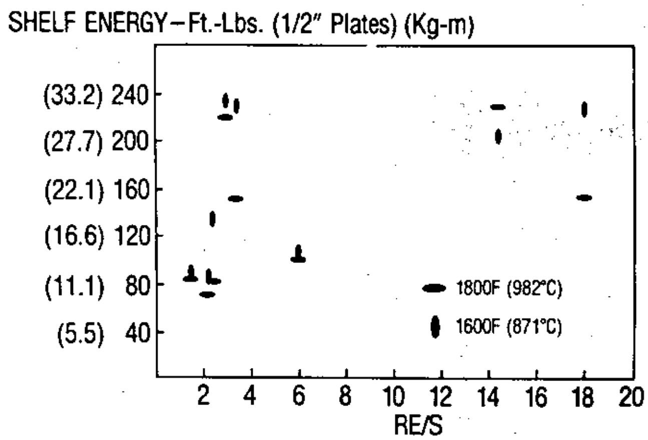


Fig. 6—Relations between CVN shelf energy and rare earth to sulfur ratio, (RE/S)

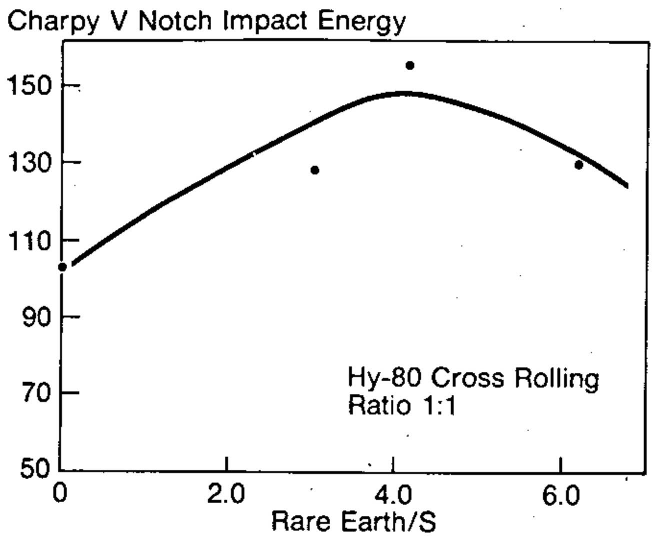


Fig. 7—Relationship between RE/S ratios and impact resistance of plates of HY-80 with a cross rolling ratio of one to one

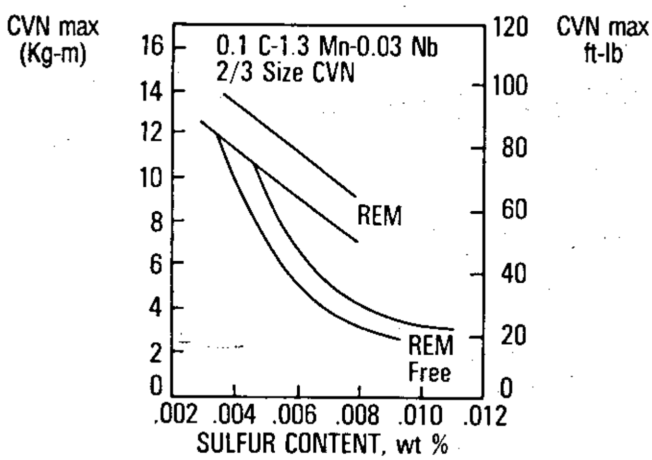


Fig. 8—Relationship between sulfur and impact energies in steel with rare earths and rare earth free

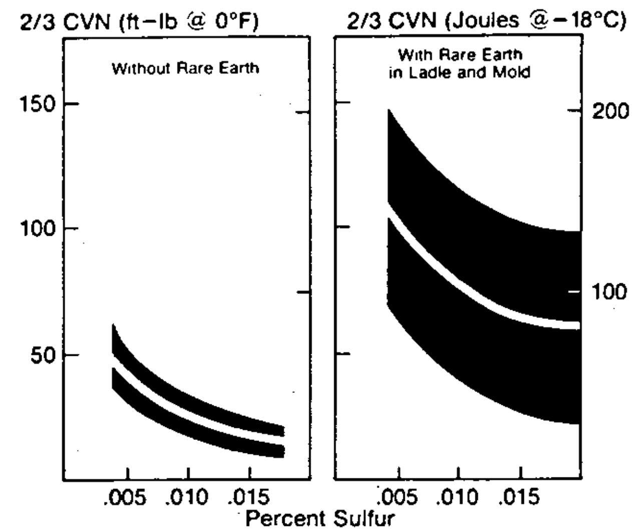


Fig. 9—Relationship between sulfur and Charpy impact energy in the transverse direction with RE additions to both ladle and mold compared to steel with comparable sulfur levels with no RE addition. Test temperature 0°F

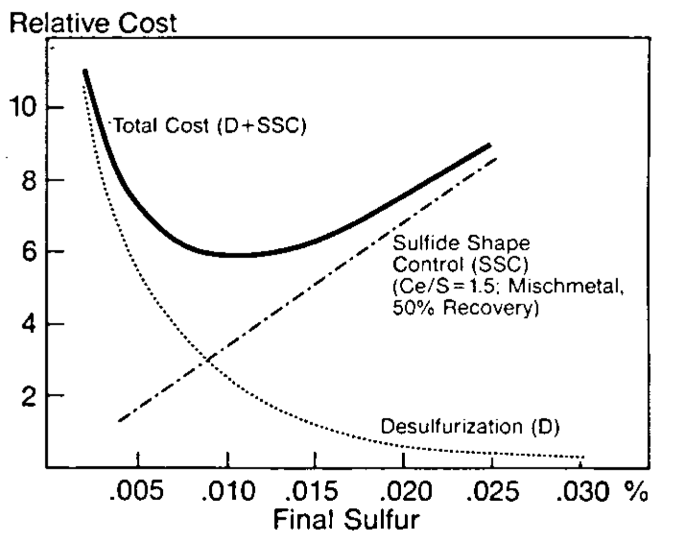


Fig. 10—The cost of optimum properties related to sulfur in aluminum killed HSLA steel applications

Reducing the Sulfur Content of the Steel — (40,000 Ton Plant Trials)

The effect of RE's on transverse impact properties in these 40,000 ton commercial trials is even more impressive than is Kosazu's laboratory data. These data (Fig. 9) from Ackert & Crozier[10] show the impact energies at various sulfur levels with no RE as compared to steels otherwise identical to which RE's have been added in both the ladle and mold to achieve full sulfide shape control. Note that with RE treatment sufficient to get complete sulfide shape control, at 0.010% sulfur, the average 2/3 CVN energy is 75 ft-lb. With no RE in the steel even at 0.004 sulfur, the average impact energy is only 50 ft-lb.

The question is often asked whether at sulfur levels of 0.005% and less can RE's still increase ductility. The data of Ackert & Crozier answer this affirmatively. At 0.004% sulfur the average CVN energy of the steel containing RE is 100 ft-lb as compared to 50 ft-lb at the same sulfur level with no RE.

Relative Cost of Ductility Improvements

The Ackert & Crozier data indicate that the average impact energy of linepipe steel, with sulfide shape control through rare earths at .010 sulfur is 75 ft-lb — acceptable for Arctic service.

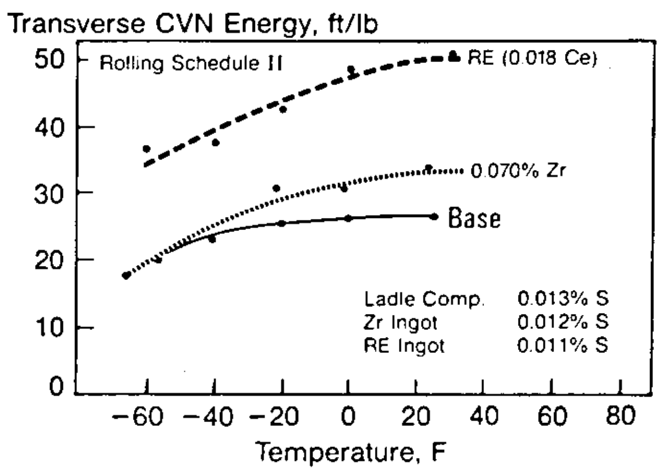


Fig. 11—Effect of rare earth and zirconium additions on impact properties

Fig. 10 visualizes the cost of obtaining such properties and the reason for selecting this level of desulfurization.[11] The upper curve is the overall total cost of combined desulfurization and sulfide shape control with RE. Note the minimum occurs at about 0.010% sulfur and at this level (recalling Fig. 9) the properties are superior even to 0.004% sulfur steel without RE treatment.

Comparison of RE and Zirconium on Transverse Impacts — (Plant Trials)

In comparison to zirconium, RE's do a better job of deoxidation and desulfurization, and result in steels with fewer inclusions — and as we have seen, such reductions in the number of nonmetallic inclusions results in higher impact shelf energies. Both steels represented in Fig. 11 were rolled from ingots of the same heat into linepipe skelp by a good controlled rolling practice. It can be seen that zirconium did improve transverse CVN values. But the RE containing steel improved them more than twice as much.

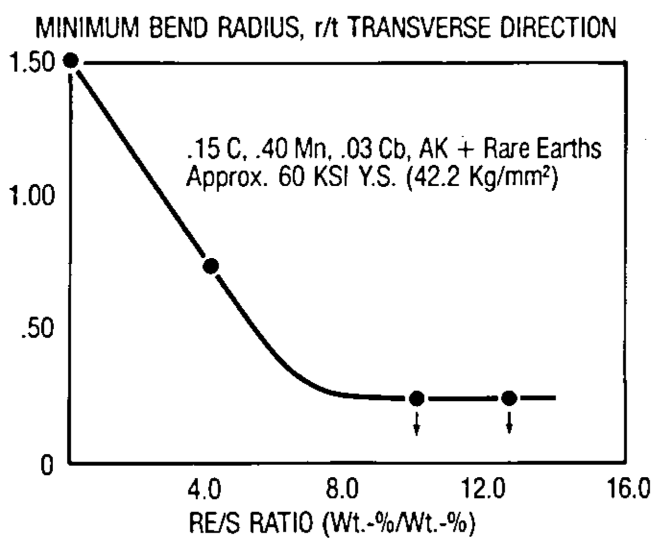


Fig. 12—Minimum bend radius of press-brake bend specimens with ground edges, 60 KSI yield strength strip product, as a function of RE/S ratio

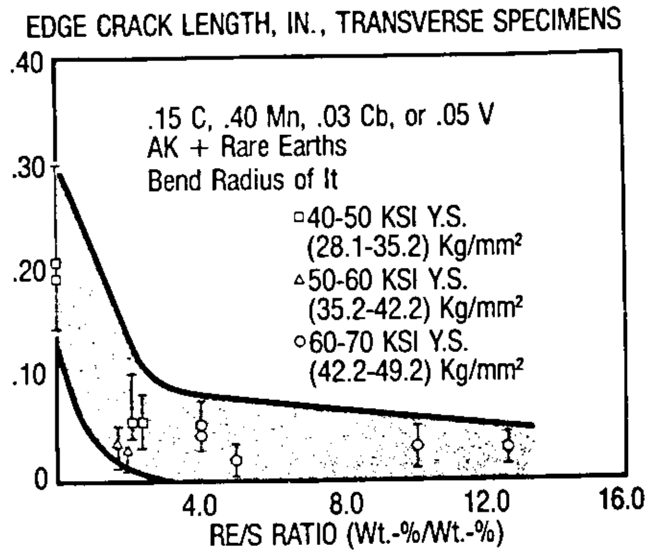


Fig. 13—Relationship between edge crack length and RE/S ratio for cold-sheared press-brake bend specimens of HSLA steels

Fig. 14—Effect of rare earth treatment on bend tests of 85 KSI (59.8 kg/mm²) Mn-Mo-Cb steels

EFFECT ON FORMABILITY

In either hot or cold rolled steel, the presence of stringer inclusions, whether they be silicates or manganese sulfides, has always been detrimental to the ability of that steel to be formed over edges parallel to the rolling direction (hard way bends). Therefore, it would be expected that globularization of the inclusions would improve these forming characteristics.

Relationship Between RE/S and Bend Radius and Edge Cracking

As the RE/S ratio increases tighter and tigher bend radius in the transverse direction can be obtained (Ballance and Minto drew Fig. 12).[12] A similar relationship exists between crack length on the bent sheared edge and RE sulfur ratio (Fig. 13). It appears that the minimum bend radius and least edge cracking occur at RE/S higher than are necessary to achieve maximum impact energy in the transverse direction.

Another way of demonstrating the ability of the RE's to improve the bending characteristics of high strength steel is shown in Fig. 14,[14] based on the work of Cryderman et al.

Such improvement in the ability of steel to withstand "hard way bends" is presently being achieved in several plants producing electric resistance welded (ERW) tubing. Certain acceptance specifications call for tubes to be bent flat. The use of RE's in such products has reduced the failure in the flattening test so much that ERW tubing can now replace some seamless tubing.

EFFECT ON THROUGH THICKNESS OR "Z" DIRECTION PROPERTIES

Both Italsider[14] and Sumitomo[15] have presented data showing that steels containing RE's have superior through-thickness ductility.

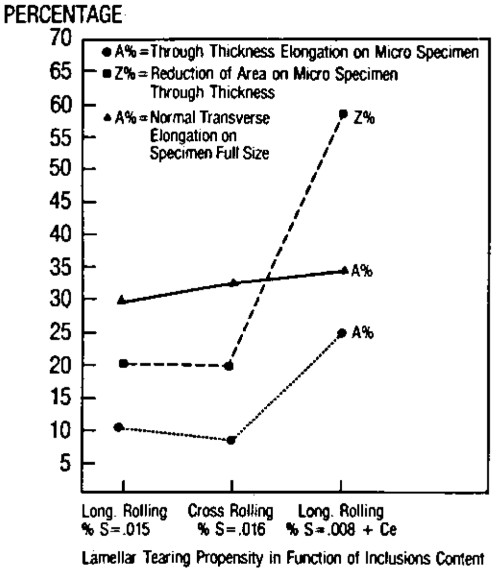


Fig. 15—Lamellar tearing propensity as a function of inclusions content

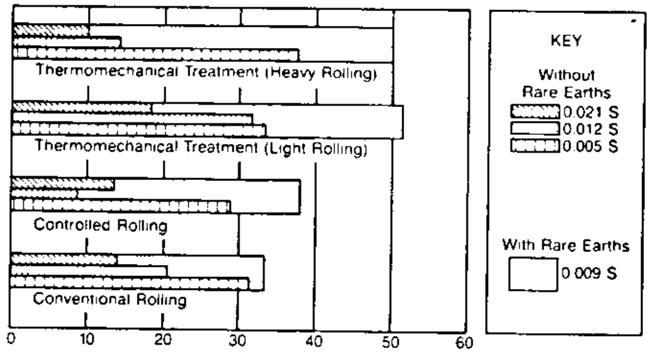


Fig. 16—Through thickness ductility as measured by % elongation in the Z direction (through thickness) for four line-pipe steels in four as-rolled conditions

Italsider documents improvements in both elongation and reduction of area (Fig. 15).[15] With less sulfur, obtained through either ladle or mold additions of RE, there is a three fold increase in reduction of area. The increase in elongation is almost of the same order of magnitude.

Sumitomo metallurgists report a similar improvement in through-thickness ductility obtained with RE's. They also show the effect on through-thickness reduction of area for four different rolling practices (Fig. 16). Note that the RE containing steel with 0.009% sulfur is superior to untreated steel of even low 0.005% S — whether produced by thermomechanical treatment (heavy or light), controlled rolling or conventional rolling. Note that the more sophisticated the rolling practice the greater the benefit.

EFFECT OF RE ON WELDING

The melting points of all the RE oxysulfide and sulfide inclusions are greater than 1900°C. This is at least 300°C above the melting point of either manganese sulfide or the silicates.

In the heat affected zone (HAZ) of weldments, inclusions with low melting points fuse and become grain boundary films reducing the ductility in the HAZ at both high and low temperature.

Because of the high melting points of all RE inclusions, the hot and cold ductilities in the HAZ of steels containing at least 0.03% RE are improved.

Reduction in Under-Bead Cracking

Even when low hydrogen electrodes are used in welding steels of high hardenability there is always a tendency toward under-bead cracking. One of the grades susceptible to this problem is HY-80 (Table I). This work, from the early 1960's, shows a reduction in under-bead cracking as the RE content of the steel increases and results in decreased sulfur content.[8]

TABLE 1—Heat-Affected Zone Cracking in Controlled Thermal Severity Samples—⅛ in. Diameter E11018 Electrodes

Plate	Residual RE, %	Residual sulfur, %	Heat Input, joules/in.	Number of cracks BT	TT	Total	Total crack length[a] BT	TT	Total	Average crack length BT	TT	Total
1 (open hearth)	None	0.019	30	1	0	1	(5)	(0)	(5)	(5)	(0)	(5)
			50	2	3	5	(48)	(17)	(65)	(24)	(5.7)	(13)
3 (open hearth)	0.038	0.009	30	1	0	1	(6)	(0)	(6)	(6)	(0)	(6)
			50	1	0	1	(12)	(0)	(12)	(12)	(0)	(12)
4 (open hearth)	0.050	0.008	30	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
			50	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
5 (electric furnace)	0.070	0.008	30	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
			50	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)

a. Numbers in parentheses give HAZ crack *lengths* in ¹⁄₁₆ in. units at X 500.

Impact Properties in HAZ of Steels Containing RE

Parrini has shown that the room temperature impact values of low carbon, high manganese, moly, columbium steels with RE are practically the same in the HAZ as in the base metal away from the weld.[14] Even at -60C the impact properties in the HAZ average 65 ft-lb as compared to a base plate average of 90 ft-lb. Fig. 17 compares the impact properties in the HAZ and those in the weld deposit itself. Normally, the HAZ is the weak link; but with Parrini's 0.062% RE Arctic linepipe steel, with submerged arc welding, the HAZ is uniformly more ductile than the weld metal.

Prevention of Hydrogen Delayed Cracking With RE's

Although most welding of high strength steels is done with low hydrogen electrodes, there are times under production conditions when the electrodes are not carefully handled and may accumulate moisture which dissociates into hydrogen in the arc. In such cases, cracking occurs soon after welding and the cracks are large. Savage has demonstrated,[16] in the same HY-80 steels used for the evaluation of under bead cracking, that the delayed hydrogen cracking is drastically reduced when such steels contain RE's (Fig. 18).

The Effect of RE on Automatic Welding

In the automatic CO_2 short-circuit arc welding process, RE's can have a detrimental effect. With increasing RE content the time between short circuits increases – that is short circuit frequency decreases. As a result, globules of metal transferred at each cycle are larger and cooler and less metal is transferred to the work piece. This poses two problems. The first, an increase in the amount of spatter (frequency connected); second, less penetration of the globules into the work piece (size and temperature connected).[17] Fig. 19 shows the latter phenomenon.

At present, a project is underway at the Welding Institute to find methods to overcome both these difficulties.

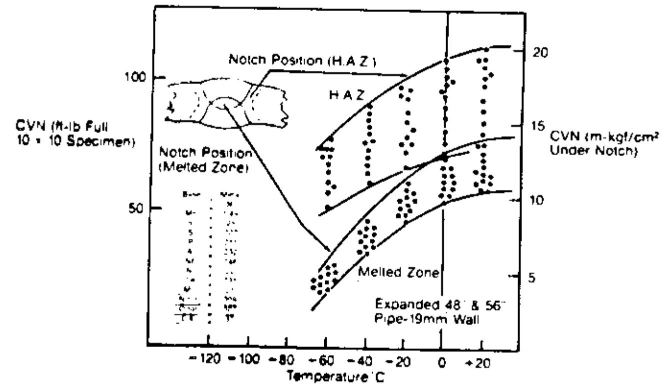
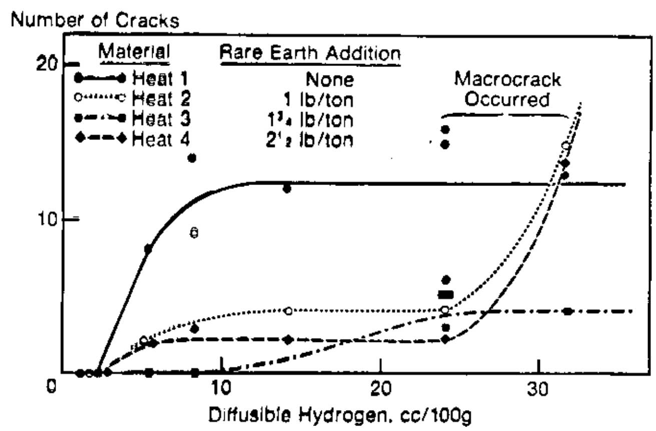


Fig. 17—Charpy V-Notch toughness of a welded X-70/X-75 Arctic steel pipe



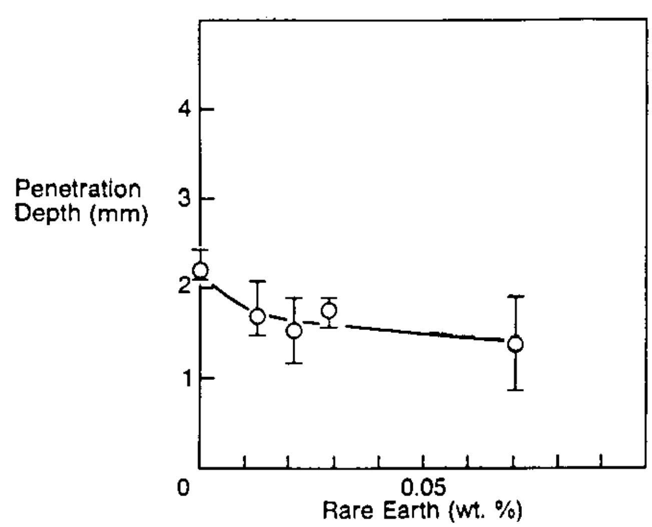


Fig. 19—Effect of RE content on penetration depth

DESULFURIZATION WITH RARE EARTHS

Basic Mechanism

The most likely mechanism by which the RE's act in the desulfurization of steel is by reducing the oxygen content of the steel to values below that obtainable with any of the other common deoxidizers. This, in combination with stirring and the use of high lime slags causes transfer of sulfur from the metal to the slag at the interface.

Illustration of the Basic Principle

Two well controlled experiments demonstrate the principle better than experience which is always confused by other factors. Both heats were performed in a three ton induction furnace with a magnesia lining to which had been added a slag composed of lime with some metallic aluminum to insure a low oxygen potential. Fig. 20A gives the results when only aluminum in the amount of 0.10% was added. Argon stirring was used in both heats. The oxygen content of this first heat went to approximately 25 parts per million (ppm) but the sulfur content remained constant.

Figure 20B gives the results when 2-½ pounds of RE's per ton were added along with the aluminum. In this heat the oxygen dropped to 12 ppm, 40% lower than with aluminum alone. The sulfur removal was very rapid – and to low levels (less than 0.004%S).

The question has been raised from time to time as to how much sulfur, if any, is removed with aluminum deoxidation – even with ideal refractories, good stirring and high lime slags of low oxygen potential. Fig. 20A shows that the answer is none. But the addition of RE's after the aluminum will achieve desulfurization to low levels (Fig. 20B).

Commercial Application

One major steel plant in North America reports the use of these principles on a regular basis and desulfurizes with the RE's to less than 0.005% S. More precise details of this application have not, unfortunately, been disclosed to date.

IMPROVING HOT WORKABILITY OF STAINLESS

Since the first commercial application of RE's was for the improvement of the hot workability of stainless steel, let us bring the record up-to-date.

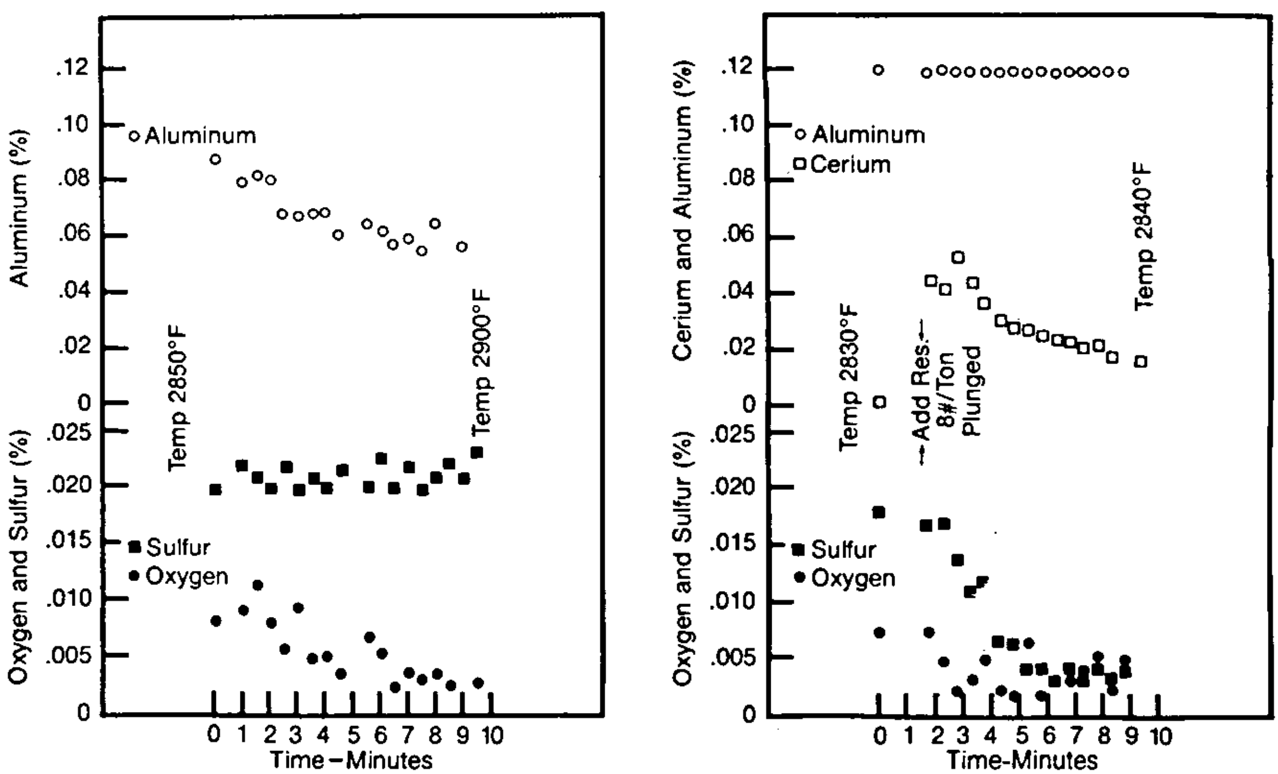


Fig. 20—Comparison of the amount of sulfur removal obtained in a three ton induction furnace with magnesia lining with and without RE

Early Results

In November 1951, Post and Beaver reported the data in Fig. 21 – using mischmetal.[18] In this correlation between the nickel content of the alloy and the RE retained in the steel, they define the ranges of composition of austenitic stainless alloys which are forgeable. Note that hot workability can be lost if either the RE content is either too high or absent, especially in high nickel alloys.

Later Results

Pinnow has[19] optimized the amount of RE treatment for steels containing 25% nickel and 25% chrome – fully austenitic (Fig. 22). He finds that 0.01 to 0.07% RE's (he used pure cerium) gives the best hot impact strength over the temperature ranges at which stainless steels are hot worked. Notice that too much RE's is actually worse than none at all. Still unexplained is the mechanism by which an optimized amount of RE's is so helpful in stainless steel metallurgy.

Weldability of RE Containing Stainless Steels

Unfortunately the welding of RE containing stainless steel is subject to the same spatter and penetration problems noted in the gas metal arc welding of HSLA steel. This has prevented the use of RE in stainless, except for those grades which are absolutely impossible to hot work without RE's. It is hoped the Welding Institute work will be helpful here, also.

OTHER ADVANTAGES

The RE's form compounds with many elements in steel such as lead, phosphorus, arsenic – all having melting points two or three times higher than the elements themselves. This fact promises achievement in controlling the detrimental effects of such tramp elements. Gschneidner[20] has shown that the thermochemistry is favorable, but work needs to be done for application to steelmaking.

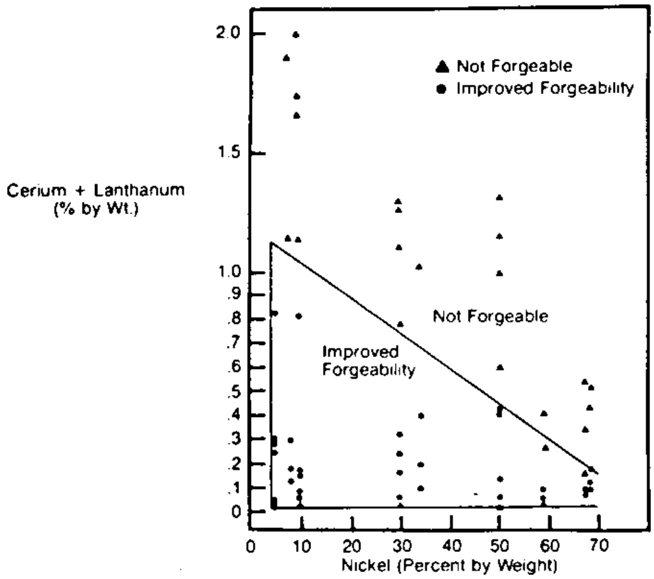


Fig. 21—Effect of nickel content on maximum and minimum residual amounts of cerium and lanthanum to improve hot-workability in austenitic stainless alloys containing chromium, molybdenum, nickel, etc.

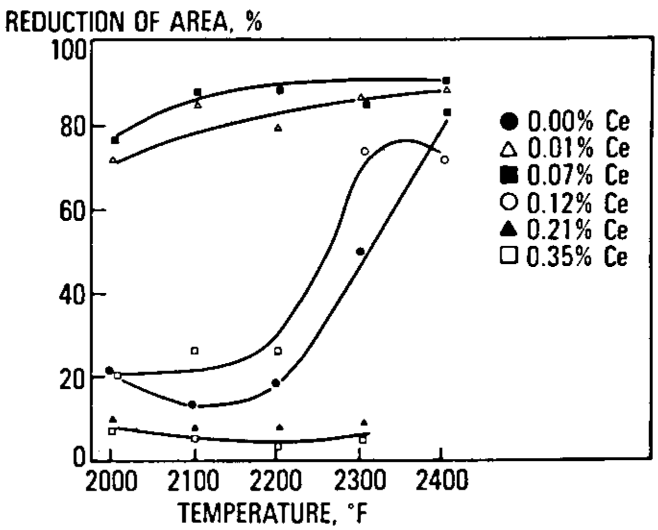


Fig. 22—Influences of temperature and cerium content on the energy to rupture. Specimens taken normal to the primary direction of solidification relative workability indicated by energy required for rupture

RE's can improve the ductility of constructional alloy steels at high temperature. Steels without RE ordinarily show a sharp decrease in ductility immediately after solidification but those containing RE show no such decrease.[21]

Even at 800 to 1000°F there is an effect. It seems to be associated with lead content. Lead is known to drastically reduce ductility in this temperature range; but in RE containing steels it does not.[22]

So much for the technical detail, let us now take an overview. Society is moving simultaneously in two directions: one, toward a zero defect concept in all products; and two, in order to save energy, toward higher strength but lighter materials of construction. RE's are being used for both these objectives in increasing quantities throughout the world to achieve these goals by decreasing the number of inclusions present, by globularizing the remaining ones, by modifying alumina, by improving transverse impacts, by improving formability, by improving ductility in the through-thickness direction, by reduction of under bead cracking, by improving the impact resistance of the HAZ, by prevention of hydrogen delayed cracking through reduction of the sulfur content of steel, and by improving the hot workability of stainless.

Projected uses of RE's in the steel industry of the world in the 1980's is in excess of fifty million pounds per year.

CONCLUSIONS

1) The ductility of steel as measured by Charpy V-Notch shelf energy, Z direction reduction of area and bend and stretch formability is largely influenced by the number and shape of the inclusions in the steel.
2) RE's can reduce the number of inclusions and globularize the remaining ones, thereby achieving these ductility improvements.
3) RE sulfides and oxysulfides have high melting points and do not melt in the HAZ of welds, thus reducing the incidence of under-bead cracking.
4) The HAZ impact values in RE containing steel remain high.
5) RE's are used to desulfurize steels to very low levels (less than 0.005%).
6) RE's can be used to improve the high temperature ductility of HSLA and constructional alloy steels and improve the hot workability of stainless steel.

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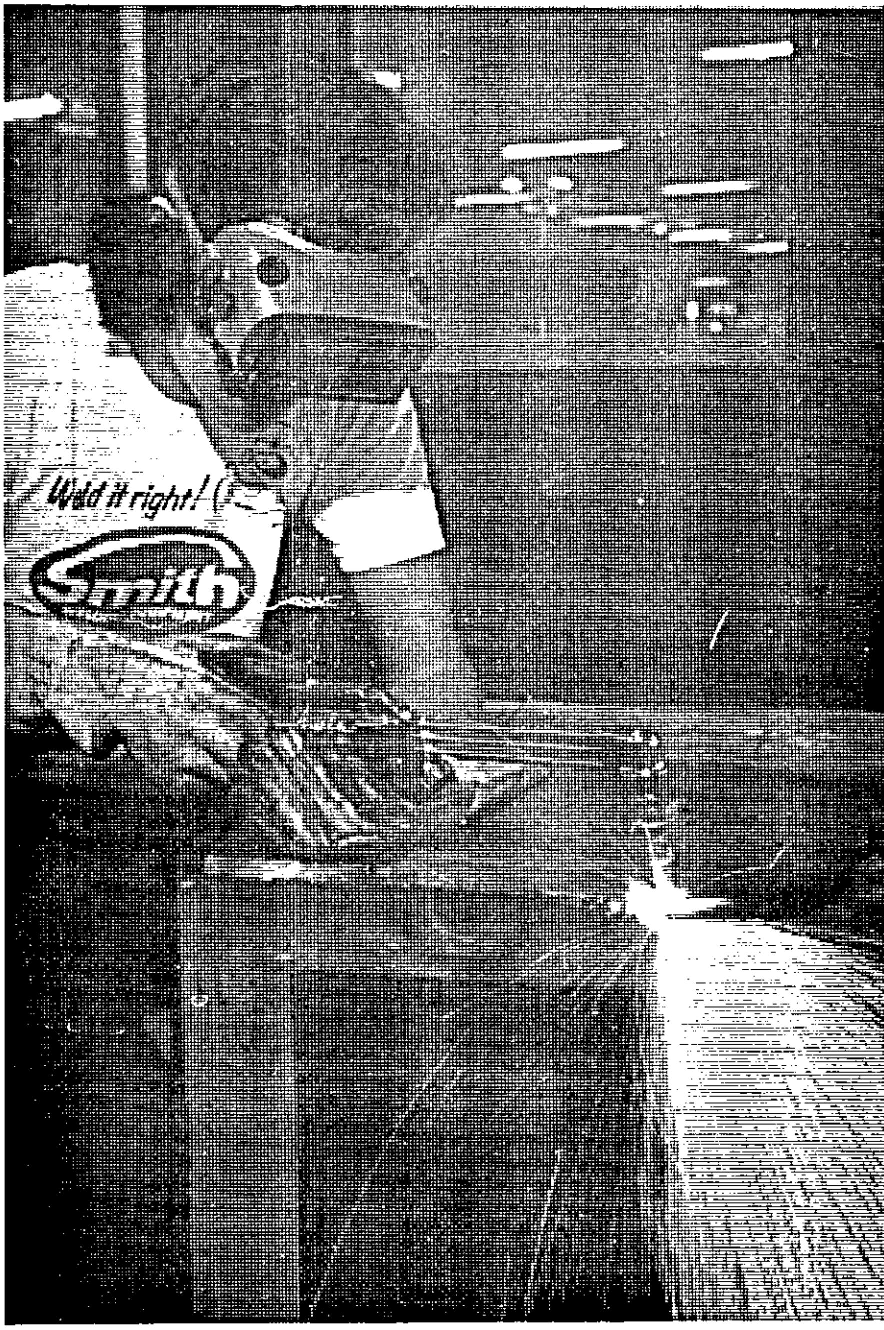

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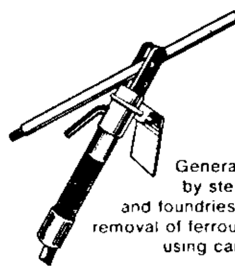

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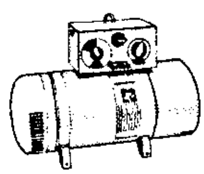

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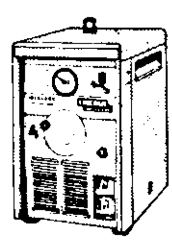

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HANDLING & SHIPPING OF MIDREX IRON

DR. ECKART E. GOETTE
President
Midrex Corporation

SOCIETY OF MANUFACTURING ENGINEERS TECHNICAL PAPER

The advent of the merchant direct reduced iron plant provides the possibility of direct reduced iron (DRI) usage for a broad range of iron and steelmaking processes. Historically, direct reduction plants have been located adjacent to electric arc furnace steelmaking facilities. In the past several years, these direct reduction plants have routinely shipped direct reduced iron to various users, as will be described later. Merchant plants, such as Norddeutsche Ferrowerke, which is currently being constructed in Emden, Federal Republic of Germany, will be able to supply various iron and steelmakers with direct reduced iron by truck, rail or ship, depending on location. Therefore, the inherent advantages of direct reduced iron, such as dependable supply under predictable price conditions, very low impurities, productivity and product quality advantages, and ease of in-plant handling and charging will be available on a broad scale basis not only to electric arc furnace steelmakers but also for use in foundries as a coolant in the basic oxygen furnace, in induction furnaces and during peak production periods as an enrichment for the blast furnace burden.

The following is a review of the means by which direct reduced iron should be treated prior to shipping.

Natural Characteristics of DRI

All DRI has some common characteristics which are independent of the particular direct reduction process. These common characteristics which relate to shipping and handling include reoxidation and corrosion behavior. Reoxidation of DRI can occur in the dry state and is the reaction of oxygen from air with metallic iron to form iron oxide, accompanied by generation of heat. Corrosion of DRI occurs only when wetted with water in the presence of air and is the reaction of water and oxygen from air with metallic iron to form rust, accompanied by generation of heat as well as a small amount of hydrogen. Both the reoxidation and corrosion reactions take place slowly over a matter of hours or days, not rapidly like the burning of flammable material.

Midrex has extensive practical experience in the behavior of DRI. From this practical experience some general rules of behavior can be listed as follows:

a) With cool, dry DRI, no reoxidation or corrosion or heating will occur.

b) Cool, dry DRI, when wetted with water, will start to slowly corrode and heat.

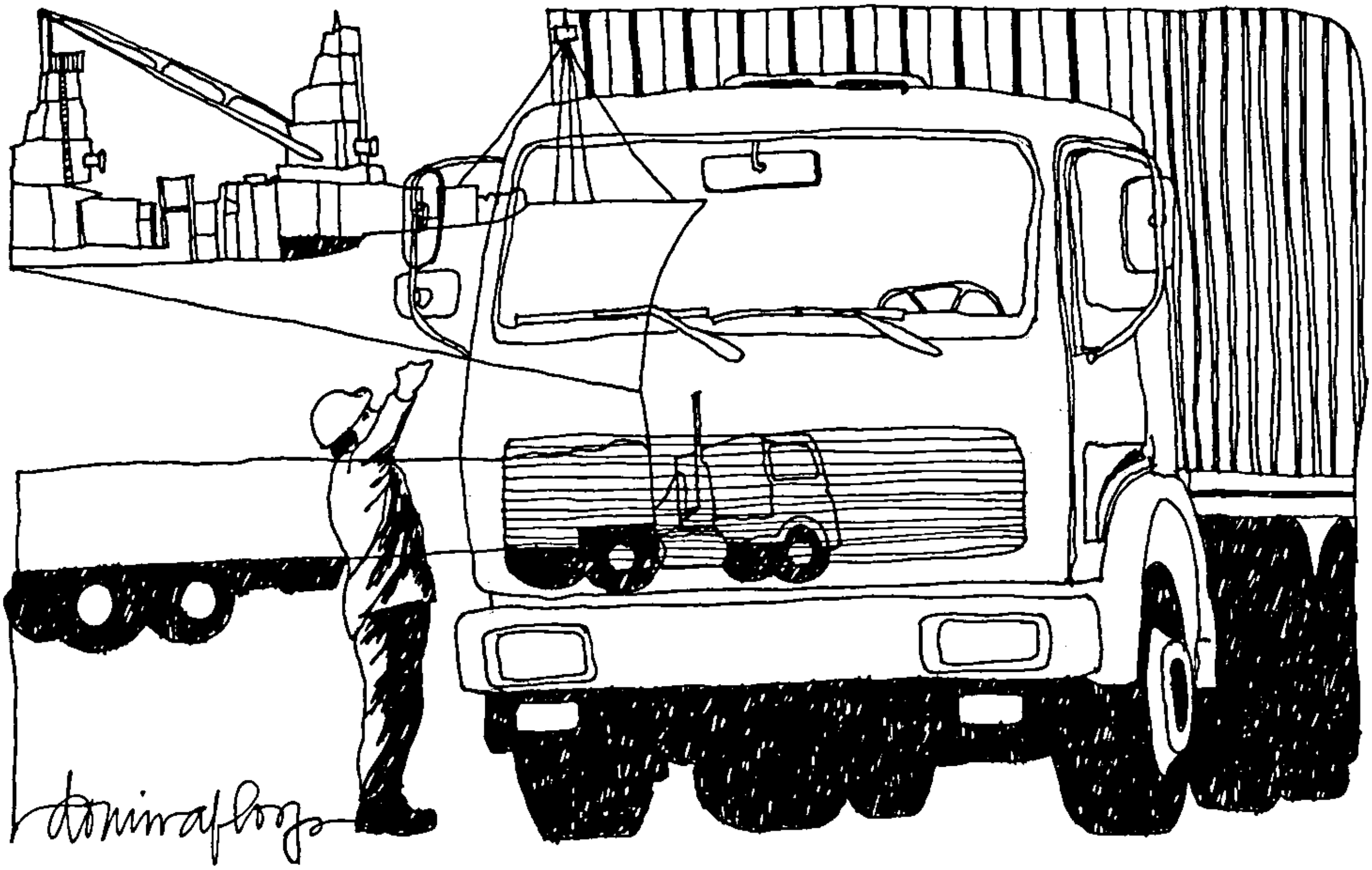
c) Dry DRI at a temperature of approximately 200°C will start to reoxidize and heat.

d) When the exterior of a pile of dry DRI is wetted by rain or snow, corrosion of the surface layer will start but is generally of little consequence since the heat of corrosion is free to escape from the wetted surface layer.

e) The principal precaution is to avoid burying wetted DRI under dry DRI in a pile. The buried corroding region cannot freely lose heat and can cause the dry region above to start reoxidizing.

Natural Aging of Fresh DRI

When cool, freshly reduced DRI is first exposed to air from the



reduction process, it has an instant initial appetite for reacting with air. However, this initial appetite is quickly satisfied in a matter of a few hours, and further reaction with air ceases. This initial reaction represents a very small amount of natural reoxidation and is termed "natural aging" by Midrex. The amount of reoxidation which occurs during natural aging is very small, representing a loss of metallization of only a small fraction of one percent, and insufficient heat is generated to cause any continuation of reaction. Natural aging occurs while the freshly produced DRI is being transported on conveyor belts and while being held in dry storage prior to loadout.

Naturally aged DRI can be safely shipped by truck and rail without further treatment. However, steps should be taken to keep the DRI dry, primarily for the receival and storage of the shipment prior to melting. DRI which becomes wetted during a truck or rail shipment will not ordinarily cause any heat damage to the truck or rail car.

Naturally aged MIDREX Iron has been extensively shipped successfully by truck and rail. The following is a listing of these shipments as of December, 1978:

Plant	Metric Tons by Truck	Metric Tons by Rail
Georgetown	8,374	146,379
Portland	141,389	16,226
Sidbec	202,860	69,039
Hamburg	20,274	82,314
Dalmine	31,904	–
TOTALS	404,801	313,958

The MIDREX Plant at Georgetown Ferreduction makes regular rail shipments of naturally aged MIDREX Iron to the Georgetown-Texas Steel Corporation in Beaumont, Texas, a distance of 1700 kilometers. These shipments, which generally amount to 10,000 to 15,000 metric tons per month, go by rail rather than by barge simply because rail shipment is less costly for this monthly tonnage due to lack of barge receival facilities at Beaumont.

Midrex Air Passivation Treatment

In 1972, Midrex developed an air passivation treatment to give DRI a controlled preoxidation to achieve an increased element of safety for ocean shipments in the event of water entry into the hold of a vessel during a long voyage. This air passivation treatment is carried out at a controlled elevated temperature in air, and results in DRI with increased resistance to subsequent further uncontrolled reoxidation. The value of this treatment is that in the event of water entry to a hold from a leaky hatch during a voyage, there is much less chance of the dry lower region of the cargo starting to reoxidize from the corrosion heat, which is generated in a localized wetted upper region of the cargo. This treatment does not, however, prevent corrosion from taking place in the wetted region of the cargo.

In 1973, Midrex installed a commercial scale air passivation facility at Georgetown Ferreduction. Numerous water shipments of air passivated MIDREX Iron have been made from Georgetown, all without incident during shipment. The following is a summary of these shipments as of December, 1978:

Metric Tons by Barge	Metric Tons by Vessel
*61,029	**50,043

*39 shipments within U.S.A.
**7 shipment to Greece, Italy, Japan, England (3) and France.

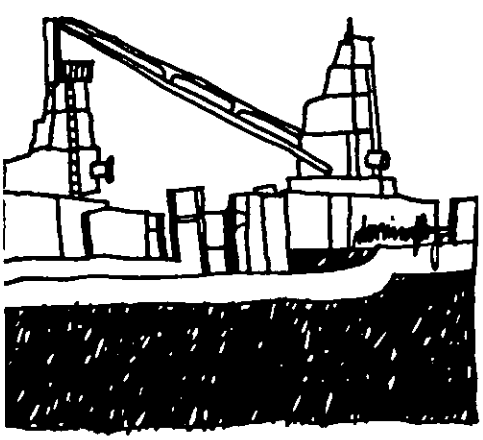
Although all of these water shipments have been made without incident during shipment, there have been a few instances where part of an unloaded cargo became wetted and heated up and lost metallization during distribution of the material from the port of unloading to the ultimate user. In these few instances, wetted material was either buried under dry material or became mixed with dry material.

Midrex CHEMAIRE Treatment

In order to make practical the shipping, distribution and storage of MIDREX Iron without the necessity of keeping the material dry at all stages of handling, Midrex has developed a treatment for DRI which makes the DRI both oxidation and corrosion resistant. This treatment is known as the Midrex CHEMAIRE® Corrosion Inhibiting Process.

The process is a simple one which consists essentially of saturating the DRI with a dilute water solution of a corrosion inhibiting chemical, followed by drying and controlled passivation against oxidation. The chemical employed is compatible with standard EAF melting practices and does not contaminate the steel or liberate any volatiles during melting of the DRI. In addition to inhibiting corrosion and reoxidation, the CHEMAIRE treatment suppresses dust liberation during handling of dry, treated product and also makes the product more resistant to breakage during handling.

The first commercial facility for treating MIDREX Iron by the CHEMAIRE Process was installed at Oregon Steel in Portland in late 1976, to permit bulk storage accumulation of MIDREX Iron on the bare earth during summer months, to provide a source of DRI for the melt shop during periods of natural gas curtailment during the winter months. Extensive tests were carried out at Portland to demonstrate the effectiveness of the CHEMAIRE treatment over many months.



The CHEMAIRE treatment enables wetted DRI to be buried beneath dry DRI in a bulk pile without occurrence of any significant corrosion or reoxidation or heating within the pile. The MIDREX Iron which will be produced at the Norddeutsche Ferrowerke plant now under construction in Emden, Federal Republic of Germany, will be given the CHEMAIRE treatment prior to shipment to insure against corrosion or reoxidation in the event the material gets wet prior to melting at the ultimate user's plant.

Midrex considers the CHEMAIRE treatment a significant accomplishment in the treatment of DRI for shipping, handling and storage, particularly for wide distribution of the product where it is not always practical to keep the material dry.

Midrex Hot Briquetting

As a potential alternate to the Midrex CHEMAIRE Corrosion Inhibiting Process for treatment of DRI, Midrex has developed an advanced design hot discharge reduction furnace which is directly coupled to a pair of hot briquetting stations, each station having the capacity to handle full furnace output. This furnace, together with the remainder of the module, will incorporate proven Midrex technology.

Although hot briquetting is a costly step, Midrex feels there may be future situations where hot briquetting may be desirable. Midrex sees the principal difference between CHEMAIRE treated product and hot briquetted product as the lower water pickup of the hot briquetted product where there is high degree of exposure to the elements. The corrosion– and reoxidation-resistant characteristics – are very similar.

Relative Corrosion and Reoxidation Characteristics

The Midrex Technical Center has made extensive determination of the corrosion and reoxidation characteristics of DRI having different types of treatments. The following is a tabulation of the approximate relative characteristics, with freshly reduced DRI reactivity indicated as 1.0 for both dry and wet DRI, even though the actual dry and wet reactivities are quite different and determined in different manners.

Type DRI	Relative Dry Reactivity	*Relative Wet Reactivity
1) Freshly reduced	1.0	1.0
2) Natural aged	0.01	1.0
3) Midrex air passivated	0.001	1.0
4) Midrex CHEMAIRE treated	0.0001	0.01
5) Hot briquetted	0.001	0.01

*Wetted with fresh water. Relative seawater wet reactivities, items 4 and 5, are not as low as 0.01.

Summary

Throughout the years, Midrex plants have acquired extensive experience in handling, storage and shipping of DRI. This experience has been obtained with both treated and untreated product and has allowed Midrex to establish clear and simplified rules concerning the handling of MIDREX Iron in its several forms and states.

In order to overcome the general rule that DRI is best kept dry, and keeping in mind the soon to be realized plants which aim at marketing DRI to a wide variety of non-captive users, Midrex has developed the specialized processes of "Chemaire" and hot discharge/hot briquetting.

Our years of experience, together with the new developments in handling direct reduced iron, have contributed to making Midrex the leader in the direct reduction field. **PM**

RATIONALIZATION WITH PNEUMATICS (3)

WERNER DEPPERT, BDW
FESTO

Operating Tipping Mechanisms Pneumatically. Containers that must be manually emptied every now and then can be found in every area of production, sometimes directly during the production process and sometimes only as incidental work associated with cleaning, washing or flushing of workpieces. The material involved may be either pourable or even small mass-produced parts.

Tipping of the container is still often accomplished with oversized hand levers, while it is exactly here that attachment of a pneumatic cylinder to mechanize the operation is very simple. With already existing tip containers, the considerably shortened hand lever can be used as the point of action of the pneumatic cylinder. Normally, the cylinder is pivot-mounted, and the tipping motion is executed as a swivel motion. The speed of the tipping motion executed can be adjusted via the outgoing air flow of a speed regulating valve.

For specific motions, a rotary cylinder that, in addition, can be simultaneously used to swivel the container back and forth during oscillating operation and thus be used to mix various materials, can be employed instead of the double-acting pneumatic cylinder, where the swivelling motion is obtained from the linear motion. In other cases, a four-position cylinder, for example, with which step-by-step tipping motions can be executed may be used.

The pneumatic control system is quite simple; using a 4/2 valve with the desired type of actuation, rotary cylinders and double-acting

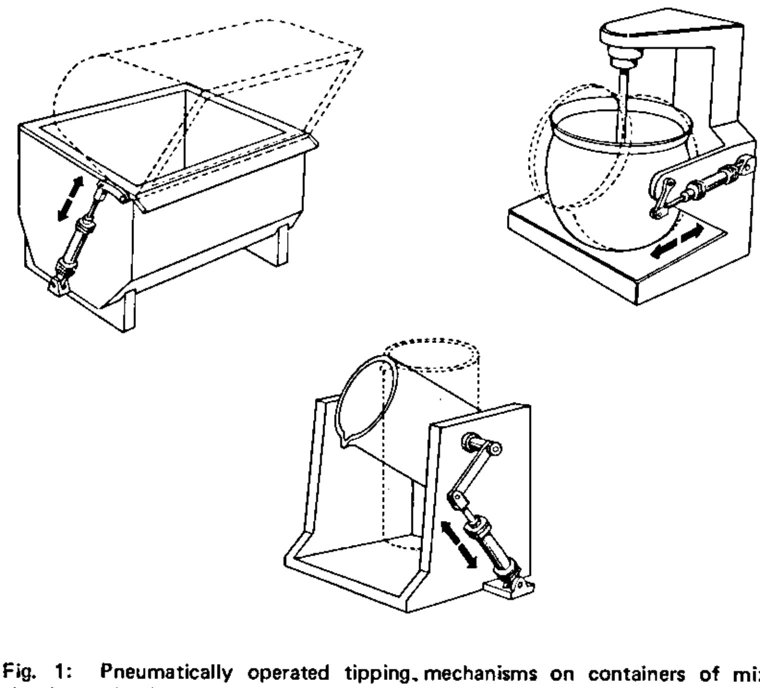


Fig. 1: Pneumatically operated tipping mechanisms on containers of mixing, cleaning and collecting systems. It is almost always possible to attach the pneumatics at a later date. (Company photo: FESTO)

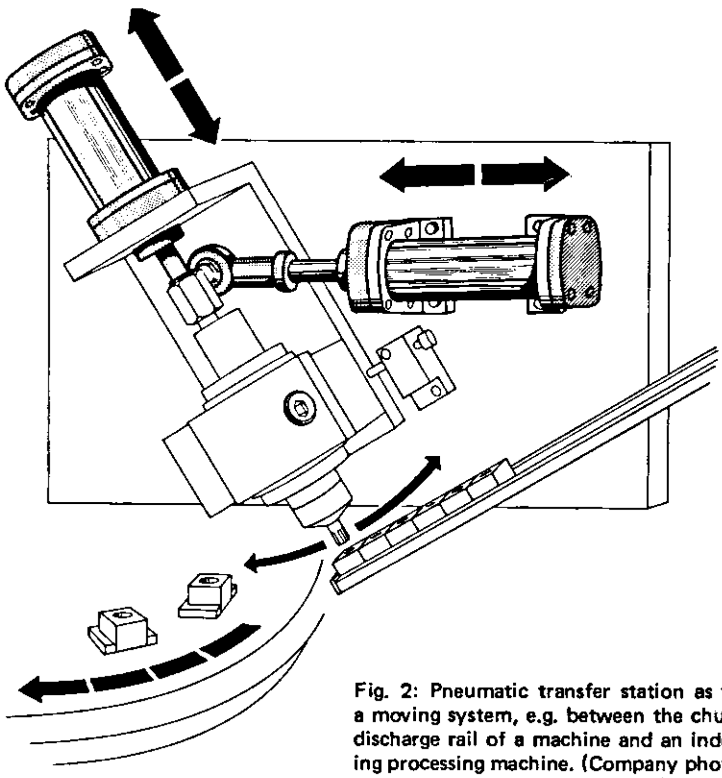


Fig. 2: Pneumatic transfer station as the link between a rigid and a moving system, e.g. between the chute of a vibratory conveyor or discharge rail of a machine and an indexed feed system of a following processing machine. (Company photo: Blosch/FESTO)

cylinders can be controlled. When multiposition cylinders are used, several 3/2 or 4/2 valves must be used, depending on the number of positions. The simplest example is probably control by means of a foot-operated valve, as long as fully automatic operation in a production line is not necessary.

The external appearance of pneumatically operated tipping devices may assume any of a number of possible designs. Mechanization of the tipping motion should be provided.

Singling, Feeding and Transferring of a Workpiece. Transferring of a workpiece from one machine to the next or from one machining system to another within a freely interlinked production line requires ordered delivery, singling and subsequent feed. It is especially difficult when the workpiece has to be transferred from a rigid system to a moving system, e.g. from a feed rail or magazine rail to the workholding plate of a rotary indexing machine. An example of such a transfer station is shown in Figure 2. The transfer station itself can be permanently incorporated into a production line or be used as an individual unit at various locations as necessary.

Construction of the Transfer Station. Two pneumatic cylinders control a gripping system, which is constructed either as a clamping device or expansion mandrel, depending on the respective workpieces. In order to achieve a wider range of application with no restrictions on use, it is advantageous if the gripping system is interchangeable. Then, workpieces with various shapes and sizes could be handled. One cylinder operates the gripping system directly for picking up and releasing the workpiece. The second cylinder executes the transfer motion, the entire gripping system with workpiece being moved along a circular arc. The feed rail is a component of the preceding station, e.g. the discharge chute of a vibrating conveyor or the output chute of a processing machine. The feed rail assumes the functions of banking and making available.

Sequence of Operations. With the transfer station in the starting position (figure 2), the incoming signal is utilized to actuate the gripping cylinder. This signal must thus be supplied by the following machining station so that synchronization is maintained.

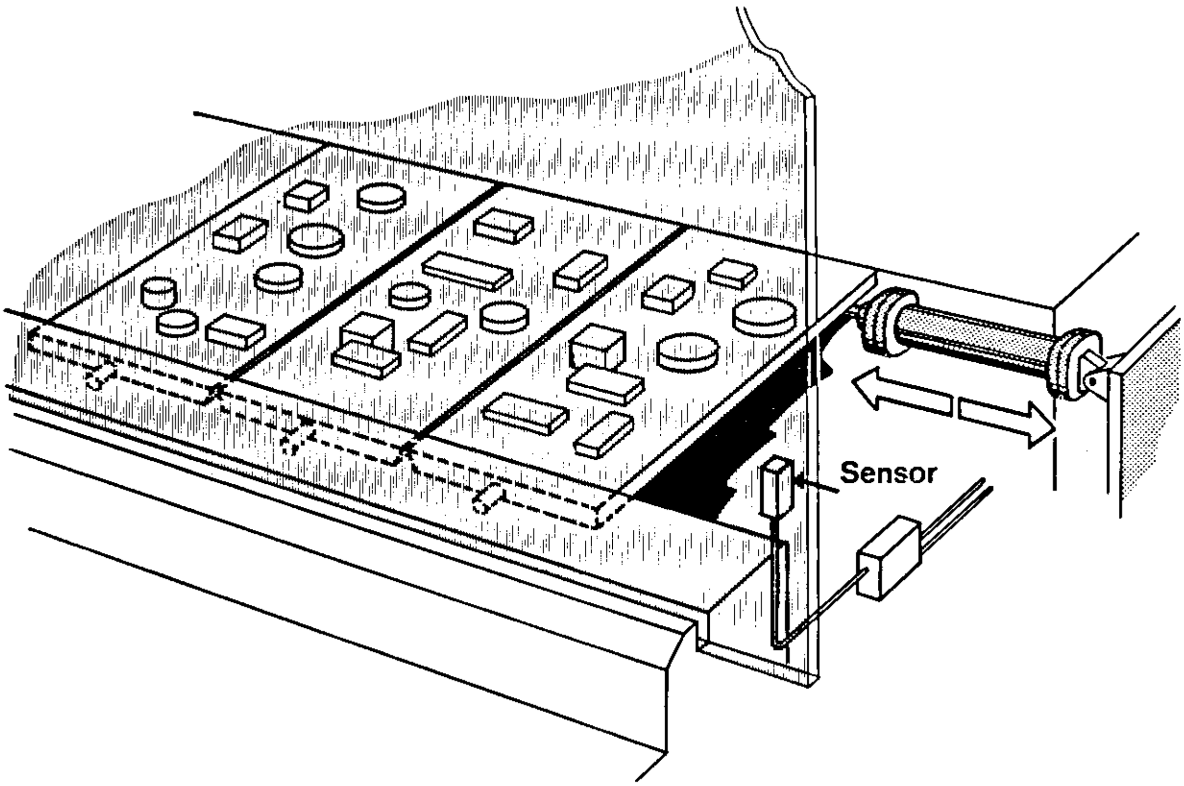


Fig. 3: A combined control unit, comprising sensor, converter and compressed air cylinder secures display windows and showcases against quick raids. (Works diagram: Bender & Jager/FESTO)

The cylinder extends the gripping system to the first workpiece. Actuation of the clamping function of the gripping system is controlled as a function of the stroke. After the workpiece has been gripped, the gripping system with the workpiece retracts, thus triggering the signal for transfer. The second cylinder swivels the gripping device with the workpiece towards the workholding fixture of the following machining station, in this example the workholding fixture on a plate. There, the first cylinder moves out and places the workpiece in the workholding fixture, the gripping device unclamps and thus releases the workpiece. The first cylinder switches to return, and the second cylinder brings the gripping device into the starting position again.

One complete working cycle of the transfer station has thus been executed. After the triggering signal has been received, all movements are executed in accordance with a certain sequence as a function of the stroke. As an additional safeguard, the control system can be so designed that the workholding plate is not released for further indexing until the starting position of the gripping system has been reached.

The individual movements take place in fractions of a second so that, depending on the size of the workpieces, up to 60 workpieces per minute can be transferred with this arrangement. The cylinder strokes needed for different workpieces and when changing the place of use can be limited either by pneumatic limit switches or by air sensors working on a non-contracting principle. The specific equipment needed depends on the individual case.

Putting Valuable Goods in a Safe Place. There is no such thing as absolute security. In spite of comprehensive and diverse security and alarm systems, again and again valuable items disappear from museums and exhibitions, from showcases and from display windows although "everything humanly possible" in the way of security had been done. In this connection, the surprise attack, which usually takes only a few seconds, is all too often disregarded. Display window and showcase exhibitors especially must take this phenomenon into consideration for bullet-proof glass alone or in connection with an alarm system, be it ever so good, presents no obstacle to reaching the valuable display objects in a split-second grab and thus making the expenditure worthwhile. Recent years in particular have provided us with the painful experience, caused in the last analysis by heavy losses, namely that by striking with a heavy hammer or ramming with a prepared vehicle, even the

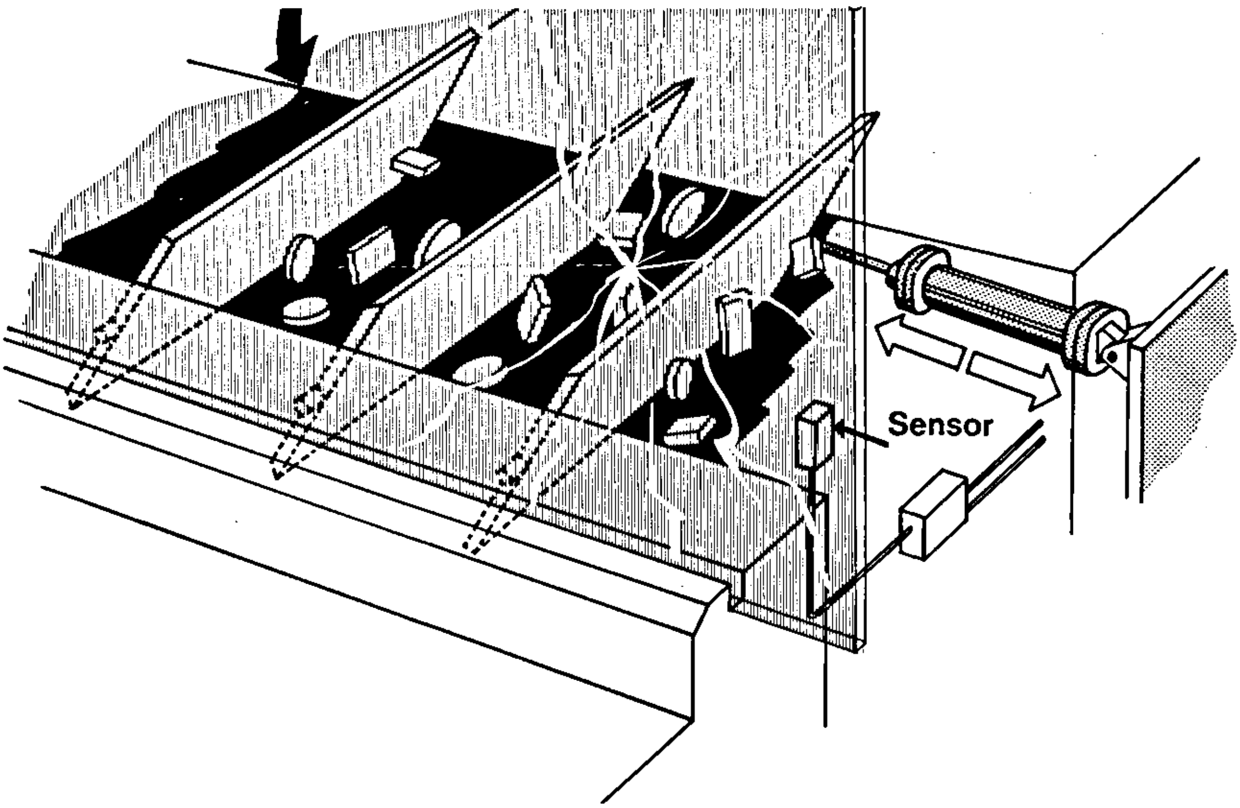


Fig. 4: Shattering glass activates the sensor, the compressed air cylinder is actuated via the control system and thus triggers the folding of the sector elements. In a fraction of a second, the valuable exhibits are tipped into a secure and closed container. (Works diagram: Bender & Jager/FESTO)

best security glass shatters and, within a few seconds, a display window or showcase is emptied, no matter how well the alarm system operates. When the security forces who have been alarmed have arrived, the fuss is over and the valuable items have disappeared.

In this context, a new security device gives a remedy which is fully operable even in the case of a split-second, unauthorized grab. The hitherto usual security devices can be fully retained and thus give additional protection.

The exhibited items and goods, especially, of course, in this connection valuable pieces of jewelry and similar items, are laid out as before in the display window or in a showcase. However, the floor no longer consists of a single part, but is subdivided into individual sectors.

These sector-sections are tiltable by 180°, with the result that the former surface is folded downwards in a swivel action (Figs. 3 and 4). In this connection, the exhibited items slip or fall from the exhibition level downwards into a closed steel container, or still further into a space lying below, e.g. cellar with steel locker. Since the sector panels are fully swivelled around in fractions of a second, the display window floor is immediately completely closed again and the goods are safe.

The technical requirements for a security device of this kind are relatively simple, but still far better, than any alarm system alone can be. A special sensor which responds only to the shattering glass, activates the control system in a fraction of a second; the control system is self-contained and can also be designed in such a way that no severable lines lead outside, or in the case of damage trigger off the security device. Via the control unit, one, or if necessary more compressed air cylinders are actuated by means of which the sector elements are folded round. In this connection, the compressed air makes possible the self-contained system in connection with a small compressed air cylinder which does not need to be any larger than a fist.

Now, before the security glass has been broken through, even if it only takes a fraction of a second, the booty, which was thought to be within reach, disappears before the thief's very eyes, and is thus safe against a quick grab.

However, this security system need not be viewed only in the context of break-ins. Other sensors, which can also be built-in and which affect the control unit, can react to smoke, fire, wetness, poisonous substances or other external influences and thus trigger off a security procedure, e.g. closing or opening of blinds, flaps, doors and the like.

PM

WHAT DOES THE USER LOOK FOR IN THE DESIGN OF A CASTING?

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SOCIETY OF MANUFACTURING ENGINEERS TECHNICAL PAPER

ABSTRACT

For decorative castings, the main quality a user wants is attractive appearance. Functional castings are rated on how well they fulfill the design parameters. Depending on the particular use of these castings, emphasis may be put on a combination of weight, cost, metallurgy, cleanliness, consistency and ease of machining. This paper gives a few thoughts for design engineers to include in their castings for easier machining and better value to the user.

Introduction

The user of a casting wants what every consumers wants – "the most of the best for the least." The definition of what is "best" varies depending on the use for which the casting is intended. For that reason, it is easier to classify two main categories for castings – decorative and functional.

Decorative Castings

Decorative castings include die castings, investment castings, plastic injection molded parts, etc. where appearance is a major factor. Examples would include brass door knockers, jewelry, automobile emblems, furniture trim, etc.

With decorative castings, the main thing the user desires is style and appearance, something to catch the buyer's eye to help sell the product. Things the design engineer should consider are shape, proportion, surface finish and color, etc.

Once a buyer is attracted to the product, he then considers other factors. Will this product adequately fulfill the function for which it was designed? Is the price reasonable for the utility expected from this product? After analyzing the consumer's acceptance of the product, the casting user must determine if he can machine, finish and assemble the final product at a profit.

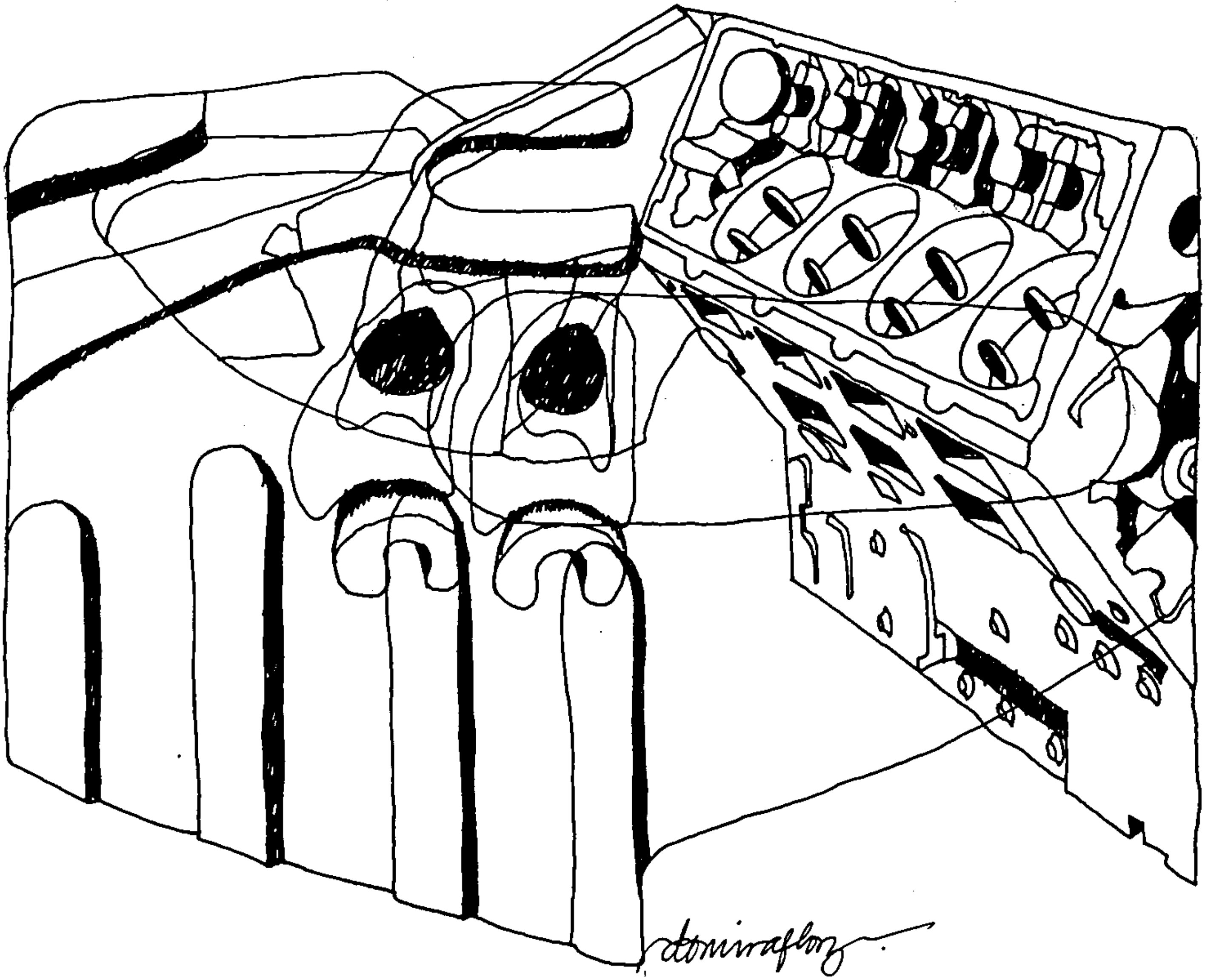
In summary, the user of a decorative casting looks for:

1. style and appearance
2. surface finish and texture
3. color
4. strength and durability
5. cost
6. ease of manufacture and assembly

Functional Castings

Functional castings include sand or shell mold castings, die castings, etc. where the casting generates or distributes power, is a structural part or serves some function other than decoration. Factors such as shape, integrity, strength, etc. become most important in the casting design. In the automobile industry, examples of functional castings would be cylinder blocks and heads, carburetor bodies, master brake cylinder bodies or transmission cases. Since these castings are hidden under the hood or car body, their appearance is no longer a prime consideration. Because they are usually complex in shape and critical to the operation of the system, other factors become more important in the design of functional castings.

A relatively new consideration in automotive applications is weight savings. To meet federal gasoline mileage requirements, all parts of the automobile are being redesigned to save weight. In castings this means switching to lighter materials such as aluminum from cast iron, using thinner walls with rib stiffeners, eliminating bosses and/or using hybrid castings with cast or pressed-in liners.



Since cost determines selling prices and profits, price is a major factor in choosing one vendor's casting over another. Many times it is unfortunate that the dollar signs are easier to determine than value.

The controller's office or purchasing personnel sometimes are not aware of the relative merits of premium prices for better designs and easier to machine castings. The "least" often carries more weight than the "best".

Metallurgically the user looks for consistency. Free carbides are hard and wear tools prematurely, ferrites are gummy to machine, and undissolved spherodizing or carbon reduction innoculants are abrasive to tooling. These elements should be minimized. A sulphur content above 0.05 aids in machineability of gray irons.

Due to recent energy shortages, easy to machine metallurgical structures are desired without the need for heat treatment. More work is needed in controlling the cooling rate of poured castings to achieve desired microstructures. The casting is already hot when poured, so why reheat it?

The cleanliness of a casting is important for more than aesthetic reasons. Too much scale can cause machine locating problems. If the jaws of a cutting machine grip scale rather than the basic casting metal, the cutting forces of the tools may tear the casting loose from the clamps. This ruins the tooling and sometimes the machine itself. Internally, all core sand has to be removed before machining and assembly. Core sand from a cylinder head or block can ruin a water pump. Therefore, a user looks at the casting for design of internal areas where core sand can not be trapped. Small cavities, narrow passages, sharp radii and acute angle bends should be avoided.

A casting can be designed to aid or hinder machining. Parting lines often have flash and hard spots which cause excessive tool wear. Designing parting lines in areas which do not get machined eliminates this problem. Thin wall sections cool faster leading to hard spots and tend to deflect under cutting forces. Thus, any area to be machined should be designed rigid enough to prevent deflections during machining and heavy enough to minimize chill.

For drilling and tapping operations, through holes are preferred to blind holes. However, partial through holes must be avoided to prevent drill breakage. Chip removal and broken cutting tools are less of a problem. Areas to be machined should be readily accessible from as few directions as possible. This allows a transfer line or multiple spindle machine to operate with less fixturing, fewer stations and fewer part re-orientations.

If possible, gating should not be attached to surfaces which require machining. When the gates are broken from the casting, a rough, unpredictable surface remains.

A heat sink is formed where a large riser or pouring basin is attached through a short gate to the part. When the mold is broken, this gated area is usually very hot and chills the most upon hitting the ambient air temperature and results in this being the hardest area of the casting. If possible, this area should be one that needs little or no machining.

Hardness consistency is very important between casting or within a given part. In many cases, cutting tools can be adopted to cut hard or soft material, but not both. There has to be a trade-off between hard enough to resist wear and soft enough to machine. A related machining consideration is consistency of microstructure.

Weight control is also important, for that often determines the amount of material to be removed. In parts such as crankshaft or connecting rods which operate dynamically, the weight distribution is critical. Consistent parts can be machined for easy balancing, but inconsistent parts often fall outside the capability of balancing equipment.

Of course, the main criteria a casting has to meet is whether it fulfills the design parameters. Strength requirements and size limitations will dictate malleable, ductile, gray iron or cast steel and the amount of nodularity desired. The casting design and material must be durable enough to last for the projected life of the product. For power transmitting components, adequate strength and rigidity are necessary. Provisions for balancing of dynamic components must be provided. Dimensional accuracy must allow for interchangeability and ease of assembly. Wear resistance and corrosion resistance must be considered where necessary. Some castings may have to be compatible to plating, coating or painting. These and other design related questions have to be satisfied to match the casting to the environment and purpose for which it is intended.

In summary, the user of a functional casting looks for:

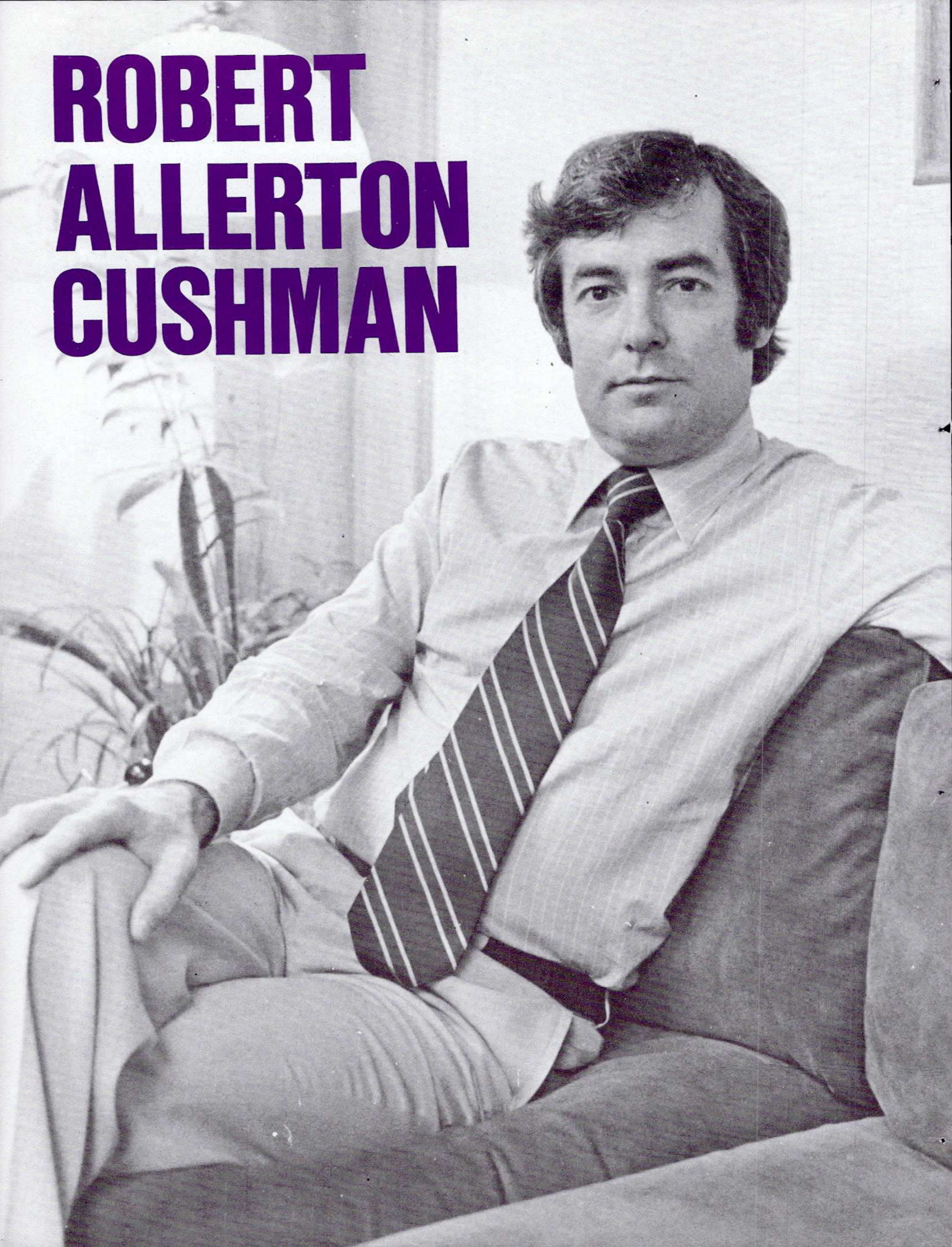
1. light weight
2. cost or value
3. metallurgy –
   a) low carbides and ferrites
   b) no undissolved innoculants
   c) over .05 sulfur in gray irons
4. cleanliness inside and out
5. ease of machining –
   a) parting lines and gates in non-machined areas
   b) parts thick enough to withstand machining forces
   c) through holes, not blind holes
   d) hardness
   e) accessible areas to be machined
   f) consistency
6. design parameters satisfied

CONCLUSION

Many trade-offs are necessary to arrive at an optimum casting design. The walls must be thick enough to withstand machining forces without deflecting and yet thin enough to keep the weight down. The casting must be hard enough to withstand wear, but soft enough to machine readily. Parting lines and gates may have to be located in areas requiring machining because the shape leaves no alternatives. Blind holes for drilling and narrow internal cavities may also be dictated by the design of the casting.

The relative importance of these tradeoffs and the other factors given in this paper will vary with the type and intended use for the particular casting. Purchasing people will weigh cost factors, designers will consider the strength and functional parameters, and manufacturing engineers will look at machineability. Therefore, what the user looks for in a casting depends on what "hat" he wears. In large corporations, these diverse interests need direct contact with each other and the casting supplier often becomes the middleman in deciding which trade-offs are most important. The points raised in this paper are intended to be a guide to the casting design engineer, so that he can supply a casting easier to manufacture and better in value to the user. **pm**

ROBERT ALLERTON CUSHMAN



men in the metals industry

He gets up at 6:00 on a typical weekday, eats breakfast, drops his two children at the International School, and goes straight to his office on the 14th floor of the Pacific Bank Building, along Ayala Avenue, Makati. His secretary as well as many of the staff are already there when he arrives, and shortly after seven his day's work begins.

He describes his job as "enjoyably hectic". His regular day is crammed with business appointments, meetings with managers, calls from associates, and regular trips to one of two operating plants. For lunch, he usually eats a sandwich in his office and continues into the afternoon with more appointments, economic reports, and other pending plans which tie him to his desk or confine him to the conference room until he calls it a day by seven. He goes home to his family at Dasmariñas tired but fulfilled. Not unusually, such a day's work can be followed by a business oriented dinner.

Nothing more extraordinary about this man except that he is Robert Allerton Cushman, Executive Vice-President and General Manager of one of the country's major producers of steel, Armco-Marsteel Alloy Corporation (AMAC). Tall, well-built, and handsome, this 39-year-old American born but "European-bred" figure manages a cooperative venture of three big companies, namely, Armco of the United States, Marsteel Consolidated, Inc. (MCI) and Philex Mining Corporation. Armco is the fourth largest steel manufacturer in the USA, and is managing over 30 steel manufacturing or fabricating plants all over the world. MCI, on the other hand, which is owned by the Martels, is a large industrial enterprise engaged in, among other things, steel manufacturing, oil exploration, real estate development, and construction. Philex Mining is the country's leading gold producer as well as an important copper mine.

Way back in 1973, Cushman, who was then Sales Manager of one of Armco's plants in Italy, was sent to the Philippines to look into the country's precise requirements for grinding media for the mining and cement industries. The motive for this trip was actually the outcrop of a suggestion by then Secretary Vicente Paterno to Jose Martel of MCI, to seek a joint venture with an internationally reputed manufacturing concern that could provide the exacting quality in grinding media required by the mining and cement companies and also provide a base for future development of special alloy steels. Armco was contracted and the Martel proposal was favorably welcomed.

It took Cushman several trips to different parts of the country to develop parameters used in building the largest integrated grinding media plant in South East Asia. When asked what determining factors made Armco decide to come to the Philippines, Cushman points to several reasons. The country's large mining industry for one, which is totally dependent on steel balls and rods to help liberate valuable minerals from the mined ore. "The Philippines has the 6th largest copper mine production capacity in the world," he states. In addition, Cushman points to the country's large population, trained technical personnel, and expanding economy, making Armco fit well into the local industrial stream. Thus after a series of negotiations, Armco-Marsteel Alloy Corporation was finally established. In 1976, the Armco-Marsteel grinding ball plant was inaugurated and Cushman has been at the helm ever since.

They say the only way to the top is through the bottom and in terms of hard work and far sighted dedication, Cushman is no exception. The man was born in Wenchester, Virginia, the youngest of four children. He recalls pleasant memories of his childhood on the family farm in Middleburg, from where his father, resuming a military career after World War II, commuted to nearby Washington D. C. He attended Kent School, in Connecticut, graduating in 1959.

Cushman entered the University of Denver in September of that year, taking a BSBA degree majoring in Management, interrupting his studies to undertake Military Police Training at the USAF Air Police School. While in college, he flew to Germany during the summers, to work as a purchasing trainee for Farbrewerke Hoechst, presently the largest chemical firm in the world. Here, Cushman lived in a "workers' home" specially provided for foreigners of various nationalities and supported himself on a measly salary of 100 DM a month, a feat in econimizing which he describes as "unpleasant".

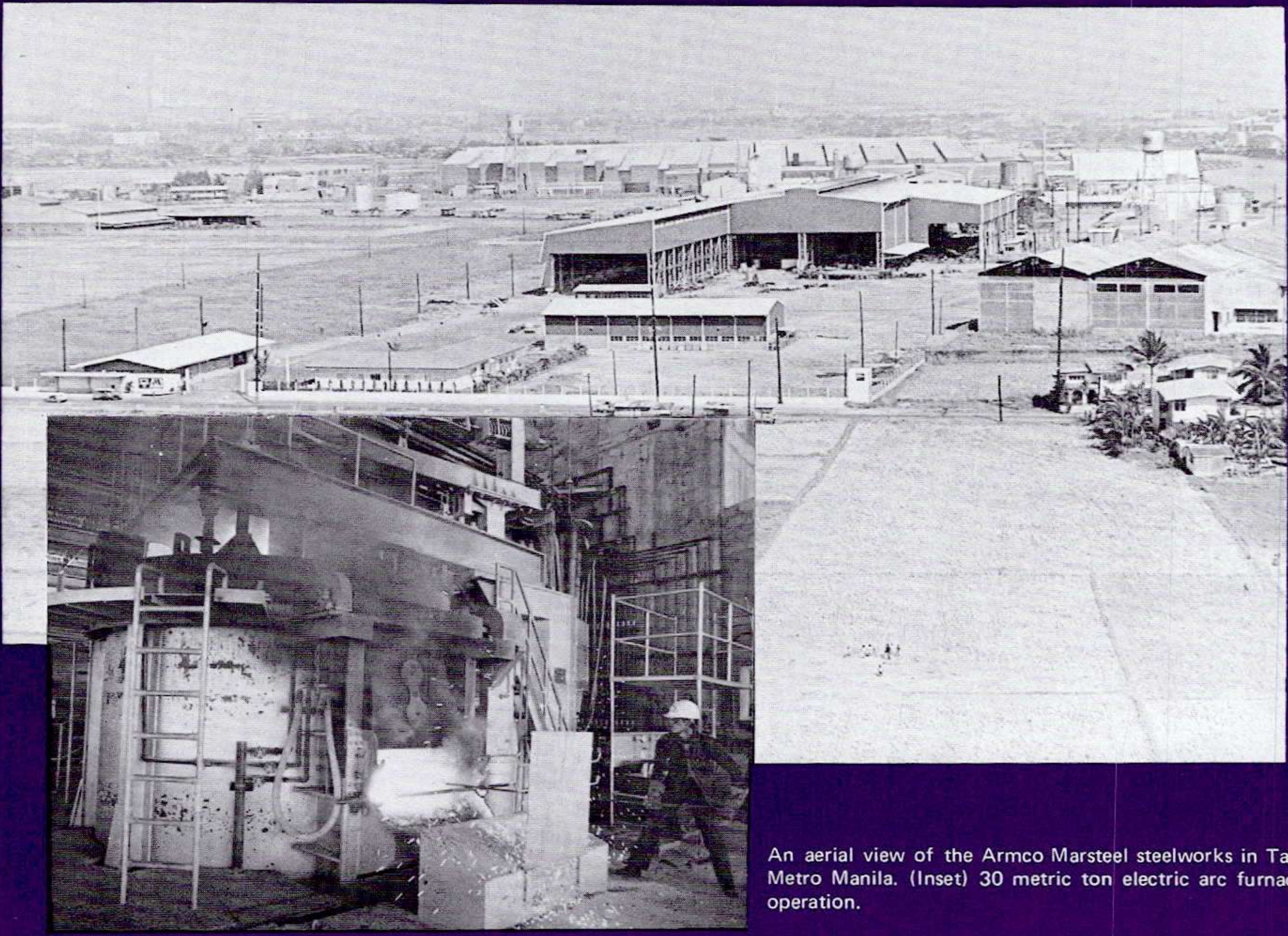
The college degree he attained did not satisfy Cushman's desire for academic preparation in the area of international business and management. He enrolled at the American Institute for Foreign Trade (AIFT) in 1965, a graduate school specializing in international business. At the time of his graduation, Armco was staging a recruitment program for its international staff from AIFT. Not surprisingly, he was taken in, and in July 1965, he started as a trainee of Armco's International Division. For two years, he was exposed to blast furnaces, melting operations and all areas of the steel business at Armco's main plant and head office in Middletown, Ohio.

In 1967, Cushman was transfered to Italy, where he worked for the next nine years, first handling national and international sales of various Armco products in Italy, Greece, Turkey and Libya from Armco's country office in Genoa. Four years later, he became Sales Manager of Armco Moly-Cop, one of Armco's manufacturing plants situated in Cividale del Friuli and moved his family to the nearby town of Udine, Italy. In 1975, he was promoted to the position of Assistant General Manager of the same firm. This was the peak of his "rise" in Italy, for in the following year he was assigned to the Philippines as Armco's Country Manager.

Cushman attributes his success in his career to hard work. "It is having the ability," he adds, "to deal with different types of people and yet bringing them together towards a common objective."

Referring particularly to the impressive growth of AMAC, Cushman points to the distinctive characteristics he has observed from the Filipino, which he believes, have considerably helped pull the company together with the back-up of Armco's technological know-how, to one of the top 100 corporations in the country today.

"It is especially in the Philippines where I get the pleasure of seeing people enjoy working together as a team," he explains. "In many parts of the world, people have the tendency to want to work on their own."



An aerial view of the Armco Marsteel steelworks in Taguig, Metro Manila. (Inset) 30 metric ton electric arc furnace in operation.

Cushman describes the time when their Taguig Steel plant at Barrio Napindan looked practically like it was in the middle of Laguna de Bay because of a flood brought about by a typhoon. This did not in any way stop their staff from going to work, even if they had to ride a banca all the way. "Our workers and employees worked in 12-hour shifts, and in only 18 days the steel mill was back in operation," Cushman narrates with admiration and awe.

"I think managers in this country can develop rapidly," Cushman continues, "as they have the capability of fully carrying out the responsibility of top management." In describing AMAC's staff, he emphasizes that the company is run by Filipinos in almost every major department. Of the 14 managers in the country, only two are foreigners.

At present, AMAC is a major supplier of 17 cement companies and 18 mining corporations in the country. Although they have a number of competitors, Cushman states that the demands of the clients have necessitated the production of the highest quality forged products available in the industry and is equal to similar products produced in the USA.

He laments, however, on some serious problems which have beset the company in the past three years.

"The major problem we face is the availability and cost of power and fuel. Here, power costs five times as much as some places in the US and is much higher than Japan and Australia. This causes a serious impact on the final cost of our product.

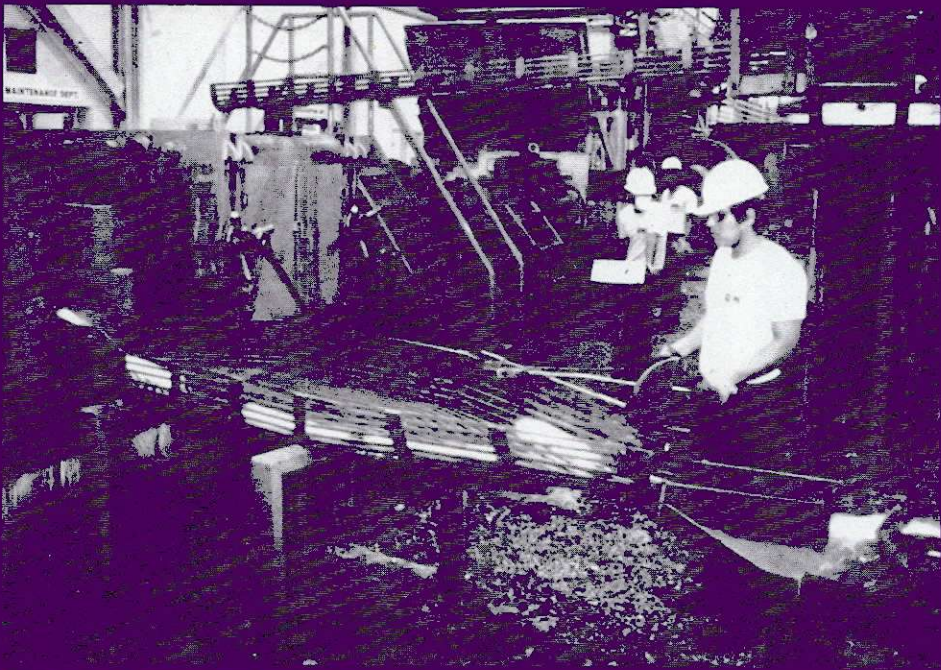
Our second problem is the non-availability of certain raw materials and the consequent dependence upon high priced importation. Lastly, the outflow of technically trained people to other countries has increased considerably. It is particularly disconcerting to note that many workers when fully trained leave the industry and take jobs in foreign countries in fields completely different to their past training."

Despite these shortcomings, Cushman has maintained a positive attitude towards his work and AMAC. Now running a progressive labor-intensive firm of about 450 workers, 40 employees and 14 managers, Cushman places utmost value on the relationship between management and labor.

"We try to develop a harmonious relationship between our workers and the management' Cushman says. "We feel it is necessary to sit down with all concerned on a regular basis to maintain an open dialogue with them. Everybody is demonstrative about his feelings and this has helped everything to run relatively smoothly."

When asked how he describes himself as the head of such a big manufacturing concern which now produces 50,000 tons of special alloy steel annually (it started with 5,000 tons during its first year of operation), Cushman laughs and says, "I don't know . . . you have to ask my staff about that. Basically however, I'm a person who enjoys working. I'm not a negative thinker. I always like to think of the positive aspects of a problem"

An Aquarian, Cushman has that basic inclination to create a harmonious environment for the people around him. He refrains



Grinding ball forming machines in operation located at Armco Marsteel's ball plant in Novaliches.

from making a big fuss out of unpleasant things. He would rather think ahead.

Thinking ahead incidentally, AMAC has a number of projects in store for its future plans. One is the putting up of a new product division which will manufacture corrugated steel pipes for water drainage.

"This would specifically be used by the Bureau of Public Highways as well as the National Irrigation Authority", Cushman explains. "By 1980, it will be in operation, starting at 1,000 tons annually within the first three years."

"We are also looking into the possibility of expanding our special alloy steels into a variety of markets. This has been approved by the BOI and we are now making in-depth analysis of the needs of the country."

At present, AMAC is exporting 20 percent of its products (steel balls and rods) to other countries in Asia, particularly Indonesia and Borneo. This speaks well for AMAC and the Philippines as the acceptance of the locally made grinding balls in the Asian market signifies that the country can indeed produce a product "as good or better than those available from other parts of the world."

The untiring effort which Cushman puts in his job has not made him forget other more important things in life. An active member of the Holy Trinity Church, he tries to spend as much time with his family, whom he places #1 in his list of priorities, during the weekends. His wife Claudia whom he had met in college is, incidentally, an interior designer.

With his encouragement and support, his wife organized the CiCi Consultant Company, an interior designing firm, which has been quite a successful enterprise.

There are a number of other things about Cushman that make him a character all his own. A non-smoker, he is quite conservative in his manners and in his thinking, yet an enthusiastic explorer of his environment wherever he may be. "During my adult years, I have lived outside of America longer than in it," he reasons, and because of this, his interests and approach to life has become uniquely international.

He and his family have found their adjustment to life in the Philippines pleasant and rewarding. Either through his job, or for the pleasure of exploring the beaches and country side, Cushman proudly quips that he has visited and seen much more of the Philippines than the average Filipino.

The man has also adapted himself suitably well to the Filipino environment and even likes, for one, its native delicacies such as "sinigang na bangus' and "lumpia."

For sports, Cushman plays pelota, tennis and occasionally, golf. However, scuba diving, his most beloved hobby and interest at present, is reserved for weekends. Whenever possible the entire family, Claudia, Kathleen, 11, and Richard, 10, head out of Manila Bay on their family boat for a weekend along the coasts of Batangas, Lumbang and Mindoro. Scuba diving has brought forth a love for shells of which he has an array of collections in his office, all found and cleaned by himself. He enthusiastically shows us a big beautiful shell which he says he got from Fuga Island.

"My next diving project is a Spanish Galleon," Cushman relates. "If I could only find one nice Spanish galeon. . . ."

Probably he will, one day, as long as Cushman stays the same positive thinker that he is, works as hard as he does and remains as devoted to his family and as enthusiastic about life and his interests, who knows what he shall find next, be it in the depths of the Philippine seas, or the horizons of his future. PM

GM

PILIPINAS

I. Introduction: PROFILE OF GMP

General Motors Philippines, Inc. (GMPI) came into existence in the Philippines on December 15, 1972 upon its incorporation under the laws of the Republic of the Philippines. It was established primarily, among others, for the purpose of assembling, and fabricating vehicles for local transport needs, and manufacturing transmission assemblies for both domestic consumption and export.

GMPI, at its inception, was a joint venture company with General Motors Corporation, Yutivo Corporation and Francisco Motor Corporation as partners with a 60%, 30% and 10% equity participation respectively.

With GMC's cash subscription of 60% of the authorized capital stock of GMPI, GMC formalized its entry into the automotive scene in the Philippines under the banner of the Progressive Car Manufacturing Program (PCMP).

The PCMP was the result of the government's desire to rationalize the Philippine automotive industry. Until that time, the industry was composed of no less than 15 assemblers fiercely fighting for a market that could barely support a few of them. The government then aimed at a restructuring of the automotive industry, which will allow it to progress from mere assembly to actual manufacturing and at the same time, generate foreign exchange savings for the country.

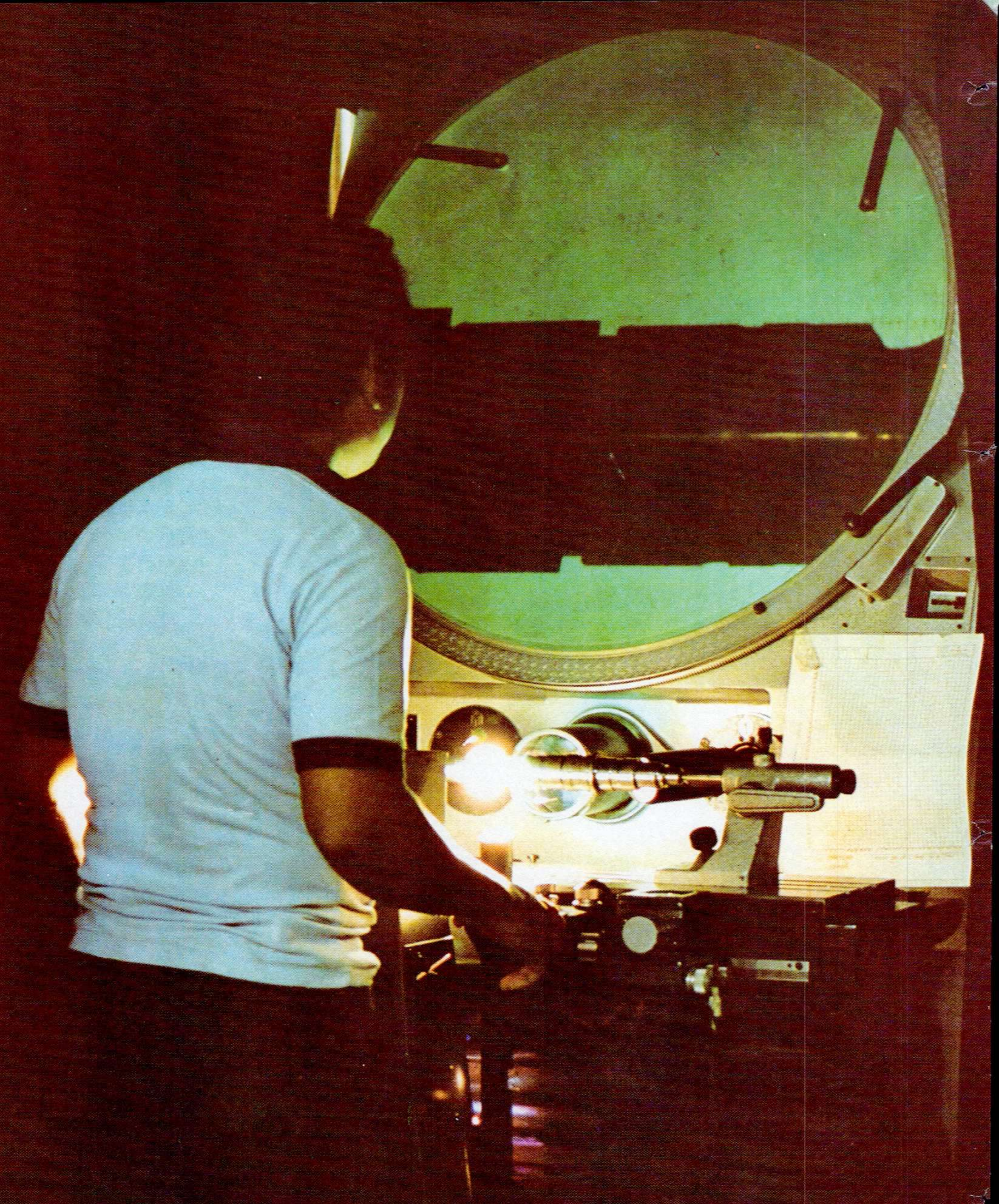
With the PCMP proposal having been approved by the BOI, the GMC-YUTIVO-FRANCISCO group formalized its joint venture, with an authorized capital stock of ₱16M. Of this capital stock, GMC subscribed and fully paid 60% or ₱9.6 million in cash. Towards the end of 1976, however, GMPI became a GMC wholly owned company when Yutivo Corp. and Francisco Motors, upon their own independent judgment, sold their equity to GMC.

While GM vehicles had been plying Philippine roads since the 1950's, the succeeding years saw General Motor's greater involvement in the Philippines.

For General Motors, the launching of the PCMP ushered in fresh hopes and far-reaching economic effects on the Philippine automotive industry and for the Filipino nation as the program is geared towards the inflow of technology, creation of employment opportunities, dispersal of manufacturing activities both in medium and small industry and foreign exchange savings.

The story of General Motors Philippines since that time is one of how it has tried to live up to its commitment to the PCMP. GMP personnel expanded from a mere handful of less than 200 employees to about 1,500 as of 1978 for which a total amount of ₱15.6M was was paid by GMP as salaries and benefits in that year. Survey results indicate that GMP's compensation package is one of the most competitive in the industry. Its investments into the country now amount to ₱397 million. Its suppliers, formerly numbering 20, now stand at over 100, each one receiving not only economic benefits but also technical assistance to enable them to produce high quality automotive spare parts. Foreign exchange savings generated by its export activities reached a total of $2.4 million in 1978 alone. Taxes and duties paid to the government in the same year runs to ₱113.1M.

Its distribution network has also expanded over the years to include 21 authorized and/or franchised dealerships all over the country, making General Motors products more readily available and serviceable to consumers.



Comparator at quality control laboratory. One of several precision measuring equipment.

BIRTH OF GM PILIPINAS

On August 18, 1979, another important development marked the history of General Motors in the Philippines when GM Overseas Distribution Corporation signed an agreement with Isuzu Motors Limited of Japan to form a joint venture in the Philippines to produce and sell motor vehicles, transmissions, and other automotive parts.

The joint venture acquired the assets of both GMPI and GMPMC, the transmission manufacturing facility. The new company formed is now called General Motors Pilipinas, Inc. with 60% owned by GMODC and 40% by Isuzu Motors Limited.

Isuzu Motors Limited is a Japanese company which manufactures passenger cars and commercial vehicles as well as engines for marine and industrial applications. General Motors holds a 34.2% equity interest in Isuzu.

The following will give an insight into the actual operations and activities of GM Pilipinas.

LOCAL CONTENT PROGRAM (PCMP AND PTMP)

Barely a year of development and production and already, Isuzu KC 20, GM's entry into the Asian Utility Vehicle (AUV) category has achieved a local content of 86.33% – way above the 35% minimum set by PCMP. Such is the magnitude with which General Motors Philippines, Inc. (GMPI) has carried out its thrust in its Local Content Program.

The only imported major parts of the KC 20 are the 1600 cc gasoline engine, steering wheel assembly, and the rear axle. The body, chassis, transmission assembly, fuel and exhaust systems, electrical and glass components, seats, tires and batteries are all locally manufactured.

Not only is the economy benefitting from the Local Content Program but also the approximately 75 Filipino suppliers and vendors – the growth and development of which GM has helped nurture and accelerate. Indirectly, some 9,000 breadwinners share in the bounty the program has injected into the lifestream of the various industries.

Perhaps the most significant contribution of GM's Local Content Program are the intangible benefits derived from it. It has generated new job opportunities not only in the assembly plant but also in varied industries like iron and steel, glass, rubber, fabrics, paints, plastics, fiberglass, tires, batteries and upholstery. It also created and stimulated manufacturing activities in local small and medium scale enterprises – the lifeblood of the Philippine economy. On the technological aspects, it has upgraded local engineering and production skills and provided technological know-how in a transfer of technology program.

The program also provides new skills and upgrades the technology of tool and die design and fabrication, metal casting, metal surface preparation and finishing, sheet metal forming, closed die impression forging, precision machinery, safety glasses and plastic, rubber and fiberglass moulding.

It is worthwhile to note that the local Content Program was carried out without sacrificing the quality and efficiency of the vehicle, truly a proof of the confidence GM has on local skills and technology.

For the past 3 years total sales for Commercial and Truck models has increased tremendously that statistics showed one Commercial or Truck vehicle has been sold for almost every one passenger car. Increased Commercial and Truck sales are largely the result of the government program for a lower priced, easy to reach, Medium Transport Vehicle and its previous move to ban the importation of used trucks under the 40,000 pound limit. Also, one significant change in the truck market is the pronounced shift from gasoline to diesel engine since year 1977. This was brought about by the government dieselization program and the ever increasing price difference between gasoline fuel and diesel fuel.

CKD unboxing

To keep pace with the growing market and to provide the customers with their particular needs, GMP totally updated its Commercial and Truck program by offering to the market an all Isuzu line-up. Since the influx of used trucks in the local market, the name Isuzu had been synonymous with the word truck, and the demand for Isuzu Vehicles has been rising not only in the Philippines, but all over the world.

GMP's present Commercial and Truck line-up provide sufficient coverage of the market in terms of GVW and application needs. In the burgeoning AUV market, the Isuzu MRV is GMP's answer to the needs of the lesser budgeted buyers who also prefer more loading capacity, high performance, economical and durable vehicles. In addition to a choice of short or long wheelbases and a diesel or gasoline engine, the new KB Four – Wheel Drive fits perfectly into today's rapidly diversifying pickup market.

Feeding of parts to the assembly line.

PROFILE OF VEHICLE ASSEMBLY OPERATIONS

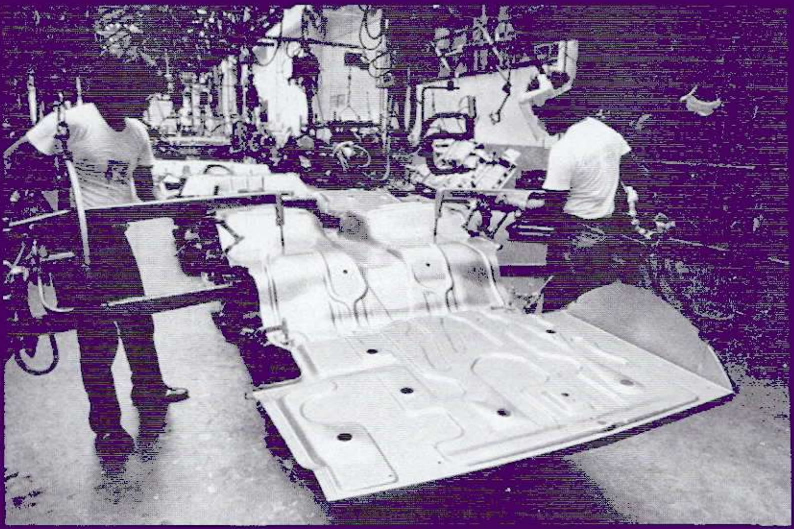
The General Motors Pilipinas factory at Paco, where the assembly of Philippine produced GM or Isuzu vehcles are undertaken, covers an area of approximately 3.6 hectares. The factory which has a maximum capacity of four per hour, is divided into three plants. Plant 1 is where the car and light commercial bodies are assembled, painted and joined to the power train. Plant 2 is where the Isuzu A.U.V. and truck bodies are assembled and metal finished. Plant 3 houses the truck assembly line and the new vehicle conditioning line.

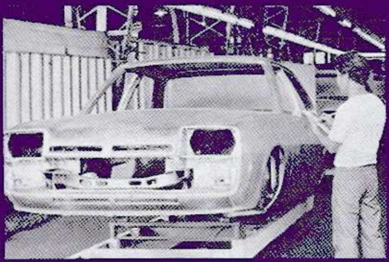
ASSEMBLY

The assembly starts with unpacking of the C. K. D. components ex-source. These are unboxed, checked, stacked, and together with the locally manufactured components are fed to the assembly line.

Once the body sheet metals are ready, the Body Shop begins the sub-assemblies of body panels. These take place in precision jigs and fixtures that hold the parts in their correct positions prior to welding. Next, high impulse electric charges fuse the butting joints of the metals and by the time the body panels are assembled into the body shell, thousands of these welds will have been used.

From the Body Shop, the car shell is transferred to Plant 2 for processing at the Metal Finish line. Here, spot welds are supplemented with brazes and mig welds for maximum structural stability, and after which doors, hoods and trunk



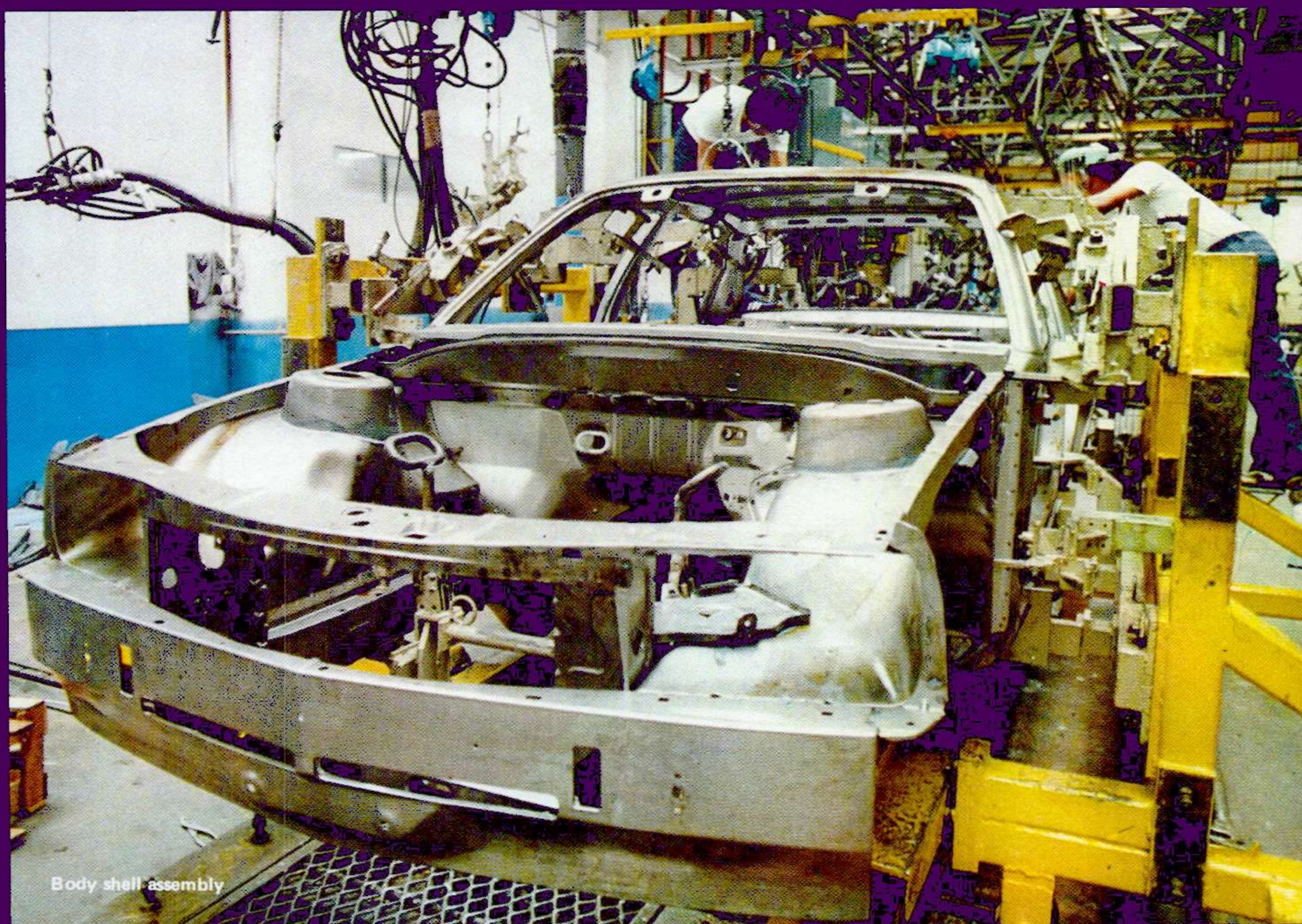


(top) Underbody assembly. (bottom left) B.I.W. obtaining "O.K." sticker from quality control. (bottom right) Unit being top coated with acrylic paint.

(top) Unit undergoes phosphating. (bottom) Paint inspection at "highlighting" booth.

lids are fitted on. Then, throughout all its stages of transformation, the unit will obtain the OK sticker of "buy-off" from Quality Control before proceeding to its next stage.

Back to Plant 1, the units go to Basic Paint where they pass no less than twenty-five stations: the different stages of degreasing, phosphating, sealing, undercoating, deadener application, sanding, top coating, etc. The unit is then sprayed with three coats of enamel and baked in a heat furnace. The next step is rustproofing of the unit inside out with antirust proofing compound. To ensure that only high quality finished vehicles pass through the Paint Shop, these are thoroughly inspected at the "highlighting" booth.



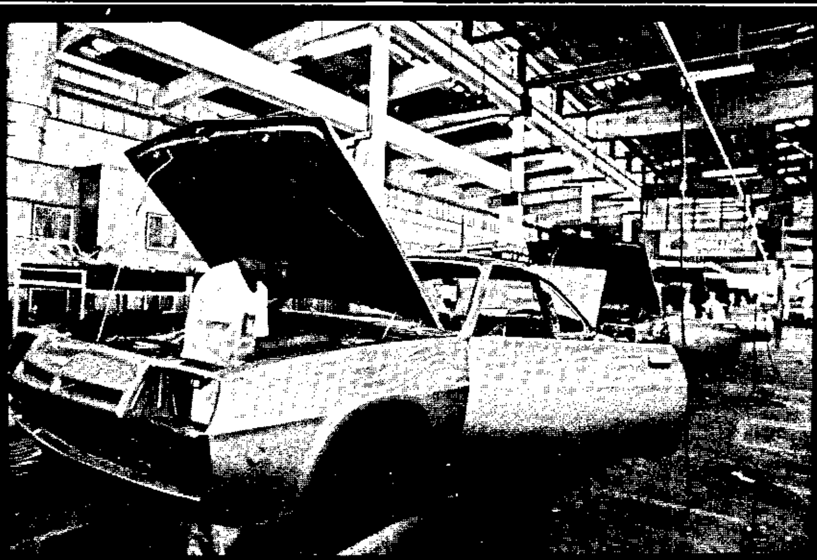
Body shell assembly

The painted body is then moved to the Trim Line. Here, "hardwares" such as window glasses, glass mechanisms, door locks, instrumentations, tail lamps and associated wirings, etc. are installed. Likewise, "soft trims" such as headlining, vinyl roofs, seats, carpets, etc.

Alongside the Trim Line, while trims are being installed, the power train is simultaneously assembled, i.e., the engine and transmission assembly is mounted to the front suspension and connected to the rear axle on wheels. Once prepared, the power train is now ready for the body drop. At this stage, the body on its own wheels is moved to the Final Completion line for the installation of door trims, body mouldings, bumpers, brakes, batteries, etc.

The unit reaches the end of the Final Line and is ready to run on its own power plant. The vehicle is then driven to Plant 3 where it goes through the Final Inspection and Conditioning line. Here, before the unit is roadtested, the vehicle undergoes engine tune-up, mechanical and electrical check, wheel alignment, water test and final paint inspection.

(top) Wheel alignment at new vehicle conditioning line.
(bottom) Final assembly line.



Trim line.

QUALITY CONTROL & RELIABILITY: VEHICLE ASSEMBLY

Essential to GMP's vehicle assembly operations is the responsibility of making sure that all products produced at the plant meet the Corporation's standards of quality, durability and performance. Quality ranks high in General Motor's list of priorities and this is reflected in its imposition of rigorous quality standards in all of its subsidiaries.

In May 1978, General Motors Overseas Operations launched a worldwide Quality Challenge Program to (a) increase GMOD's worldwide quality performance; (b) raise the overall level of quality awareness; and (c) formally recognize the attainment of assigned quality performance goals.

Specific Model Year Quality Objectives are assigned for each GM plant to meet. Performances are recognized by giving awards to plants which have attained their respective quality goals for the first time and a very prestigious plant award for attaining the quality goal three consecutive times. GM Pilipinas, Inc. has already received two awards, an in-plant banner and Production and Quality Control Managers' awards for its first attainment of the plant's quality goals. GMP has every intention to maintain this record.

There are 22 overseas plants participating in this Quality Challenge Program. Included are all GM plants in Europe, South America, and Asia. GM Philippines has been consistently among the top five in quality among these 22 participating plants. This is no mean achievement, considering that GMP competes with plants in highly industrialized countries with far more sophisticated facilities.

Receiving Inspection

Locally purchased components are inspected at the local component Inspection Station upon delivery by the suppliers. This inspection station makes sure that all parts stored in the parts warehouse are fit for use in the assembly line.

Gear cutting operations.

Final assembly test.

Vehicle Line Inspection

Parts for vehicle assembly are received as completely knocked-down components. Sheet metal parts are welded together to form the body shell; trims and hardware items are installed after the body has undergone metal finishing and painting processes; chassis parts are assembled together and the bodies are dropped by hoists onto it, followed by functional tests like engine tune-ups, brakes, electricals, etc.

All these activities involve thousands of different components which are either appearance, functional or safety related items.

The Quality Acceptance standards on the assembly of these parts are based on current engineering specifications.

Line inspectors control vehicle assembly line and are assigned to different work stations. They make sure that the vehicles are quality tested by stages and that jobs are done properly in their respective stations. Why inspection by stages and not simply have one final inspection? This is because GMP believes that quality cannot be "inspected" into a product. What must be done is to build quality into each one.

Quality awareness at GMP is not restricted only at the plant level. Suppliers are also part and parcel of the company's quality control program. To stimulate quality consciousness among suppliers, GMP sends them a monthly quality index rating based on the standards followed by General Motors Corporation all over the world. Suppliers are qualified into Class A (best suppliers); Class B (average suppliers); and Class C (poor quality suppliers). This approach encourages suppliers to exert effort in order to meet quality standards in their components. Receiving a Class C rating for an extended period of time would naturally indicate that their business with GMP may lose ground. Moreover, technical people from the Quality Control staff regularly visit suppliers' plants and factories to assist them in whatever problems they may encounter in maintaining quality.

On the international level, General Motors Corporation has established a basic method of control and at the same time, evaluates the plants' internal quality control and outgoing vehicle quality. This is the GM Uniform Audit Procedure. This procedure is a tool which has aided in establishing a basic corporation acceptance level and has resulted in the rating of all assembly plants all over the world.

This audit is performed daily in a plant by a Quality Auditor who spots and monitors potential as well as actual problem areas that could affect vehicle quality. Standard demerits are presently enforced for the Quality Auditor to follow. These demerits are based on the severeness of the discrepancies which are likely to happen in a vehicle. The daily average results of the audit, in terms of discrepancies and demerits are converted for use as a management quality index measurement. The numerical values which are similar to an efficiency rating are vital data and are reported to General Motors Overseas Management.

Monitoring auditors from the overseas control office group periodically make an inplant evaluation of vehicles and determine the official plant quality rating.

TRANSMISSION MANUFACTURING

Transmission manufacturing operations and facilities of GMP are housed in a plant in Almanza, Las Pinas. This plant, which cost ₱17.4 million to build, has the distinction of being one of the most modern, up-to-date automotive plants both on a national and international scale.

The main building is actually composed of two buildings: the two storey administration building and the manufacturing area. The entire facility is equipped with sophisticated safety and fire prevention systems. The manufacturing area, which occupies close to 11,000 sq. meters, contains facilities for machining, assembly and heat treatment.

The transmission plant is capable of producing 72,000 transmission assemblies annually when running in full capacity. GMP transmissions are exported to Australia, Germany, and Korea. A total of 20,805 transmissions were exported last year worth almost $4 million, thereby contributing to the country's foreign exchange position.

START OF LOCAL MANUFACTURING

In-plant machining of transmission components started in October 1974. Using imported castings from GM-Brazil, Cast Iron Department commenced production of clutch housings. A few months later, machining of the extensions & transmission cases was started.

The first gear was cut in mid 1975 and 12 months after, all the 11 gears in the transmission assembly have been phased in the production line. Other components such as shafts & shifter parts were manufactured locally by the end of the 1st quarter of 1977. All told, 26 major components of the transmission are manufactured in Almanza transmission plant.

PROCESS FLOW

Raw materials in transmission manufacturing consist of castings, forgings and bar stocks that are supplied by both national and international markets.

All raw materials as received are stored in the Receiving Inspection area. Dimensional & Metallurgical tests are made prior to release to productive stores.

The process flow of transmission parts manufacturing generally starts with blanking operations. Blanking is performed on special purpose, high precision automatic lathes for all gears, shafts and shifter parts, while cast parts are blanked in milling machines. This initial operation establishes precisely the reference point for subsequent machining operations and is therefore very critical in tolerances. The parts then go through a series of cutting processes which consist of drilling, boring, hobbing, broaching and shaving among others. With the exception of castings and synchronizers, all the semi-finished parts are heat treated in gas atmosphere type of furnaces. In this process, the parts are heated to a temperature as high as 900°C in an atmosphere of carbon monoxide, hydrogen and nitrogen for several hours to harden its surface. The case-hardened gears are then shot peened for further increased strength and to remove internal stress. Case-hardened shafts are straightened. All these parts go to final grinding operations. Final inspection is done 100% on all parts prior to assembly. At the end of the assembly line is a special equipment to test noise and shift quality of each assembled unit.

The whole process of transmission manufacturing can best be described by one word – precision. Experts in the auto industry believe that transmission manufacturing is much more difficult than engine manufacturing.

EXPORT SALES (In Transmission Units)

YEAR	AUSTRALIA	GERMANY	KOREA	TOTAL
1974	1500	–	–	1500
1975	6200	–	–	6200
1976	5600	35	200	5835
1977	10700	156	–	10856
1978	18500	2100	205	20805
1979 (1st semester)	5900	5600	140	11640

*EXPORT SALES (US $)

1978 – $ 3,984,400.00
1979 (1st semester) – $ 3,009,800.00

* Including parts sales

LOCAL CONTENT

As mentioned elsewhere, 26 major components of the transmission assembly are produced locally. Other parts such as bearings, fastening rings, gaskets, bolts, washers, springs and pins are imported from abroad.

Based on the average of 4 models presently being produced, local components represent 65% of cost of transmission.

RECEIVING INSPECTION

The quality of a product includes not only dimensional conformity but also material conformity to specification. It is essential that materials are in accordance with engineering requirements for their use in production. The over-all quality of a product is intrinsically related with the quality of material used. Receiving Inspection assures that all purchased material conforms to specification, and that unapproved materials are not used in production. Receiving Inspection is provided with a written inspection plan and instruction for each part received, giving consideration to part criticality, significant dimensions and characteristics, sampling plans, standards for rejection, source performance and part performance in service. Necessary tests are conducted to certify to the quality of material. Quality Control is ably supported by the Metallurgical Laboratory in analyzing and testing materials. In addition, Receiving Inspection establishes procedures to provide all involved departments with the information they require concerning the quality status of purchased materials. The procedure assures good communications with Material Production Control, Purchasing, Production and Product Engineering to accomplish: (1 prevention of use of unapproved material in production; 2) speedy disposition of rejected material, by reworking in the plant or returning to the vendor; 3) fast feedback and corrective action for discrepancies found; 4) maintenance of an adequate supply of approved material for production.

TRANSMISSION TESTS

In the Almanza Transmission plant, each transmission assembly is put into the Shift and Sound Testing machine for final inspection. The Shift and Sound Testing Machine (SSTM) simulates the cars' various load and speed condition. The transmission under test is then evaluated for noise, shift quality and other characteristics. For assurance, several transmissions, are randomly picked daily from among the tested and accepted units that passed the SSTM. They are installed into a test car for noise and shift effort evaluation.

INSPECTION FUNCTION

In the manufacturing floor, transmission component parts are constantly monitored for conformity to manufacturing requirements and engineering specifications. Three types of inspection are availed of to cover this responsibility. In-Process/Final Inspection Section is responsible for checking parts before they go to the next process line. Inspectors assigned in this area inspect machined parts before they are heat treated, or finished parts before they are assembled. In short, there are various check points where parts are either accepted or rejected before they are moved to the next operation. Patrol Inspection performs inspection of parts not on a routinary schedule but based on statistical probability and trend. Hence, Patrol Inspectors utilize Histograms, Control Charts, Distribution Charts, and other statistical tools. They determine whether a process operation is under control or not. They pinpoint areas were quality or manufacturing problems are likely to occur. Their importance to the Quality Control function is underscored in preventing scraps at the production source before it builds up.

AUDIT INSPECTION

Audit Inspection is the thermometer of Quality Control. Its function is to measure the quality level of finished parts and finished assembly units on the degree of conformity of the parts to the engineering specification expressed as Quality Index. The Audit Inspector randomly checks transmission components at the assembly area. All parts in this area are considered accepted, thus, they reflect the efficiency and effectiveness of inspection as a whole. Audit Inspectors are also required to select parts and sub-assemblies in a manner most likely to reflect the complete range of machine, operators, sequence, shift, and process variation as established in the Audit Master List. Components checked are then given demerit points depending on the degree of variance from specification and on the degree of severity they might cause like part failure, high warranty cost, decreased part service life or inconvenience to customer. In addition, the Audit Inspector includes other characteristics observed to have obvious deficiencies such as missing parts in sub-assemblies, loose attachments, handling damages, mis-identified part, etc.

SOURCE/VENDOR SURVEILLANCE

Closely allied to Receiving Inspection is Vendor or Source Surveillance, which simply is a continuing program to evaluate the capabilities of local sources to comply with contractual requirements for production material. Vendor Survelllance involves: 1) pre-award surveys of suppliers' capability of continued compliance to specification; 2) Vendor Inspection to secure first hand information of vendor's material, manufacturing process, machine and inspection facility; 3) Vendor coordination for evaluation and correction of quality problems should they occur, and quality improvements needed to upgrade the suppliers' product. Potential sources are surveyed prior to the release of purchase orders to determine whether they have the capability to meet General Motors' requirements. A potential source survey is conducted under the following conditions: 1) If a new source is being considered that is not currently under contract to GM; 2) If the complexity of the product to be procured is such that verification of the source's capability is necessary regardless of existing surveillance; 3) If the product to be purchased differs completely from the product on which a previous survey was made; 4) If a former source, not currently supplying parts, is being reconsidered.

The survey is conducted at the source's facility by a member of Quality Control in conjunction with Purchasing, Production and

Engineering as required. Scheduled surveillance of vendors under contract is determined by: 1) Part criticality; 2) Survey results of source not yet in full compliance; 3) Purchased quality standards; 4) Degree of receiving inspection; and 5) other controls in effect such as production process.

If any deficiency is noted during the survey, a written commitment is obtained from the source that contain the anticipated date of correction. To assure that planned corrective action has been implemented, a re-survey is made based on the anticipated corrective action date established during last survey. When it becomes necessary to visit a source to help resolve specific problems, the following actions are considered: 1) Analysis of plant records pertaining to the number of shipments accepted and rejected, non-conforming material reports and source quality rating when applicable; 2) Discussion of the plant's experience with the source based on the preceding analysis; 3) Correlation of plant and source records and review of the specific part quality standards; 4) Discussion of characteristics checked. 5) Review of the source's inspection facilities, 6) determination of corrective action and commitment to prevent repetition; and 7) Follow-up to determine if corrective action is implemented and is effective.

It is in this area of Vendor Surveillance that General Motors Philipinas has made modest contributions to the Philippines' growing industry. By continuously coordinating with suppliers, mainly the leading foundry and forging plants, to meet its standard of quality, General Motors, in turn, helps upgrade and improve the quality of the supplier's products.

OTHER QUALITY FUNCTIONS

Aside from the Quality Control functions already mentioned, QCR perform other duties like **scrap and salvage control, gauge control, tear-down and failure analysis.**

A) SCRAP CONTROL

Scrap disposition of all rejected parts and material is done during the daily scrap meeting conducted by QC. Production supervisors and key supervisors from other support departments participate in this meeting, the purpose of which is to highlight the causes of parts rejected. The disposition of all rejected parts are decided during the meeting – whether to accept, to rework or to scrap. It is also in this meeting that the department responsible is charged for the cost of generating scrap.

The scrap meeting has its role in impressing upon supervisors cause and cost of scrap and therefore, the necessity of immediate corrective actions.

B) GAUGE CONTROL

The objective of Gauge Control is to ensure and provide manufacturing its gauging needs and requirements. A gauge control program is administered in such a way to assure and protect the company's measuring capability. Quality Control assumes the primary responsibility in carrying out this program and establishing the basic policy to acquire not only initial accuracy but also continued accuracy, by ready detection of deficiencies and timely corrective actions. Gauges and test equipment are calibrated against standards or equipment of the next highest accuracy. Checking schedule and calibration intervals are based on (1) frequency of use, part experience, and calibration history, (2) severity of use and environment, (3) tolerance being gauged and stability of the instrument, (4) accuracy of measurement required and importance of quality characteristics, and (5) recommendations by gauge and equipment manufacturer.

In addition, Gauge Control is responsible for ensuring that suppliers maintain an acceptable calibration system by: (1) Auditing suppliers' facilities and procedures, and (2) verification of material received from suppliers.

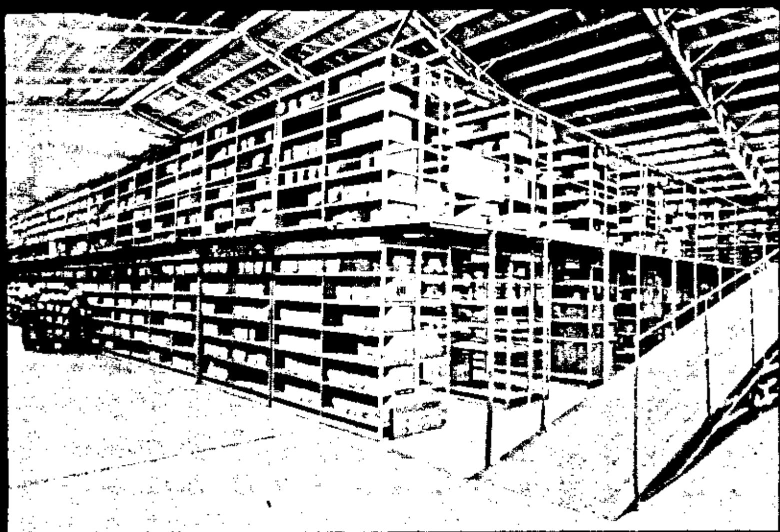
GMP – NPDC

The National Parts Distribution Center has come a long way to what it is now – the center for distribution of all genuine GM parts and accessories. And with the emergence of GM Pilipinas, prospects look even better for the Center.

As the NPDC gears up for more volume, it has realigned all its forces to meet its objective.

To start off, the NPDC took a bold step this year by drastically reducing its price levels to the point where service gets top billing over profit. At a time when everybody is complaining of the tight money situation, NPDC boldly opted to generate more volume to make available genuine parts, particularly Isuzu parts to customers at cheaper prices while competing in a market already flooded with imitation replacement parts.

The distribution Center has opted to discard its old procedures to a more sophisticated operation, employing the latest techniques in computerization especially in its inventory control system. The new system cuts down delays and



A portion of the GM Parts and Accessories Division warehouse.

provides efficient service and convenience to the dealers.

The Center started its computerization program three years ago and expects to complete computerization by early part of 1980.

One aspect of its operations which got a shot in the arm from computerization is the sourcing of parts abroad. NPDC stocks come from different multinational origins which include AC Delco of US and England, GMPD Delco Romy of France, Vauxhall of England, Holden of Australia, Isuzu of Japan and Opel of Germany. The efforts of NPDC's worldwide sourcing is nothing but getting the parts avaliable at the best price for the GM customers.

Realizing the need to infuse vigor at the Center, GMP management thought it wise to transfer it, in 1976, to a new site from its former home at Paco. The Center now stands on a half hectare lot in the heart of Makati on Pasong Tamo Extension where it houses an office and a modern warehouse to better serve its customers.

With a combination of youth, dynamism and experience present in its staff of 48 knowledgeable parts people, the NPDC can well afford to discharge its most important function of making GM parts available everywhere. However, to do this it must have the wares. And NPDC has them.

Its warehouse houses over 30,000 line items broken down into following carlines: Isuzu, Opel, Holden (Torana), Vauxhall, and Chevrolet. The present inventory figure is ₱22 million and is increasing. Around 32% of this total is Isuzu parts which went up by 22% from its previous stock level. Opel follows next together with the other carlines.

Parts may be classified into two types. "Genuine" parts are those directly manufactured either by the maker of the vehicles or by its authorized parts suppliers. These parts go through rigid quality control tests to make sure that each one follows engineering specifications and ensure superior performance. There are "limitation" or "substitute" parts which are manufactured by private establishments. Cutting out the quality control process, substitutes are easier to manufacture, but are inferior in quality although they naturally cost less. They do not pass prescribed testing and control procedures and therefore do not conform with set quality standards. They may even be rejected parts by the manufacturer for some defect or other but are passed on to the market by an enterprising supplier whose sole aim is to make profits.

Inside the warehouse are three distinct sections: Receiving; Storage and Issuance; and Shipping and Packing. The receiving section takes care of unpacking and recording of all deliveries coming from both local and foreign sources. On the other hand, the storage and issuance section takes care of the physical stocking of parts and sees to it that they are properly binned in wooden racks and steel bins. The warehouse has 14,000 bin openings to house even the tiniest bolts and nuts. At the same time, this section takes care of locating and picking items ordered by dealers and placing them in huge universal bins assigned to each dealer. From there on, the shipping and packing section takes over. It makes sure that the parts are properly crated, marked and ready for pick-up or shipping for final delivery to their destinations.

A major duty of any Parts and Accessories division is to anticipate how much parts to stock in order to meet the demands of dealers and end users. Since there are roughly 3,000 replaceable parts in a vehicle alone, it is impossible to determine the exact figure of demand. Parts forecasting is done through an exercise called demand analysis. This process includes taking into account the number of units sold by dealers, the types of vehicles sold, the nature these vehicles are likely to be used (commercial vehicles such as taxi units are most likely to need replacements sooner), existing road conditions and other countless considerations. They evaluate these statistics and data, compare these with existing records and from these try to make nearest to accurate projections.

The parts reach the GM vehicle owner through 19 vehicle dealers and 19 GMP parts distributors who supply fleet operators and parts retail outlets selling genuine GM parts. The NPDC marketing group also coordinates with GMP's vehicle sales group in assisting fleet operators, such as Pepsi Cola Bottling Company, San Miguel Corporation and Philippine Rabbit Bus Company to facilitate parts availability in order to minimize downtime.

As the National Parts Distribution Center faces the challenges of 1980, it hopes to accomplish the following:

1. The NPDC will, as its policy, make maximum effort to keep prices at fixed levels and adjustment to a minimum despite inflation and fluctuation of exchange rates. This is to allow more wholesale activity and facilitate better inventory planning by the dealer with the end in view of more sales volume thru better inventory.
2. In addition to its regular stocks, the Center plans to go more on accessory and high performance parts which carry high sales potential in the market, adding to sales volume. This has the additional benefits of profitability and merchandising values.
3. The Center will undertake more aggressive merchandi-
4. On personnel development, the Distribution Center plans sing campaigns to bolster its sales and enhance its role in the automotive industry. to extend to all the dealerships a training module on Partsmanship which is currently being undertaken by its own Warehouse staff.
5: The NPDC will exert aggressive efforts to assist the dealerships by developing their logistical capabilities in order to generate more volume sales, resulting in lower costs and increased market penetration. This will lead to making parts more available at lower cost to the GM customer.
6. And as volume increases, the Distribution Center will aggressively increase order volume to meet requirements, resulting in better service fill.

Finally, as the Distribution Center bats for more volume for the coming year, there is high hope that NPDC will not only help contribute in improving GM's position in the market but also live up to its name as the hub of genuine GM Parts and Accessories in the country.

FUTURE PLANS

That, in capsule, outlines General Motors Pilipinas - - what it is, and what it does. With regards to its plans and programs for the future, "GM Pilipinas," according to its Managing Director Herbert L. Telshaw, Jr., "looks back to the commitments it made to the industry and to this country when it first started. Its future plans, activities and programs will all be geared towards living up to these commitments. Our continued presence in the Philippine market over the years is indicative of the faith we have in the growth of this country and our desire to be an active participant in its development. The technological, financial, and managerial resources available to us will all be utilized to provide maximum assurance of fulfilling the company's commitments in full realization of the objectives of the PCMP.

"We shall continue to exert efforts to further the gains and achievements we have made in the past years. We shall continue to keep in step with the ever changing technology in the automotive industry and build products to suit current needs and demands at competitive and reasonable prices. In short, General Motors Pilipinas will continue to do what General Motors does best — serving the people through better transportation." PM

index to advertisers

PHILIPPINE INSTRUMENTATION & CONTROLS SOCIETY

in the limelight

Now in its 3rd year of existence, the Philippine Instrumentation and Controls Society (PICS) has become the voice of the country's instrumentation and controls sector, developing itself to be the central force that shall propel the industry towards its advancement. Primarily, the PICS was established with the major objective to unite the country's professionals, scientists and technologists involved and interested in the design, the manufacture, the use and the servicing of industrial instrumentation and controls.

The inception of the PICS came about as a result of two Conventions on Industrial Measurement and Process Control sponsored by the Metals Industry Research and Development Center (MIRDC) in 1976 and in 1977. In these undertakings, participants who came mostly from the private industrial sector strongly urged that an association which shall aptly symbolize the entire instrumentation and controls industry in the country be formed. Confronted with this imperative which carried with it an overriding significance in the light of existing industrialization thrusts, avid supporters thus incorporated the Philippine Instrumentation and Process Control Society (PIPCS) with MIRDC extending a helping hand. The PIPCS was given official sanction to operate on 25 February 1977.

On 29 June 1977, the PIPCS Board of Directors decided to change the Society's corporate name in order to widen its contours to include the broadest possible expanse of the industry. And on 5 August 1977, six months after its creation, the Society was officially granted recognition to function as the Philippine Instrumentation and Controls Society (PICS).

Presently, the PICS records a total membership of 295 companies and individuals who exist as one homogenous body continually adhering to a set of lined objectives while pursuing the Society's goals, among which are:

a) To work for a fruitful fusion of all professionals, scientists and technologists in instrumentation and controls.
b) To promote and safeguard information dissemination through the publication of a technical bulletin; sponsorship of seminars, exhibitions and a yearly local convention; and active participation in regional and international conventions.
c) To evolve a pool of technical experts from among the members to support and hasten the country's industrial thrusts relative to industrial instrumentation and controls.
d) To work for the establishment of standards relative to the testing and calibrating of equipment involved in instrumentation and controls.
e) To promote the use of local substitutes in the manufacture or assemblage of equipment involved in instrumentation and controls.
f) To strive for the rationalization of the instrumentation market with the aim to reduce and simplify maintenance and repair problems.
g) To work for the furtherance of instrumentation and controls in theory and in practice and in its application to allied fields of engineering and to human needs by undertaking or sponsoring research projects and other related scientific inquiries.
h) To evolve a scholarship program intended to assist deserving students in instrumentation and controls.

As currently constituted, the PICS Board of Directors tasked with the overall management of the Society has the following members:

Domiciano D. Isorena – President
Rosauro C. Aquino – Vice-President for Internal Affairs
Ernesto S. Taca – Vice-President for External Affairs
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Alfredo I. Borja, Jr. – Treasurer
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The PICS counts technical information dissemination among its current projects, as one of the programs which demand top priority. Pursuing its role as a medium for information exchange, the PICS adopts a yearly work program that promotes the conduct of regular seminars, plant visits and in-plant training programs designed specifically for private industrial groups who wish to contract the Society's services for their personnel skills training and upgrading. These regular activities culminate with an Annual Convention and a simultaneous Small Instruments Exhibit, in celebration of the Society's anniversary, which draws the participation of a majority of members as well as a substantial number of non-members from various industrial sectors. Significantly, the know-how and experience of local and foreign technical experts in instrumentation and controls have been intensively tapped by the PICS to assure maximum effectiveness of these annual events.

Aiming for the professional advancement of instrumentation and controls practitioners, the PICS likewise launched recently the Instrumentation Engineering Certification Program. Under this program, local instrumentation engineers and technicians who have acquired the minimum standards of professional accomplishment in their specific areas of expertise can now qualify as a Certified Instrumentation Engineer or Certified Instrumentation Technician. These two types of certification may be conferred on qualified candidates who have either successfully passed a series of examinations or qualified under the Clemency Clause of the program, a period for the accreditation of senior practitioners without undergoing formal examinations. Aside from the purpose of providing accreditation to qualified practitioners to improve their chances for professional growth, the certification project has likewise been launched to regulate and upgrade the general practice of instrumentation and controls in the Philippines.

The PICS is also mulling over the establishment of regional chapters in Visayas and Mindanao to better serve the needs of its growing membership from these areas. Set to be finalized late this year, the Visayas and Mindanao regional chapters shall endeavor to make available to its provincial constituents the same various services extended by the PICS head office to Metro-Manila members. The move to establish PICS regional chapters is expected to result in a bigger, more expensive and solid membership upon which the PICS could build on its prospects for growth in the future to make it truly potent spokesman of the local instrumentation and controls industry. **PM**

USING ROBOTS TO REDUCE MINING DANGERS

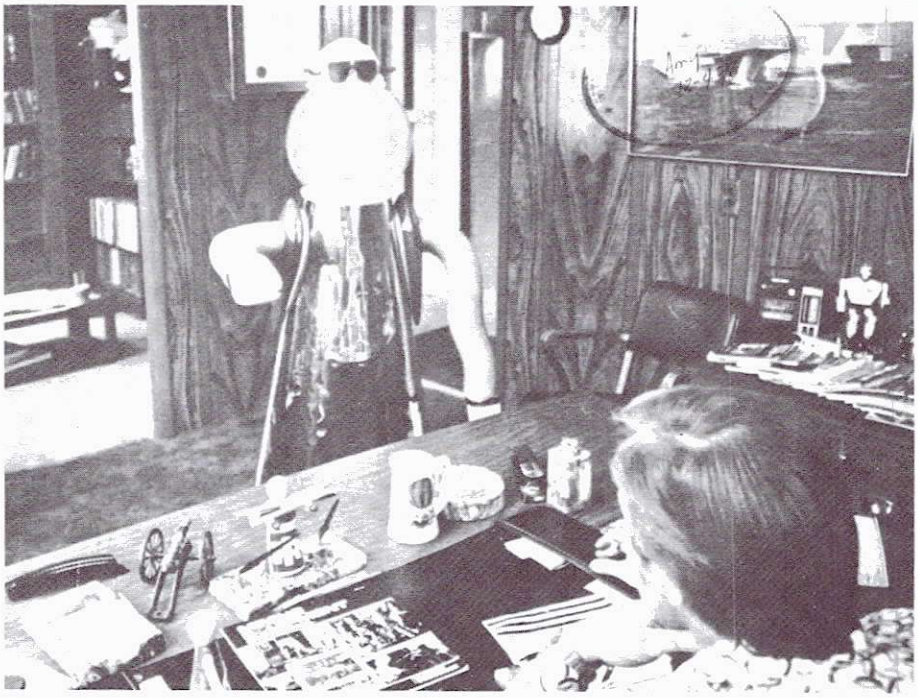
In addition to the fact that robots never go on strike and don't demand any pay beyond a battery recharge, the main advantage of robots is that they can carry out highly dangerous tasks without risking human lives. This is why the first two Quasar mining robots to be built are used in security and in setting explosives. Ideally, a robot that can set roof bolts – mining's most dangerous job – will be ready next.

Robots can be built of materials to withstand working conditions that human beings find intolerable. This makes the use of robots worthwhile in South Africa with its very hot, deep mines, and such materials are equally important for deep ocean mining or in arctic areas.

Robots are good employees – they don't steal, and they need no lunch breaks. There's no "time off" for vacations, weekends, holidays, or sickness. Maintenance and repair procedures are surprisingly uncomplicated and do not generally require much time. *Mining Equipment International, July/August 1978.*

DEVELOPMENTS IN HOT GALVANIZING OF WIRE

The capacity of hot galvanizing installations for steel wire has been limited by the fact that with increasing speed of the wire, rough and irregular deposits occur. The development and introduction of the jet process as a replacement for conventional wiping rollers has brought about increased throughput speeds from 50-80 to 150 m/min., reaching 180 m/min. in special cases.



Robots are being utilized on a greater scale than ever, especially in hazardous jobs which present great risks to human lives.

engineering and technological developments

The gas jet process utilizes a wiping bed made of inert un-wettable granulate, through which a gas mixture is conducted, thereby avoiding air access and burning away when leaving the wiping bed. This gas is a non-oxidizing carrier gas, such as propane or natural gas, with an addition of hydrogen sulphide gas which, at the surface of the drawn out zinc, causes the formation of a mechanically more solid zinc sulphide film. With the process, it is possible to apply higher zinc layer thickness with the same roughness of the coating than by means of wiping with oil carbon. As an additional advantage it is stated that, with higher speeds, the reaction time for the formation of brittle iron-zinc layers is shorter. This has a positive effect on adhesion.

Another development is "high speed hot dipping" (HSHD), which comprises a furnace where the zinc is melted. The liquid zinc is fed into a horizontal tube which is closed at one end and through which the wire is led transversely through two nozzles. In laboratory studies, it was found possible to conduct the coated wire through the nozzle several times without re-melting the coating. In this way, very thick coatings can be produced. The uniformity of the zinc coating, also the effect of subsequent heat treatments, largely depend on the precleaning of the wire. Careful and uniform precleaning of the steel surface is considered to be an absolute prerequisite for good adhesion and uniform coating thickness. *Metallurgical Plant and Technology, 1979.*

ECONOMICAL SILVER-PLATING PROCESS

Ullrich Copper Inc. of Kenilworth, New Jersey is now offering an "in-house" continuous flash-plating process for silver-plating fabricated electrical parts and bus bars. With this new process, bus bars up to 30 ft. (9.1m) in length can be uniformly plated on a continuous basis, eliminating the time consuming and costly multi-dip tank procedure used in standard electrolytic plating.

Ullrich Copper's in-house process permits uniform and continuous silver plating of electrical parts and bus bars.

The process also meets exacting specifications for thickness and bonding quality. The silver plating can be applied to bus bars at the rate of 60 ft/min. (0.30 m/s). This is said to result in a reduction of standard flash plating costs by more than half.

Silver-plated bus bars and fabricated electrical parts are suited for panelboards and switchboards where the prevention of copper oxide is critical. *Materials Engineering, January 1979.*

AUTOMATION OF CRUSHERS

Attempts to automate crushers have been successful as far as secondary crushers are concerned. For primary crushers the results of the development work have not been so good, due to the big block size of the material to be crushed and, consequently, the uneveness of the feeding. New developments by Lokomo and other manufacturers probably mean automation will be possible soon.

The regulation of the capacity of the feeders could easily be arranged with a Lokomo horizontal feeder equipped with hydrostatic drive. The hydrostatic drive allows an infinitely variable regulation of capacity, and it can be remotely controlled from the current of the crusher's drive motor through a current transformer. The latest technology also makes it possible to furnish the jaw and gyratory crushers used as primary units with a remote-controlled hydraulic setting regulator.

The fully automatic setting regulation can be installed on all gyratory and cone crushers equipped with a hydraulic adjustment system to allow adjustment of the crusher setting while the crusher is running under full load. The automatic regulating systems developed by various manufacturers have one thing in common: they sense either the axial (hydraulic) pressure or the radial pressure (torque), or both, of the crusher's work load. They try to maintain the preselected setting, and to level off the variations in loading at the same time. *Mining Equipment International, July/August 1978.*

MAGNESIUM REGAINS LOST GROUND

The recent maturation of hot chamber die casting has propelled magnesium towards the frontlines, with such advantages as thinner casting walls, shorter cycle times, longer die life and reduced scrap rates. In appreciation of these properties, hot chamber magnesium casting is being groomed to provide automotive manufacturers with a lighter alternative to zinc, aluminum and iron castings.

Hot chamber die casting allows production of very close tolerance parts which need no secondary machining. Tolerance control is execellent, due to magnesium's lower affinity for steel in the dies than is possessed by aluminum. There is also better regulation of the die surface temperature. Other advantages of the process are the extremely long die life, energy efficiency, extremely fast cycle time, and low scrap loss.

For those not adequately familiar with the process, hot chamber die casting operates by vertically submerging a crucible into molten magnesium. The magnesium flows through an intake port, into the shot cylinder, and an injection piston moves into the cylinder where it seals the intake port. Magnesium is forced into the die through an S-shaped passage called a gooseneck. After the shot is made, the injection piston retracts to a position above the intake port and the shot cylinder automatically refills with molten metals. *Modern Metals, March 1979.*

NITROGEN SHROUDING OF ALUMINUM EXTRUSIONS

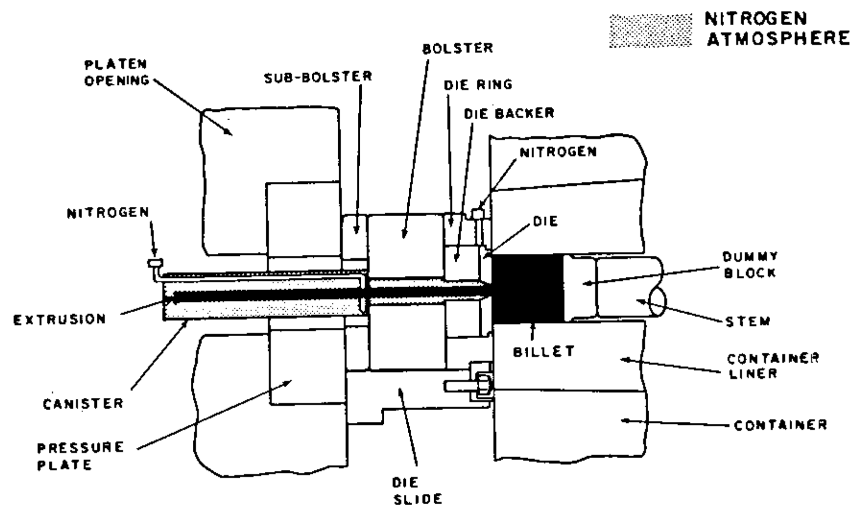
Nitrogen shrouding has been used by most hard alloy aluminum extruders for the last ten to fifteen years. As the demand for increased production and product quality have risen, many soft alloy extruders have turned to the shrouding practice as an economical means of improving their operations.

Nitrogen shrouding involves injecting gaseous or liquid nitrogen into the die area of the extrusion press. The inert nitrogen serves a dual purpose: it displaces the oxygen laden air from the die area and it cools both the die and extrusion. Generally, with nitrogen shrouding an extruder can push anywhere from two to eight times his normal poundage before polishing. This saves press downtime and labor costs associated with die changes and polishing.

The following qualitative benefits can be achieved with the nitrogen shrouding system:

1. Increased press speeds without reduction in surface quality.
2. Improved extrusion surface quality.
3. Elimination of die polishing on long production runs.
4. Reduction of extrusion rejects attributable to die pickup.
5. Increased die life.
6. Substitution of secondary for primary billet. *Light Metal Age, April 1979.*

Press modification for injection of gaseous and liquid nitrogen.



MICROCOMPUTERS IN ALUMINUM EXTRUSION

In 1977, a new size computer appeared on the market which is ideal for many production control applications. These small computers, called microcomputers, are now reported to benefit their users in the following areas: reduction in scrap, increase in capacity, reduced manpower, and better production information.

PS2/D is Foy Enterprises' latest step in the development of a complete production control system for aluminum extrusion companies. The complete system will include order entry, press loading, billet requirement planning, billet inventory, press scheduling, practice planning, production reporting, and order status capability.

Even though microcomputers are a very new tool, they are being used by a rapidly growing number of extrusion companies. Whether an extruder buys a program or attempts to develop his own, each extruder should investigate seriously whether or not micros would be beneficial to his company. Properly programmed, they have proven to be of tremendous benefit to the industry. *Light Metal Age, April 1979.*

GREENSAND PRE-TREATMENT

In an effort to resolve fundamental problems of greensand preparation, Richards (Leicester) Ltd. carried out operational surveys on greensand preparation plants by means of a monitoring technique developed to investigate mulling characteristics. For the equally important purposes of both cooling and homogenising, the company developed a fluidised hopper wherein sand, equivalent in mass to some mixer batches, is held in a state of air turbulation by means of a low pressure fan.

Sand which fluctuates in temperature and moisture content is fed into a mass where it is blended and cooled by evaporation before being fed in a constant state to the mixer.

Return sand of varying temperature and moisture content frequently includes foreign bodies in the form of small tramp iron and hard coresand. Fluidising this return sand has presented many conventional problems, which the company hopes to remedy through an entirely new system of vertical, contra-flow fluidising.

(Literature on this system is not available, but the following address welcomes inquiries: The Export Department, Richards (Leicester) Limited, P. O. Box 78, Phoenix Iron Works, Leicester, England).

NEW AUTO BODY SHEET STEEL

Cold-rolled, high tensile strength, low yield stress sheet steel, or CHLY, has been developed by Kawasaki Steel Corp. to augment programs in substantially reducing the weight of automotive component parts and boosting car fuel efficiency. Weight saving with CHLY, added to its high strength and unique properties, make it most suitable for use in such car components as doors, hoods, trunk lids, fenders, bumpers, and frames. This new product is said to trim the weight of outer body panels by around 6%.

CHLY is a dual-phase steel which, combining the ductility of ferrite and the strength of martensite in its microstructural constituents, features both markedly low yield stress and high percentage elongation. This results in the exceptional ease of formability and makes CHLY bounce back only slightly when formed into the desired shape.

Another major advantage is the steel's capacity for hardening. CHLY is ductile by nature, readily lending itself to the forming work. However, when component parts fabricated from it are painted and baked in the furnace to about 170°F, they gain sufficient hardness and become more dent resistant. In addition, CHLY retains non-aging characteristics unless put under extremes of temperature. Free from the aging effect, it does not deteriorate even when stored for a long period of time before the start of secondary work processing.
News Release, Kawasaki Steel Corporation, June 21, 1979.

FORGED STAINLESS VANES IN TURBINES

Large stainless steel vanes in the final four stages of nuclear steam turbines used in electric generating stations are now being forged rather than cast. In-house forging expertise at Westinghouse Electric Corp. was used to develop the vane manufacturing capability. Purchased castings may be adequate, but they can now be effectively replaced with higher-quality forged vanes at no increase in production costs.

Forgings have significantly higher strength and ductility than castings. As such, forged stainless steel vanes result in a more precise airfoil contour and a more efficient turbine. Vanes are stationary airfoils that direct the flow of steam to the rotating blades of the turbine rotor. The efficiency and reliability of a turbine depends in part on how precisely the vanes are made. While the rotating blades have always been forged, vanes were formerly cast or rolled because of the lower stresses experienced in service. *Materials Engineering, January 1979.*

Westinghouse Electric Corporation forges large stainless steel vanes for use in electric generating stations.

CUT-TO-LENGTH LINES FOR SHEETS

Today's range of cut-to-length lines are a product of many decades of development, and such developments have necessarily led to a complexity of available lines. This relates to available gauge and width from the mills, also related to ferrous and non-ferrous materials with further selection according to quality of material finish.

Modern cut-to-length lines are electronically controlled and a basic requirement is proper relationship between the length measuring system, the main power drive, and the strip itself, which can be achieved in such a way that the electronic control equipment can overcome mechanical manufacturing tolerances. On the basis of decades of experience in this field, three typical line designs have crystallized, and all meet the requirements of quality of cut sheet, capacity, and economy. These are:

a) Lines with stationary shears and intermittent strip feed through the levelling machine. This line design represents an ideal solution for applications where relatively low-priced, simple, and easy-to-operate machines are required in a medium-thickness range.

b) Lines with staionary shears with intermittent strip feed through a heavy-duty roller feed and continuously working levelling machine. This design guarantees freedom from slippage and thereby accurate high-speed production and totally high output from the line.

c) Lines with flying shears and continuously running roller levellers. This design is the ultimate solution for modern, efficient lines for cutting to length of cold- and hot-rolled coils where high output is of prime importance. The strip to be cut passes at a constant speed through the line, and loop pits are not therefore necessary. When a high levelling effect is desired, and when working on highly sensitive surface finish, this type of line is recommended.
Sheet Metal Industries, December 1978.

CADMIUM-THE MALIGNED METAL

Cadmium was discovered as a metallic element in 1817, and since then many valuable uses have been found for its unique properties. More recently cadium has been used in solders and brazing alloys, nickel-cadmium batteries, photo-electric cells and stabilisers for PVC. In each case the metallic or chemical properties of cadmium impart specific and often unique characteristics to the product or material.

In the past few years, however, the technical merits of cadmium have been clouded by the metal's health hazard image. It has been linked to bone disease in Japan (known as itai-itai), although its effects have never been directly confirmed. In addition to this, it has long been recognized that cadmium has affected the respiratory and the renal/kidney systems of some workers in the cadmium industry.

Concern over the effect of cadmium extends beyond the factory or works and into the greater environment. Effluents from plants electroplating zinc, silver, copper, nickel and chrome as well as cadmium are presently under scrutiny, and platers are responding by improving existing effluent treatment facilities and investigating new possibilities.
Metal Bulletin Monthly, February 1979.

FIRE-RESISTANT HYDRAULIC FLUIDS

Water-based hydraulic fluids are coming into full view again, as a result of rising petroleum costs which make petroleum-based hydraulic fluids expensive. Of all hydraulic fluids untreated water is still the most inexpensive, although its use is restricted because it fails in providing the lubrication and corrosion protection required.

Water glycols were introduced during World War II, for use in aircraft catapult launchers and aircraft hydraulic systems. Water glycols are not emulsions, but rather true solutions that derive their fire resistant nature from their water content.

Water-in-oil emulsions are milky in appearance, and may contain as much as 40% water. The remainder of the fluid is oil containing an emulsifying additive. The continuous oil phase provides lubricity and adequate viscosity, and the emulsifying additive package normally includes rust and foam inhibitors and antiwear agents.

Phosphate esters are man-made synthetic fluids which offer excellent fire resistance and lubrication. They are somewhat superior to water-glycol fluids. These are available with viscosities from 90 to 600 SSU, and thus are suitable for use with most hydraulic pump designs.
Plant Engineering, February 1979.

RELIABILITY ASSURANCE IN DESIGN

The role of the designer in achieving reliability should be a) to ensure that he receives a clear objective statement of reliability requirements; b) to understand fully the environmental, safety, performance, and maintenance constraints which will apply; c) to "trade-off" reliability and maintainability characteristics and thus achieve an optimum design which meets the availability and performance requirements; d) to ensure that, in meeting the specified reliability requirements, the design does not exceed the capabilities of the resources available to manufacture the product; e) to plan and implement economically a test program which provides sufficient information for him to predict reliability with the desired level of confidence; and f) to pay full regard to the data fed back during production and in service life, to analyse its significance, and to apply the result in improving the level of product design.

Equipment reliability can be achieved by using a combination of well established and proven design techniques, incorporating standard components of known reliability, and insisting on comprehensive testing of all stages of development of new components, modules, and assemblies. Synthesis or simulation can be used to predict the overall reliability of a product and to pinpoint those parts of the design with potentially high failure rates.

Using this information the designer can either modify the design, use redundancy or some other techniques to overcome reliability problems, or, when alternatives prove impracticable, determine what additional maintenance and testing facilities are necessary to offset unacceptably low reliability and achieve the required level of availability. By adopting these good design practices, assurance can be given that the final product will meet the requirements specified. *Quality Assurance, December 1977.*

ECONOMIC EVALUATION OF CAPITAL PROJECTS

One of the most important planning functions of management is the economic evaluation of capital projects. It is vital that major investment decisions are taken with the fullest possible knowledge of all areas of the project. Results from many of the traditional methods of appraisal can sometimes be misleading and inappropriate for management decision making. For significant projects, it is widely recommended that the internal rate of return be calculated, and compared with the cost of finance, to give the initial criteria by which the viability of the project may be judged.

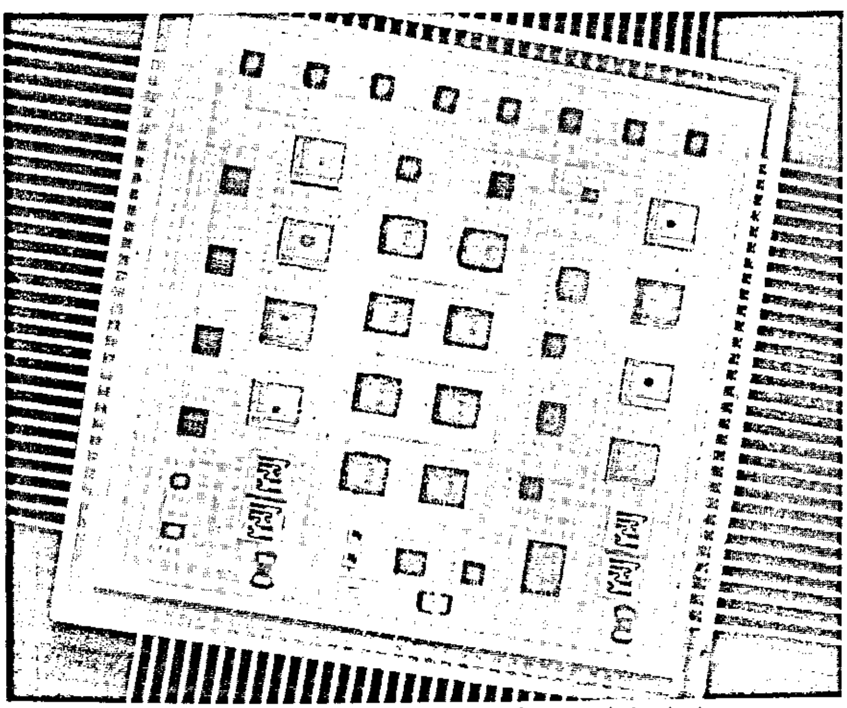
The internal rate of return (IRR) or "yield" is defined as the rate of "interest" which discounts the future net cash flow of a project into equality with the capital cost. That is, the rate of interest which results in a zero net present value. The present value (P) of any project is found by discounting, at the firm's cost of capital, all future net cash flows to their present value equivalent. The net present value (NPV) is found by subtracting the capital cost of initiating the project.

The difference between the two methods is primarily in the presentation of the result. NPV expresses the result in terms of cash value, whereas IRR presents the the results in terms of a percentage. IRR is conceptually easier to understand and the format is more familiar to management planning, with the result presented in the same dimension as the risk involved. This explains its widespread use and the recommendations of experienced planners. *Foundry Trade Journal, January 1979.*

DIE CASTING: A PROBLEM SOLVER

To avoid problems in their base well cable housing for pulse code modulated regenerative cirduitry, GTE has started using aluminum die castings for tight tolerances and good 'O' ring sealing surfaces. These qualities were lacking in the company's previous sand cast housings, which also involved extensive machining.

In another sensitive area, Motorola now utilizes digital data housing made from die cast aluminum. The housing shields


Conductive epoxies can bond microelectric chips to integrated circuits in consumer products and sophisticated aerospace applications.

delicate electronic circuitry against radio interference, dust, moisture and vandalism. Aluminum's excellent thermal conductivity also prevents premature component failure from heat buildup.

These are only examples in the current widespread use of die castings, which have progressed despite skepticism to pay off in terms of economy, utility, and sales-stimulating good looks. These advantages are especially true for manufacturers of communications gear, machine tool controls, office machines, cooking utensils, film strip projectors, life support systems and plumbing hardware. *Modern Metals, March 1979.*

MANGANESE POWDER INJECTION

Alloying of molten aluminum by manganese powder injection is now possible, as has been proven in a laboratory scale. However, for successful injection, the following processing variables must be controlled during the penetration, settling, and dissolution of managanese powder:

a) The critical particle size that will penetrate the bath is inversely related to the injection velocity, and thus higher injection velocities will allow smaller particles to penetrate the bath.

b) The dissolution time is directly related to particle size; however, it is also inversely related to the mass transfer coefficient. Thus, stirring of the bath during injection will increase mass transfer and will, in turn, lower dissolution time.

c) To minimize clinker formation, it is necessary to use a narrow size-distribution of manganese powder.

d) Even though fine powders should have higher dissolution rates due to an increased surface to volume ratio, the fine powders (less than 20 micro-meter) do not penetrate the bath during injection, and upon surfacing react with oxygen and thus cause the observed smoke, flame and manganese losses. On the other hand, coarse powders which have better penetration also have slower dissolution rates. In the laboratory work conducted, the optimum combination of solution rate and recovery was obtained using 50 x 70 mesh (200 micro-meter x 280 micro-meter) manganese powders. *Journal of Metals, February 1979.*

ADHESIVES THAT CONDUCT ELECTRICITY

Electrically conductive adhesives are now utilized for making electrical connections where hot soldering is impractical, or where joining at high temperatures must be avoided.

Conductive epoxies can bond microelectronic chips to integrated circuits in both consumer product and sophisticated aerospace applications. These conductive bonding agents provide electrical connections for LEDs (light emitting diodes) and LCDs (liquid crystal displays) in watches and calculators. It is estimated that 99% of all LED manufacturers use a conductive epoxy that is applied by machine dispensing, screening, or stamping.

Almost all electrically conductive adhesives are epoxy-based systems. Electrical conductivity is provided by a conductive, metallic filler conventionally gold, silver, nickel, copper, and even carbon (where higher resistivity is acceptable). Application methods range from dipping to silk screening, and include brushing, spraying and positive-displacement dispensing, such as use of syringes. Different viscosities are available to fit the method of application. *Materials Engineering, January 1979.*

LATEST IN FLAME CUTTING MACHINERY

Recent advances in flame cutting machinery include the ring cutting nozzle, automatic billet bloom cut-off machine, automatic slab cut-off machine, slitting of slabs, iron powder cutting improvements, and safety hand cutting torch.

The ring cutting nozzle has a compact one-piece tip of the internal mixing type. If offers safe, efficient, and fast cuttings, with little maintenance and producing sharp edges and smooth cutting surface.

The automàtic billet bloom cut-off machine is shaped like a barrel, has all vital parts such as motor, gear, clutch, clamping mechanism, edge detecting device and all electrical components built into a double wall housing with constant cooling water flow. It applies electronic length measuring devices to cut continuous cast slabs into required lengths and/or other digital measuring or control procedures such as total length measuring, rest length measuring and length optimization.

The automatic slab cut-off machine, or "riding" slab cut-off machine sits down on a slab for synchronism, and requires up to 60% less repair time per year as against three other types of conventional strand cut-off machines.

Slitting of slabs improves full utilization of the furnace ladle and caster capacity, and can be applied economically, as no smaller moulds and no mould exchange are necessary.

Iron powder cutting improvements for steel mills are widely known as an important aid to make the oxygen cutting of high alloy, i.e. stainless, feasible with respect to allowing a quick start of a cutting process on steel not having the required ignition temperature.

The safety hand cutting torch has no valve body at the torch itself, which reduces weight and leakage possibilities. Electrical switches replace valves at the torch and actuate solenoid valves at the pressure regulator board. *Metallurgical Plant and Technology, March 1979.*

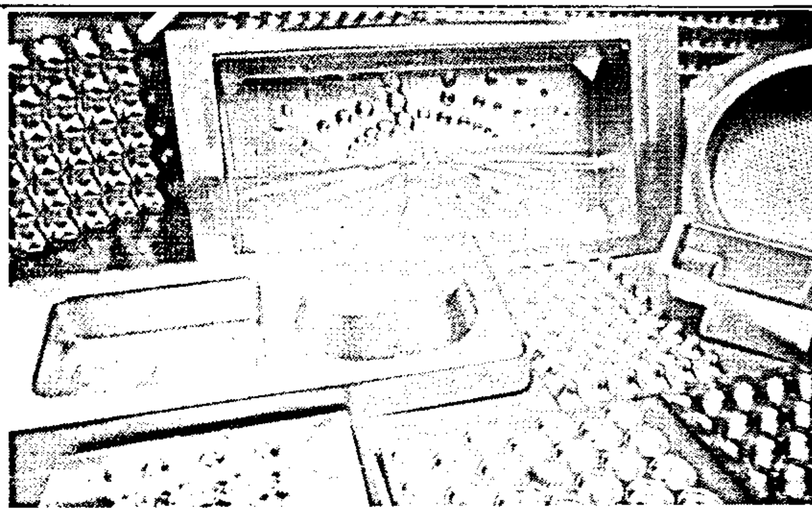
WHY USE PREFINISHED METALS?

Prefinished metals are of five distinct classes: a) prepainted metals; b) plastic-metal laminates; c) preplated metals; d) other metal-coated metals (by hot dipping); and e) pre-anodized aluminum.

A recent survey indicated that the use of prefinished metals are primarily because of their lesser cost, less space occupied, and lesser manufacturing operations required. Other reasons included better paint adhesion and weathering, higher quality product, and less air and water pollution problems.

Another advantage is its being used to avoid metal treatment and painting.

However, some problem areas still occur despite impressive gains in the use of prefinished metals. For example, one user complained on the limited use because of raw edges. This problem can be overcome by crimping the edges, or applying edge coating, or by designing around the problem by concealling the edges. Another area for consideration is that prepainted metal is too difficult to run through progressive dies. There is only one suggested solution for this: pad the steel coil so the surface won't be scratched, and cushion the dies. The user should work with the product, not against it. *Materials Engineering, March 1979.*



Special purpose aluminum can be stamped to wide variety of shapes and displays light weight, good design strength, and corrosion resistance.

SPECIAL PURPOSE ALUMINUM

Aluminum has long been a candidate to substitute for steel in automotive applications. The metal's light weight and corrosion resistance are characteristics badly needed by automotive designers. Unfortunately, the formability and finishing qualities of aluminum have not always met automaking standards. Consequently, aluminum producers have turned to a variety of specials and experimental grades in the hopes of winning specific automotive applications. No one can predict how those new alloys are being accepted by the automakers, but the alloys are also available for any applications that can make use of their special characteristics.

A new alloy specially formulated by Alcan for the thermoforming process holds promise for applications in such industries as transportation, machinery, office equipment and small appliances. The alloy, which contains calcium and zinc, displays light weight, good design strength, and corrosion resistance. It is formed into complex shapes by compressed air forcing the heated metal into or over molds.

Aluminum forms alloys with a large number of other metals. The addition or removal of various combinations of these elements can alter many properties of the more common alloys. While no element has complete solubility in aluminum, several including copper, magnesium, zinc and silicon are sufficiently soluble to impart important changes in aluminum properties. *Materials Engineering, May 1979.*

DIVIDING ROUND STEEL BY AUTOGENOUS FLAME CUTTING

Autogenous flame cutting with oxygen and natural gas has proved to be an economical dividing method for tube rounds. As experienced by Mannesmann AG Huttenwerke, construction of a central mechanical, computerized dividing line in the rolling mill, comprising two four-strand cutting machines with a rated capacity of 40,000 t/month has increased monthly output by more than 50%. This was in comparison to the rated capacity, after elimination of some difficiencies and introduction of constructional improvements.

Four methods were investigated for the determination of performance: flame cutting with oxygen and natural gas (autogenous), flame cutting with oxygen and acetylene, sawing without the use of carbide-tipped saws, and abrasive cutting-off.

On account of the most favorable yield as well as low costs and smallest space requirements, the flame cutting method with oxygen and natural gas is widely recommended for flammable steel types. With regard to location, the dividing plant should be erected in the rolling mill of the steelworks, with the following advantages: a) yield improvement through compound optimization between hot saw and dividing plant; b) lower investment costs because fewer aggregates are required for a centralized dividing plant; c) lower processing costs through larger production quantities; and d) lower price of oxygen at the steelworks. *Metallurgical Plant and Technology, March 1979.*

PROCESS DEVELOPMENTS IN PYROMETALLURGY

Copper: Control of SO_2 emissions has been the main reason for changes at many existing smelters, and this factor along with particulate emissions control, working conditions, and energy consumption are the main driving forces behind many primary technological improvements. At many of these smelters, working conditions have improved and the plants will be in a much better position to cope with the labor and energy situations in the 1980's than if no changes had taken place. It is considered that the greatest advances in the industry at this time are to be made in the converter process. Key areas which have to be investigated are vessel shape and design, tuyere location and design, liquid and gas dynamics flow patterns, plant layout, and materials handling and scheduling.

Nickel: A converting operation on the matter produced is still required, despite INCO experiments of smelting nickel concentrates in an oxygen flash furnace. It is suggested that a continuous smelting and converting process to Bessemer matte may even be more atractive. This general approach, patterned much after established processes for copper, is likely to see commercial application in the future. Somewhat along similar lines, the continuous smelting and converting of nickel concentrate along with reverberatory type matte in a converter has been tested in the USSR. In this work, a Cu-Ni Noril'sk concentrate was converted with Pechenganikel matte in a horizontal converter with the required fuel being injected through a tuyere nozzle. It was found that optimum conditions were achieved when the concentrate/matte ratio was about 0.25.

Lead and Zinc: The KIVCET CS process and status were covered in detail in last year's reviews; the stiuation is virtually unchanged today.

Secondary Materials: Treatment of scrap is an important area in non-ferrous metallurgy and is likely to increase in importance with more awareness in recycling from the viewpoint of both cost and supply. A high recycle recovery rate is achieved in the case of lead, since a large amount of lead produced (around 70%) is used in batteries which have a fairly short life. *Journal of Metals, May 1979.*

ADVANCES IN PHYSICAL AND EXTRACTIVE METALLURGY

Thermodynamic descriptions of a number of pyrometallurgical processes have been written in the past few years. In a recent study, Nagamori and Mackey applied a computer-oriented thermodynamic model to analyze various aspects of the Noranda copper smelting process. The model was shown to be capable of predicting the effects of operating and chemical parameters on matte smelting and converting operation, and the behavior of minor elements during the production of metallic copper or high grade matte.

In hydrometallurgy, Sepulveda and Herbst presented a population balance model to extend a single-stage leaching model to the description of a multi-stage leaching system. The application of the pseudosteady-state approximation to liquid-solid reactions was shown to be valid even when the ratio of liquid reactant concentration to molar density of the solid is high.

Cementation reactions continue to attract substantial attention. The rate of copper precipitation with iron balls in sulfate chloride solutions was shown to depend on the diffusion of hydrated copper ions. The rate of codeposition of copper and cadmium onto zinc under inert and oxygen-containing atmospheres was reported to depend on various reaction conditions. The effect of chloride ion additions from various sources on the rate of copper cementation on aluminum was also studied. The deposit morphology on the rate of copper cementation on iron and aluminum has been examined, using the rotating disc technique. The maximum rate was usually associated with a fine, dendritic structure. *Journal of Metals, May 1979.*

QUALITY STANDARDS

A major objective of standardization is to establish and/or improve the quality of products, services, procedures, etc., for economic benefit. This objective is better achieved if the standards themselves are of a high quality. Hence, it is necessary to examine such aspects of quality of standards as: clarity of expression and presentation of facts, instructions, and requirements; technical accuracy; and the adequacy and accuracy of compliance sampling procedures.

To aid this objective, certification provides a means of implementing standards. It directly helps to improve the quality of the standards through feedback of errors, inefficiencies, and misinterpretations to technical committees, standards councils or other responsible bodies — provided the feedback loop itself is implemented.

It is important for standards personnel to be able to separate and give reasonable weight to trivial versus critical requirements, tests, QC programs, etc. Standards per se do not indicate the relative importance of one test or quality requirement over another in the assessment of product quality. This is perhaps a deficiency of the standard-making process and may need to be corrected in the future. It is corrected, to a large extent, by the specification of sampling procedures, including sample sizes and acceptance criteria for various groups of quality characteristics. *Quality Assurance, December 1977.*

SELECTING HEAT EXCHANGERS FOR STEELMAKING

There are three basic types of heat exchangers used in the steel industry: shell and tube, plate, and spiral. Each basically consists of two channels or systems of channels — one for each medium. These channels are physically separated by partitions through which heat passes from the warmer medium to the cooler one.

Each of these major types of heat exchangers has its advantages, and it is not uncommon to find a different configuration on similar applications at different plants. The fact is that while basic processes may be the same from plant to plant, certain variables change which make heat exchanger selection on an individual specific installation basis imperative.

No matter what type of application is being reviewed, the first thing to take into consideration in determining the type of heat exchangers needed is the total thermal requirement. Naturally, if the plant is in the planning stage, specification of heat exchangers should be done during initial design. If the plant exists, however, avaliable space will have great bearing on the type of exchanger which is eventually chosen.

Next comes a determination of the desired temperature program. That is regulated by the amount of heat loss permitted at any given point in the process. Finally, the program narrows down to a determination of volume, flow rates, and pressure tolerances required and the nature of the medium to be cooled. Media flow rates are vital factors in obtaining as high U-values as possible. For clarification, the formula for the U-value is given as:

$$U = \frac{1}{h_1} + \frac{1}{h_2} + ff + \frac{L}{K},$$

U = effective heat transfer coefficeint overall
h_1 = film coefficient of hot side
h_2 = film coefficient of cold side
ff = fouling factor
L = wall thickness
K = thermal conductivity of material

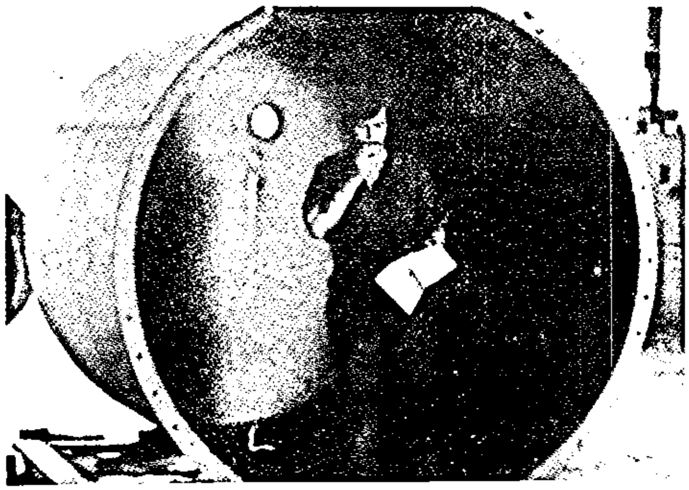
In the final analysis, the best cooling advice can be summed up as: do not plunge into a program without the assistance of thermal specialists. The money saved in the long run will make the cost of assistance insignificant. *Iron and Steel Engineer, January 1979.*

QUALITY CONTROL IN AUTOMATED MANUFACTURING

There is a rapid world-wide development of computer automated manufacturing systems now taking place, with the prime objective of improving the economic performance of batch production. Corresponding developments for in-process measurement and quality control during manufacture are also under way.

Japan has pioneered in the development of the computer-integrated automatic factory, whereby through gradual full implementation of a computer hierarchy an integrated software system operations in all cells and at other work centers within a plant are dynamically programmed. These are also coordinated for overall on-line optimization and automation of the plant's operations. This includes interfacing the system with computer-aided design in such a manner that initial programming of the automated optimum manufacture of a product is generated in the design stage, with the design optimized for minimum manufacturing cost.

The sequence of actions to control quality in automated manufacturing can be likened to a closed-loop error-feedback servo-system. Maximum efficiency in quality control can be achieved when the speed of response to this servo is at its highest. In other words, the closer the control loop is applied to the point of manufacture, the greater the efficiency. Automatic control produces highly repeatable results. The reducing of randomness to insignificance and the correction of any remaining systematic errors enable total error to be readily corrected virtually to nil. *Quality Assurance, December 1977.*



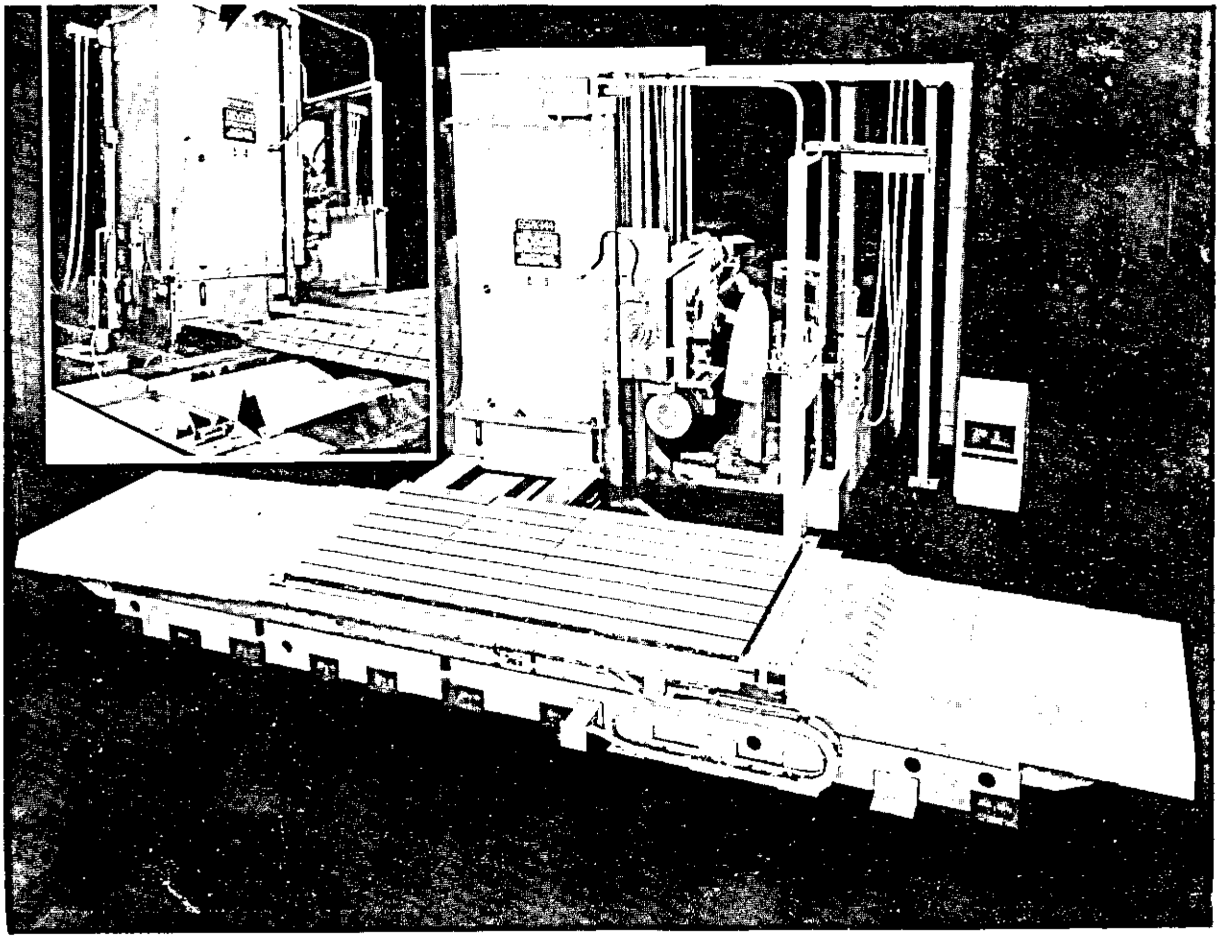
High performance coatings can handle demands for protection that were considered impossible a few years ago.

HIGH-PERFORMANCE COATINGS

Today's high-performance coatings can handle demands for protection that were considered impossible a few years ago. These coating systems have superior chemical resistance, high-temperature resistance, antifriction characteristics, abrasion and damage resistance, electrical properties, and/or release characteristics. They can be applied either as a dry, solid powder or as a liquid system in which the polymer is dissolved or dispersed in the carrier.

Most of the polymers used as high-performance functional coatings are fluoropolymers. These are composed of flourinated ethylene propylene (FEP), ethylene tetrafluoroethylene (ETFE), ethylene chlorotrifluoroethylene (ECTFE), polyvinyledene fluoride (PVF_2), polyphenylene sulfide (PPS), polyphenylene sulfide/polytetrafluoroethylene (PPS/PTFE), and thermoplastic urethane (PU). PPS and thermoplastic polyurethanes are not fluoropolymers. However, PPS does have chemical resistance and high-temperature resistance similar to the fluoropolymer resins. Polyurethane is included in this group because of its extreme toughness and resistance to damage.

Base resins are usually modified by the coating formulator to enhance their use as a coating. For example, the addition of UV stabilizers will improve outdoor weathering. Or particle size and melt index may be modified to fit a particular method of application. *Materials Engineering, April 1979.*



The new Devlieg RK Series Jigmil.

DEVLIEG RK SERIES JIGMIL WITH BUILT-IN LASER

The new Jigmil RK series is designed to handle a maximum work envelope of 12' x 9' x 6' (648 ft^3) with parts weighing up to 40 tons. This is equipped with a built-in laser measuring system with telescopic way covers. When rolled back, these covers expose the X-axis laser transducer and interferometer. The Y-axis transducer is enclosed in an aluminum channel running vertically on the column.

The numerically controlled Jigmil and laser combination is a machining/quality assurance system designed to produce large parts to Jigmil tolerances. This also enables superior quality control and inspection of such parts. The system of automated production of parts and subsequent inspection result in several advantages: precision machining of large work pieces, accuracy of large parts inspection, elimination of redundant fixturing, and minimized inspection time. *MESCO Press Release.*

CLASSIFYING FRESH AND REGENERATING USED FOUNDRY SAND

Growing industrialization necessitates the discovery of new deposits of foundry sand, or regeneration of used sand to meet the annual increase in the use of foundry sand. For fresh sand, classification is a closely controlled process, carried out by exact dosage of several pulp and fresh water flows. For this purpose calibrated rubber valves with snap closure are used at all underflows. Fresh water is regulated in a measuring tank, also by valves or by a flow control device. Each single flow of classification can be changed during operation by changing these valves.

The possibility of reclaiming foundry sand depends generally on the type of binders used. Generally, the feasibility of regenerating foundry sand cannot be given, because it is influenced by too many parameters (local prices of sand, water, energy, etc.). However, there are a number of valid factors in favor of regeneration.

1. Up to 85% of the foundry sand can be re-used after regeneration, with consequent savings in new sand.
2. All expenses for stockpiling and dumping the used sand are greatly reduced.
3. It is not necessary to have a big storage capacity for raw sand.
4. Difficulties in deliveries of the raw sand do not influence the operation.
5. The quality of raw material is not so important for the operation, because it is possible to raise the grade by classification.
6. Transport costs of raw sand are reduced.

Metallurgical Plant and Technology, March 1979. **PM**

JAPAN MISSION SUBMITS FINAL STUDY

Eight of the original 13-member Japanese mission returned to the country last September 3-5 to submit the final feasibility project study on the first Philippine integrated steel mill.

The group handed in the results of the final study conducted at the early part of the year, which covered raw material, infrastructure, demand forecast, finance, plant planning, production control, hot strip mill, cold rolling, and steel making.

The mission's activities included discussions with COCIS (Commission on the Organization and Construction of the Integrated Steel Mill Project) officials, representatives from financial institutions, members of the Philippine Iron and Steel Institute, and the Board of Investments headed by Minister Roberto Ongpin.

The members of the study mission were composed by Toshihiko Ariga (leader), Shohei Sato, Akira Oda, Yoshihiko Yoshihara, Shinsuku Hashimoto, Hidetsugu Nishimura, Michio Ookubo and Hideo Yasuki (coordinator, JICA).

Members of the Japan mission on the integrated steel mill project study meet with Dr. Antonio V. Arizabal, Executive Director of MIRDC prior to final talks.

JICA SURVEYS METAL CASTING CENTER

The Japan International Cooperation Association sent a 5-member working mission to the Philippines last July 1 to 15, 1979 to undertake a thorough study on the establishment of a metal casting center within MIRDC. This JICA-assisted project, now on its preliminary stages, has been designed primarily to develop local capability through production of capital goods to assist small and medium scale foundry industries along three major areas: shell moulding, die casting, and investment casting.

The JICA preliminary survey involved extensive discussions with officials from the National Science Development Board, National Economic and Development Authority, Ministry of Industry, and Board of Investments, as well as talks with members of the Philippine Foundry Society. These were supplemented by plant visits to foundries in the Metro Manila area to effectively assess the industry's capabilities and needs.

Another part of this program will be the development of MIRDC capability in the production of die casting molds, which is basically linked to tool and die making, with extensive manpower training and shop demonstrations.

The JICA mission was composed by Terushi Murata (leader), Kazunori Kobayashi, Seikei Fujimori, Tokuro Hishigori, and Akihiro Ohtani.

TIMEX TRAINEES GRADUATE

The MIRDC Mechanical Workshops Department (PPIII) recently concluded the 4-month training of ten employees from Timex, Phils. (Cebu). The training course covered basic metalworking and machining, primarily on turning, milling, grinding, and fitting. This also covered classroom sessions on workshop theory, technical drawing, engineering materials, and technical maethematics.

Recent graduates were Clemente Berdin, Delfin Burgos, Danilo Cemron, Nicolas Daclan, Rene Dakoykoy, Felix Jaca, Victor Patalingjug, Dario Dante Tino, Reynaldo Ramoneda, and Danilo Tabasa.

Lectures and general supervision on practical training were conducted by Joel Geronimo, Alex Tolentino, Gerry Nualla, Alan Masocol, and Leonardo Roque, Jr.

MIRDC WELDING CENTER ESTABLISHED; AUSTRIAN ADVISER ARRIVES

The Republic of Austria and the Philippine government joined hands recently to establish the MIRDC Welding Center at the Pilot Plant III, NSDB Science Community, Bicutan, Taguig, Metro Manila.

The project was initially proposed and specified by the Metals Industry Research and Development Center during a visit to Vienna by Economic and Planning Minister Gerardo Sicat at the last quarter of 1977, and came into full realization only in April this year with the arrival of welding equipment from Austria as stipulated in the Austrian technical assistance program. This program also includes the training of three instructors in Austria for a period of three months (March to May 1979), and advisory services of two Austrian welding experts who will stay in MIRDC for the duration of one year each.

All in all, the Welding Center shall undertake tungsten inert gas (TIG), metal inert gas (MIG), arc, oxy-acetylene, spot, and projection welding using the following machines and equipment: welding transformer; welding rectifier; shielded gas welding equipment; semi-automatic gas welding equipment; DC-AC-Pulsed shielded gas welding equipment; hand cutting machines; universal coordinate flame cutting machine; 3 drying furnaces; 16 sets cutting and welding equipment for oxyacetylene cutting; welding tools and accessories; welding electrodes; electrode holders and auxiliaries; pedestal drilling machine; double ended pedestal grinding machines; and didactic instruction and training devices.


Schwaiger

Richard Schwaiger, the first Austrian welding expert, arrived last May after his one-year advisory stint at the Materials Testing Institute in Bandung, Indonesia. A native of Bad Ischi, Ahornstrabe, Austria, he has undergone technical training with Deutsche Reichsbahnen and Osterreichische Bundesbahnen (machine division), and underwent training and study tours in various centers and machine tool factories at Chicago and Cleveland, USA.

Schwaiger worked as chief trainer at the Osterreichische Bundesbahnen, Attnang Pucheim in 1955, and further supplemented his studies through training courses at the WIFI-Wirthschafts-forderungsinstitut der Bundeskammer der gewerblichen Wirtschaft (federal chamber of commerce).

His expertise on welding and its applications, material testing and treatment, and other related fields is expected to give a great boost on the Welding Center's initial projects.


Asanti

ASANTI IS UNIDO/UNDP ADVISER

Dr. Paavo Asanti, a UNIDO/UNDP consultant, joined the MIRDC last August as chief project adviser for metallurgical research and development. Prior to this assignment, Asanti worked as consultant for UNIDO in Vienna in 1978-79, and served as metallurgy expert from 1972-73 and 1974-75 in Teheran, Iran. He was also a consultant in Finland and Scandinavia on foundry, mining, metal, and small scale industries for 33 years. In between this period he was at the same time a professor/lecturer in Foundry Metallurgy at Helsinki Institute of Technology, Finland.

Asanti completed his Diplom-Engineer degree in Chemical Metallurgy at Helsinki Institute of Technology, then proceeded to undertake special studies on metallurgy of iron and steel at the Royal Institute of Technology in Stockholm, Sweden. He pursued his doctorate course in 1943-44, finishing his Dr.-Engineer degree in Metallurgy of Non-Iron Metals at the Institute of Technology in Berlin-Charlottenburg. From 1944 until recently, he served as Director/Professor at the Metallurgy Laboratory of the Technical Research Center, Finland.

Aside from his impressive qualifications in the field of metallurgy, Asanti is also proficiently multi-lingual, speaking Swedish, German and English aside from his native Finnish tongue.

SEMINARS

A seminar on "Heat Treatment of Tools, Dies and Castings" was held last July 9 to 13, 1979 at the MIRDC Seminar Room, 5th Flr. Ortigas Bldg., Ortigas Ave., Pasig, capped by a plant visit to the Pilot Plant I, NSDB Science Community at Bicutan on the last day. The course dealt with theories, principles and applications of heat treatment of tools, dies and foundry castings commonly used in metal manufacturing and allied industries. Some basic aspects of metallurgy relevant to heat treatment were also included.

MIRDC resource speakers were composed of: Marcelo B. Villanueva, asst. manager, Materials Technology and Research Dept.; Mateo E. Espana, metal finishing engineer; Eduardo P. Lacbay, heat treatment engineer; and Fidelino E. Adriano, Jr., physical metallurgist.

From July 30 to August 3, "Production Planning and Cost Calculation" (in small and medium metalworking enterprises) was the topic of another seminar held at the MIRDC Seminar Room with demonstrations carried out at Pilot Plant III in Bicutan.

The course covered production planning and control, calculation of machining time, cost calculation and accounting in production, sequence of operations, and demonstrations on turning of cylindrical workpiece and calculation of cutting time for HSS and cemented carbide tip tool.

Speakers included the members of the German Advisory Group with Horst Witt, project manager; Reinhold Zimmerman and Johann Gerle, advisers for basic training; and the following MIRDC technical staff: Leonardo Roque, Jr., asst. tool & die engineer, Dante Garvida, planning and scheduling officer II; and Jesus Climacosa, analyst.

The last seminar for the quarter, "Gating and Risering", was conducted last August 27 to 29. Mainly focusing on the fundamentals and practices involved in the complete assembly of sprues, runners, gates, and individual casting cavities in the mold, the seminar also included practical data and application of the gating system design as formulated by the Casting Division Committee of the Japan Foundrymen's Society.

Dr. Kiyogi Deguchi, steel casting expert, and Antonio F. Lazo, MIRDC senior foundry engineer, lectured on various topics.

ARRIVALS/DEPARTUREs

Nonito Garcia (jr. engineer) and Julian Oro, Jr. (asst. foundry engineer) arrived from Germany last July after 19 and 21 months of training, respectively. Garcia trained on operation and workshop management while Oro concentrated on workshop management and organization, under the auspices of the MIRDC-Federal Republic of Germany Technical Assistance Program.

Feliciano Dungca (jr. engineer), Aristeo Mercado (welder III) and Salvador De Paz (welder II) arrived from Austria last August 30 after three months of intensive training on welding technology. This area is part of the MIRDC-Austrian Technical Assistance Project, which started last May with the establishment of the MIRDC Welding Center.

Marcelo B. Villanueva, head of the Materials Technology and Research Dept., left last August 12 to attend a 3-week seminar on "Management of Technology Transfer" in Pattaya, Thailand. His trip was sponsored by the European Economic Community (EEC) and the Association of South East Asian Nations (ASEAN). **pm**

new arrivals

MIRDC library

JOURNALS

American Machinist	:	*January, April, May 1979*
Analytical Chemistry	:	*Vol. 50 nos. 4-14; Vol. 51 nos. 1-6*
Control Engineering	:	*January-May 1979*
Corrosion Science	:	*Vol. 19 Nos. 1-2*
Die Casting Engineer	:	*January, February 1979*
Electrical Construction & Maintenance	:	*January – June 1979*
Electronic Engineering	:	*March 1979*
Foundry Trade Journal	:	*May 10, 1979*
Instrument & Apparatus News	:	*January, February, April, May 1979*
Instruments & Control Systems	:	*January-March 1979*
International Modern Foundry	:	*January 1979*
Iron Age Metalworking International	:	*January 1979*
Iron & Steel Engineer	:	*January-March 1979*
Iron & Steel International	:	*February-April 1979*
Ironmaking & Steelmaking	:	*Vol. 6 Nos. 1-3 1979*
JENA Review	:	*Nos. 1-2 1979*
Journal of Metals	:	*January-May 1979*
Journal of Testing & Evaluation	:	*January 1979*
Light Metal Age	:	*January-February 1979*
Machine Design	:	*January-June 1979*
Manufacturing Engineering	:	*January-June 1979*
Mechanical Engineering	:	*January-July 1979*
Metal Bulletin	:	*January-August 1979*
Metal Bulletin Monthly	:	*January-February 1979*
Metal Finishing	:	*January-February 1979*
Metal Progress	:	*January-March 1979*
Metallurgia	:	*January, February, April 1979*
Metallurgical Plant & Technology	:	*Nos. 1-3 1979*
Metallurgical Transactions	:	*January-May 1979*
Metals Australia	:	*January-April 1979*
Metals Technology	:	*January-July 1979*
Metalworking Production	:	*January-February 1979*
Metrologia	:	*Vol. 15 No. 1 1979*
Metrology & Inspection	:	*January 1979*
Modern Casting	:	*January-May 1979; July 1979*
Modern Materials	:	*January-March 1979; June 1979*
Modern Metals	:	*January-March 1979*
Plant Engineering	:	*January-July 1979*
Popular Electronics	:	*January, February, April, June, August 1979*
Practical Metallography	:	*January-May 1979*
Product Engineering	:	*January-July 1979*
Sheet Metal Industries	:	*January-February, April 1979*
Steel in the USSR	:	*January 1979*
Transactions of the Iron & Steel Institute of Japan	:	*January-May 1979*
Welding Journal	:	*January, February, March, May 1979*

domestic prices

TABLE 1
DOMESTIC RETAIL METAL PRICES
(In Philippine Pesos)
July-September, 1979

ITEMS	UNIT	PRICE
G.I. Roofing Sheets;		
Corrugated, Gauge # 26 x 32"	Linear ft.	₱6.00 – 6.10
Corrugated, Gauge # 31 x 32"	"	3.80 –
Plain, Gauge 26 x 32"	"	6.00 – 6.10
Aluminum Sheets (1100 Alloy):		
.016 x 36" x 8'	Sheet	60.00 –
.019 x 36" x 8'	"	71.10
.024 x 36" x 8'	"	88.75
.027 x 36" x 8'	"	99.75
.320 x 36" x 8'	"	117.45
Square Bars, 20':		
3/8" x 3/8"	Each	14.50 – 15.00
1/2" x 3/2"	"	220.00 – 22.00
5/8" x 5/8"	"	37.00 – 38.00
1" x 1"	"	unquoted
Round Bars, 20':		
1/4" (5mm)	Each	6.50 – 7.00
3/4" (std.)	"	42.00 – 43.00
3/8" (9mm)	"	13.00 – 13.50
1/2" (11mm)	"	21.00 – 22.00
5/8" (14mm)	"	30.00 – 32.00

TABLE I
DOMESTIC RETAIL METAL PRICES
(In Philippine Pesos)
July-September, 1979

ITEMS	UNIT	PRICE
Angle Bars, 20"		
1/8" x 3/4"	Each	₱22.00 – 23.00
1/8" x 1"	"	28.00 – 30.00
3/16" x 1"	"	36.00 – 38.00
1/4" x 1"	"	47.00 – 48.00
3/8" x 3"	"	47.00 – 48.00
Flat Bars (mm size) 20':		
1/8" x 3/8"	Each	10.00 – 12.00
1/8" x 1/2"	"	11.00 – 12.00
3/16" x 1"	"	25.00 – 26.00
1/4" x 1/2"	"	19.00 – 25.00
1/2" x 1/ 1/4	"	unquoted
Galvanized Iron Pipes (ordinary) 20'	:	
1/2"	Each	39.00 – 40.00
3/4"	"	56.00 – 58.00
1"	"	80.00 – 82.00
1 1/2"	"	135.00 – 140.00
2"	"	170.00 – 175.00
Black Iron Pipes, 20':		
1/4"	Each	41.00 – 42.00
1/2"	"	35.50 – 36.00
1"	"	60.00 – 65.00
1 1/2"	"	115.00 – 120.00
2"	"	140.00 – 150.00

Source: *Bureau of Domestic Trade*
Ministry of Trade
Quezon City, Philippines

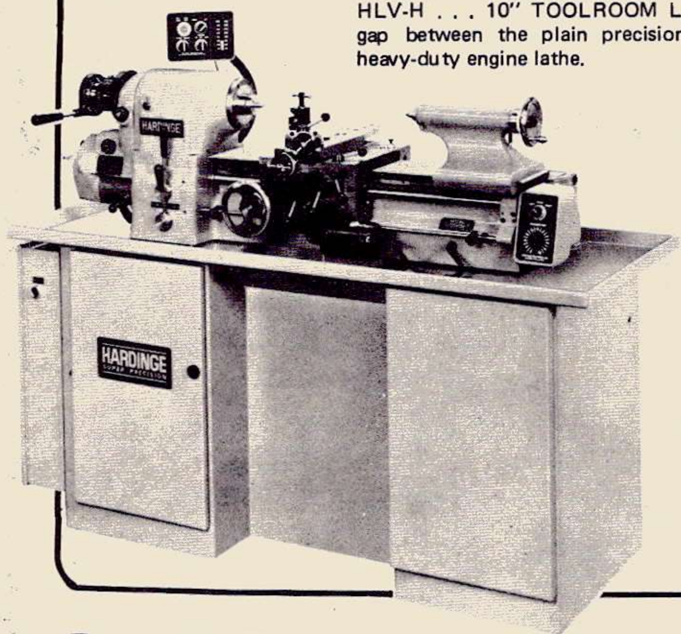
TABLE 2

Japan Monthly Average Price
(In U. S. $ per M. T. unless otherwise indicated)
July – September, 1979

IRON & STEEL	July	August	September
Round Bar, 9 mm	301.27	313.29	310.08
16 – 25 mm	311.19	328.19	322.00
Flat Bar, 6 x 50 mm	341.68	346.77	330.06
Equal Angle, 6 x 50 mm	306.91	310.19	303.07
10 x 90 mm	315.63	318.88	311.02
Channel, 6 x 65 x 125 mm	321.68	323.74	317.84
H–Shape, 9/14 x 250 x 250 mm	391.61	390.35	383.38
Hot–Rolled Sheet (3 x 6), 1.6 mm	413.33	401.58	390.96
Cold–Rolled Sheet (3 x 6), 1.2 mm	456.88	454.24	444.37
Medium Plate, 3.2 x 3 x 6	402.84	389.96	377.69
Plate 6 x 4 x 8	397.44	382.99	372.01
9 x 4 x 8	391.19	378.82	368.23
Gas Pipe (black), 15A (1/2 inch) (per leg)	0.45	0.45	0.44
Water Pipe (white) 15A (1/2 inch) (per leg)	0.64	0.64	0.63
Galvanized Sheet			
(plain), 0.30 mm	551.05	550.82	539.31
(corrugated), 0.25 (per sheet)	1.78	1.80	1.76
Wire Rod, 5.5 mm	92.63	92.36	90.36
Round Nail, 100 mm (4 inches)	501.17	502.65	495.51
Iron Wire, No. 8	438.23	436.82	427.32
Annealed Iron Wire, No. 8	458.79	463.54	454.60
Barbed Wire, No. 14	641.77	642.06	628.49
Tinplate, 90L (0.23 mm)	558.04	556.25	544.16
Wire Rope – JIS (per 200 m)			
1st Grade, zinc coated (24 x 6)			
10 mm	1.98	1.97	51.93
20 mm	508.16	506.52	495.51

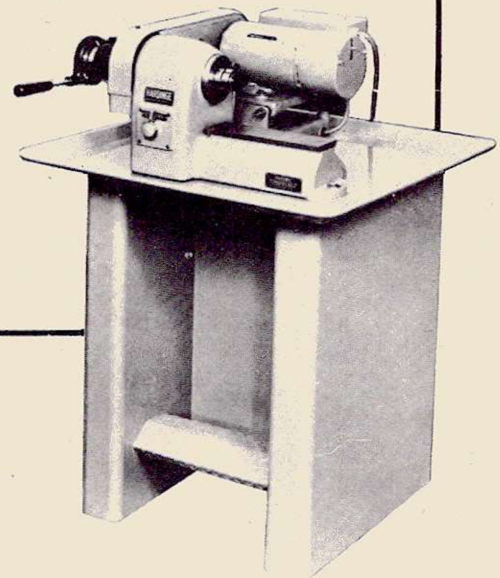
NON – FERROUS METALS	July	August	September
Electro. Copper	1,912.96	1,984.27	2,034.71
Electro. Zinc	912.17	879.45	837.98
Electro. Lead	1,425.41	1,378.21	1,335.77
Tin	16,421.89	15,850.13	16,005.71
Antimony	3,892.77	3,802.78	3,591.34
Nickel	8,158.50	8,132.25	8,107.03
Selenium	53,613.00	53,440.50	52,279.00
Bismuth	11,188.80	11,152.80	9,546.60
Cadmium	9,347.31	9,317.24	8,367.40
Mercury	410,256.00	393,445.97	372,772.00
Aluminum	1,851.19	1,769.35	1,732.78

PHILIPPINE metals



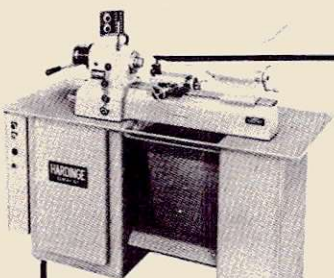
HLV-H . . . 10" TOOLROOM LATHE. Fills the gap between the plain precision lathe and the heavy-duty engine lathe.

HSL-59 . . . SPEED LATHE. Can be used to face, chamfer, drill, turn external thread, radius turn, taper turn, form knurt and cutoff.

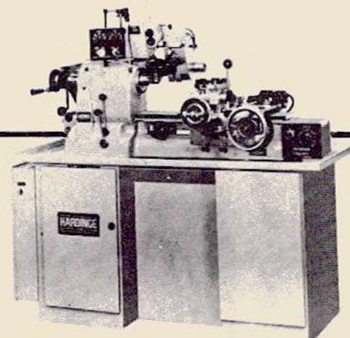


Our Technology — Your Productivity

The Hardinge Family consists of Super-precision toolroom lathes, chucking, second-operation, and bar and chucking machines. Any one is a guarantee of accuracy and durability. Assures better returns on investment.

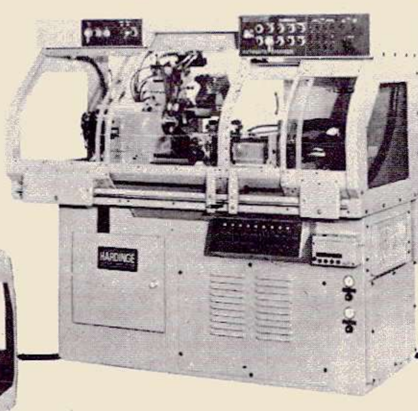


DV-59 . . . Meets the requirements of extreme lasting accuracy, high spindle speeds, and the case in operation required for the smaller diameter work range.

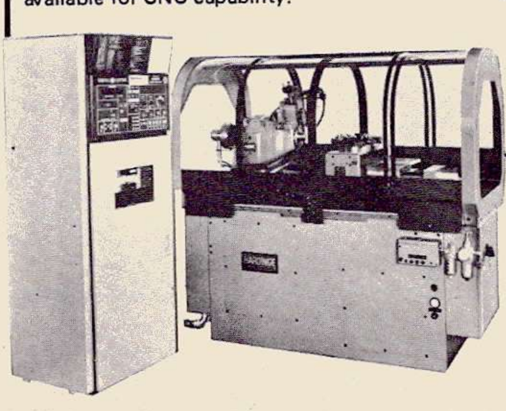


HC-AT . . . This CHUCKING MACHINE can finish diameters, shoulders and end faces, and cut precision threads in one setting. Produces closer tolerance parts on a production basis.

HNC . . . BAR AND CHUCKING MACHINE
Two modes, precision and super-precision, are provided for .0001" resolution and .000020" resolution respectively. The super-precision mode is used to provide low micro finishes and tight tolerance. The precision mode insures minimum cycle time. Optional microprocessor is available for CNC capability.



AHC . . . FULLY AUTOMATIC CHUCKER AND BAR MACHINE.
Has a simple direct unit for programming automatic cycle, including the closing and opening of collets, operation of the cross slide, carriage, vertical slide, automatic threading unit and all 6 stations of the turret. The AHC can turn, face, bore and thread with One Chucking and One Handling.



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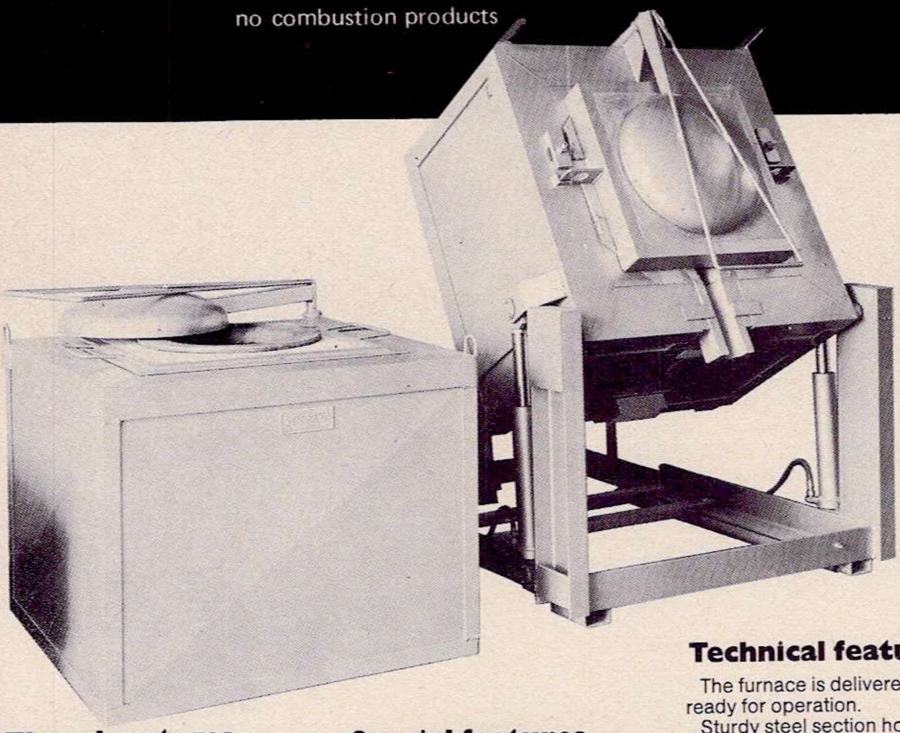

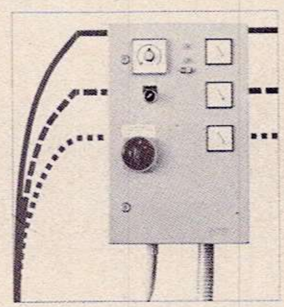

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PHILIPPINE metals

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On the cover:
The Toyota Tamaraw, Delta Motor's successful entry into the utility vehicle market.

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DEPARTMENTS

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HERALD PRINTING SERVICE

When applied to blasting processes, automation requires the integration of material handling and blast systems. The result of this is expected to produce faster or better products than a non-automated process. There are various types of blasting systems and each has its own advantages and disadvantages. The same applies to material handling methods that can be employed. The various aspects of finish, handling methods, and blast systems are presented by Harry Y. Jackson, senior engineer at Empire Abrasive Equipment Corp., in "Automated Blasting Processes for Scale Removal and Finishing."

On the other hand, "The Testing of Vibratory Finishing Media" by John B. Kittredge, vice president and technical director of Roto-Finish Co., discusses the reasons for testing vibratory finishing media. Also mentioned are the relevant points to be included, significant variables which control the accuracy and reliability of results, and recommendations for good testing procedures. Several equations on media wear rate, hours of operational use of media, and media depreciation rate as derived from chip dimensional changes are likewise presented. Serious investigators are encouraged to test media as required to suit their purposes. Many users of vibratory finishing systems will gain knowledge of their process and valuable cost saving by such effort.

Modern methods of cutting metal into various forms, sizes, and different materials are covered in "Modern Metal Cutting", prepared by the technical staff of Sandvik Coromant Division, Sandvik AB, Sweden. Among the topics covered are machinability, tool materials, cemented carbide and its manufacture, carbide grades classification, geometry and edge clamping, and cutting edge wear. Of importance in this paper is the knowledge that the variation of products involved in metal cutting is considerable and according to functional demands. The cutting edge involved in machining ranges from super-alloy components in aircraft engines to cast-iron auto engine blocks, and can be operated on products ranging from aluminum frames for sewing machines to steel axles, gears, bearings, etc.

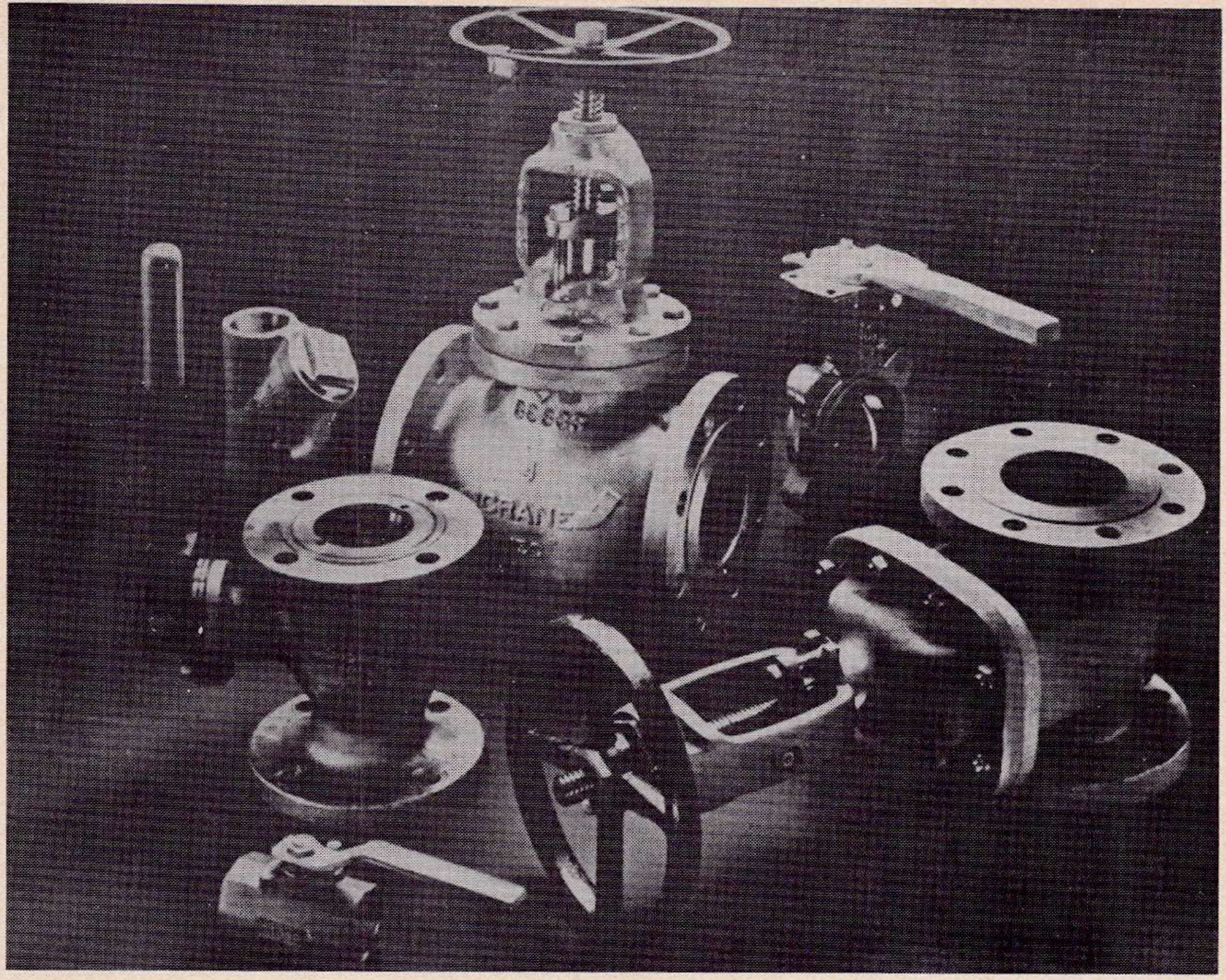
Eliseo Santos of Philippine Electronic Industries, Inc. undertakes a comprehensive report in "Factors to Consider in Choosing an Oscilloscope", the latter being an instrument for displaying or recording electrical oscillations in a wavy line, visually projected on a fluorescent screen of a cathode-ray tube (crt). Oscilloscopes are used nowadays not only to record electrical and sound waves, but specifically for speech therapy, electro cardiograms, and monitoring speech patterns in criminal investigations. As such, these have been adapted for quite a number of uses with different variations in crt displays. This article takes into account key specifications and features, configuration, crt displays, crt phosphor data, and other factors.

In another development, the Oracle of Delphi is applied in a parallel context in the field of manufacturing technology, as explained in "Making Technology Forecasts Come True", by Frank Daley, Jr., Director, General Motors Corp. The author identifies some of the more significant predictions in the 1977 Delphi Forecast of Manufacturing Technology, and discusses obstacles to the achievement of the forecast. These include deficiencies in R & D community credibility, limited investment incentives, and problems of technology transfer. Several strategies for overcoming these obstacles are presented. Among them are tracking the time value of money, understanding the production environment, clear communication with management, and cooperative R & D.

As regards forecasts and foresight, these are perhaps the passwords at Engineering Equipment, Inc., which has mobilized a highly competent labor force to gain inroads abroad in construction, quality castings, and machinery. And how does one manage such a diversified corporation? Through common sense, says EEI president Ven. O. Ducat, who is featured in our interview on "Men in the Metals Industry." This suave and affable person is not one who plays with words, reflecting a kind of management that has put EEI in the highly profitable bracket. We encourage you to read on about the man who, through common sense and effective leadership, stands out among the country's corporate giants. Surely an inspiring subject.

On an equally interesting scale, we have Delta Motor Corporation for our "Cover Story." Starting literally from scratch, Delta Motor was the brainchild of a group of young entrepreneurs led by Ricardo C. Silverio, who dreamed of conquering a market then dominated by American and European models. Despite the fact that the industry was considered the "big leagues," the company made it through all the travails and hardships of a seemingly impenetrable market, emerging as the industry leader after only seven years. Asserting its superiority in sales and PCMP content, Delta Motor now ranks as the 11th largest corporation in the Philippines. The company presently turns out not only passenger cars, utility vehicles, buses, commercial, industrial, and military vehicles, but also quality precision castings for export to Japan and other countries.

For those who belong to the field of metal manufacture, "In the Limelight" this issue is the Metalworking Industries Association of the Philippines (MIAP). The association was recently established to answer the need of consolidating all companies engaged in metalworking into one body. Its primary aim is to achieve unity and cooperation in the industry. Among the areas covered by the metalworking industry are the manufacture and fabrication of: metal products; machine tools; engines and general industrial machinery; transport equipment; farm machinery and equipment; heavy equipment; construction and mining machinery; electrical machinery; transport equipment; chemical processing machinery and equipment; food product machinery and equipment; textile and shoemaking machinery; office machines; appliances; and tools, die, jigs, fixtures and gages.



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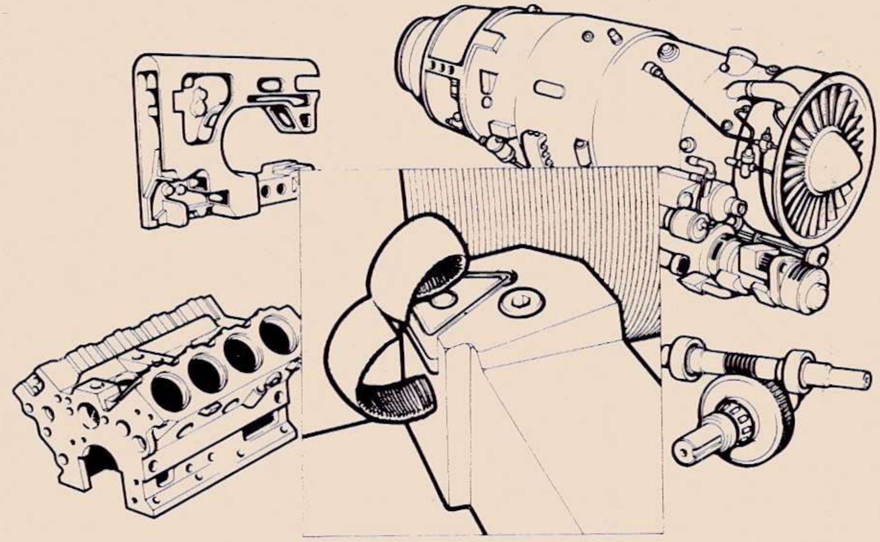
Modern Metal Cutting

The Technical Staff
Coromant Division
Sandvik AB, Sweden



INTRODUCTION

A considerable part of the manufacturing industry is known as the metalworking industry. It produces all the things in every day life which are made from metal.

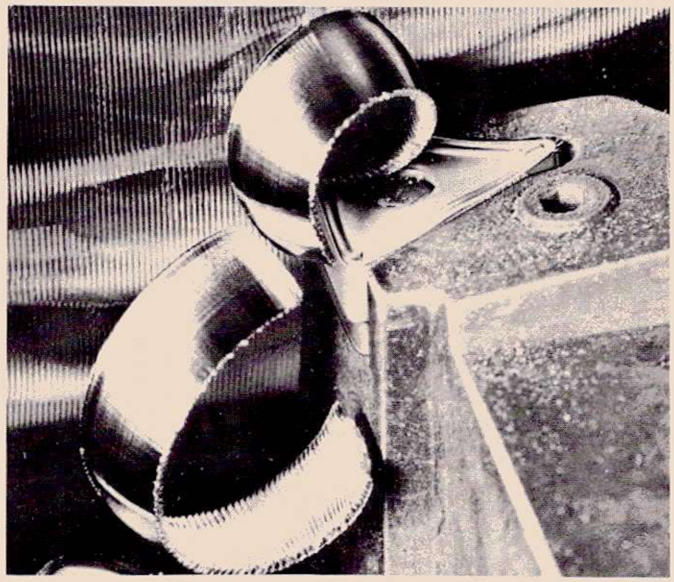
There are various ways of making all these products from the initial material in form of metal bars, rods, tubes, sheets, etc. This initial material can be subjected to one or more of three common metal working methods: *casting,* where the metal is heated and poured molten into forms; *forming,* where the metal in a hot or cold state is forged into shape; and *metal cutting,* where the shape is obtained through removing metal with a cutting edge. Often a combination of two methods is the rational way of making a product, for instance, first forming or casting the piece somewhat close to the shape of the product and then cutting it to the right shape and size.

This training material will cover only *metal cutting*. We will review modern methods of cutting metal into various forms, sizes and in different materials. The variation of the products that are involved in metal cutting is considerable and all according to the functional demands. The cutting edge is involved in machining ranging from the super-alloy components in aircraft engines to cast-iron auto engine-blocks and from aluminium frames for sewing machines to steel axles, gears, bearings, etc.

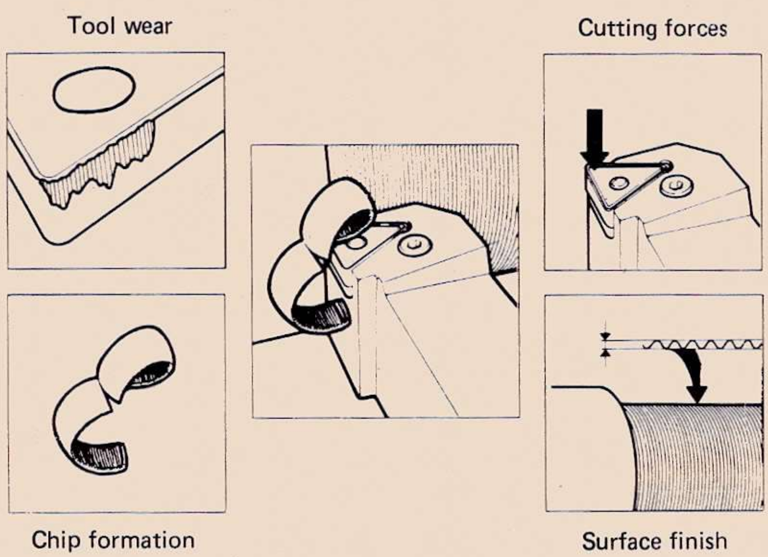
Machinability

Although not so apparent when being examined with just the basic human senses of perception, these metals are different, some of them considerably so. Apart from the obvious differences in appearance and weight, many of the characteristics are not apparent until the metals are to be machined. A casual examination reveals metals to be hard when compared to most other materials. However, some of them are so hard they can only be cut with great difficulty while others are so soft they cut easily and even stick to the cutting edge. Some metals flake off while others almost refuse to have anything but very long chips cut off.

The characteristics that are of interest in metal cutting are those that affect the *machinability* of metals. This is an informative data description of the demands involved in cutting the metal to a certain form, size and finish. Usually the most important factor is the wear the cutting tool is subjected to. Others are the way the metal comes off when cut (chip formation), the forces generated when the tool cuts into the metal and how the surface turns out after machining.



This is a close-up view of metal cutting. The chip can be seen being parted from the piece of metal by the cutting edge. Metals vary considerably in how they can be cut and the cutting edge has to be adapted to stand up to the various demands imposed on it.



The strife in metal cutting is for fast removal of metal and reliability. An important factor for success is to consider the machinability of the metals to be machined and select cutting tools accordingly. Later on we shall review the metals as they most frequently occur in the metal working industry but first: What is a modern metal cutting tool?

Irrespective of the metal cutting method — there are only a few principal ones — the cutting tool can be said to be made up of three components: the material from which the cutting edge is made *(tool material)*, the shape of the actual cutting edge (*cutting edge geometry)* and the way in which the cutting edge is held in the tool, as the edge is usually made from a different material to the rest of the tool *(edge clamping method)*. These three tool components are key factors for selecting the tools for machining and how successful the operation turns out to be. The cutting edge geometry and edge clamping method are very much related to the metal cutting method and will be treated when we review these. The cutting tool material, however, is very much the same for most methos and can be treated in general.

Tool Materials

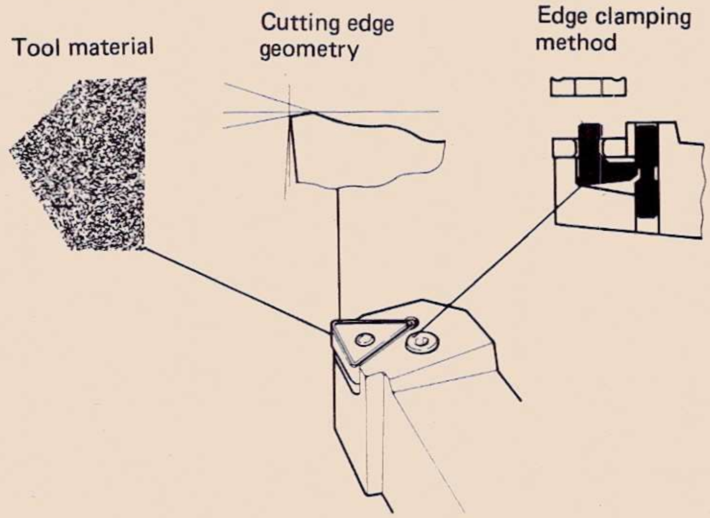
Let us first study the historical development of tool materials. An interesting way of looking at this is to see how much time was needed to machine a certain workpiece for each of the various tool materials as they were developed.

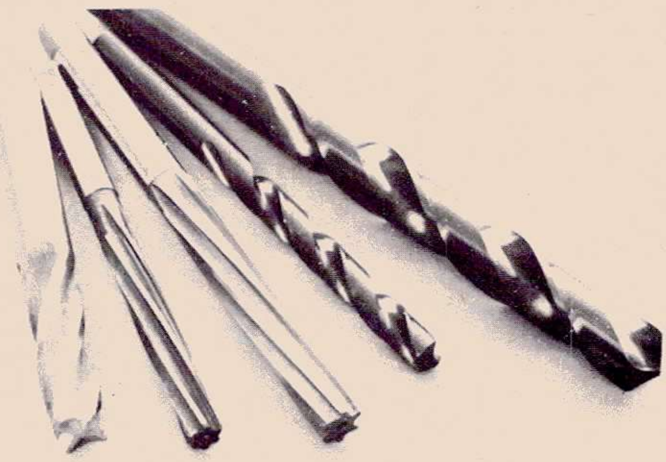
Up to the beginning of this century, *steel* was the main tool material for cutting metal. The edge of the tool was hardened and could stand a machining temperature of 500°F, which is very low compared to the temperatures generated in modern metal cutting. Low machining speeds had to be used and let us say we are looking at a workpiece which in 1900 took 100 minutes to machine.

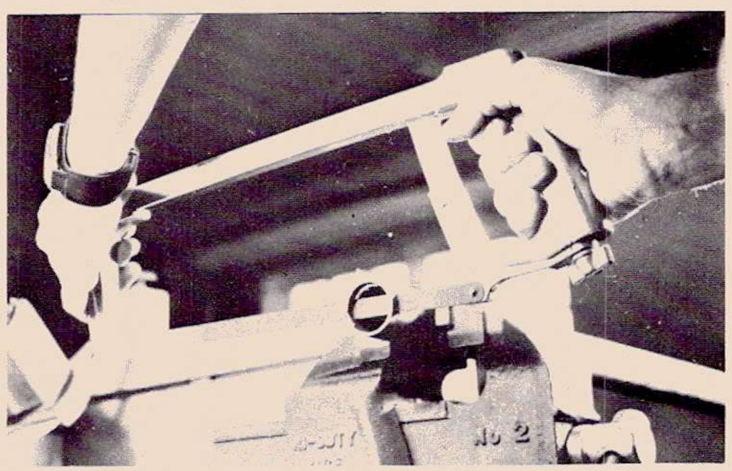
During this period, an American named F.W. Taylor found that there existed a relationship between the heat treatment of alloyed steel and the way the cutting edge stood up to machining. In actual fact he discovered that by including a number of very hard particles he could increase the durability of the edge. In 1906, he had produced a high speed steel (HSS) which could stand 1200°F and machined the mentioned workpiece in 26 minutes. HSS has been subjected to considerable development as regards the alloying elements and the manufacturing process. It is still a very widely used tool material and for some applications is still the best choice.

After further experiments, an improved tool material was formed called *stellite*. In 1915, this tool material had a temperature limit of 1500°F and could machine the workpiece in 15 minutes.

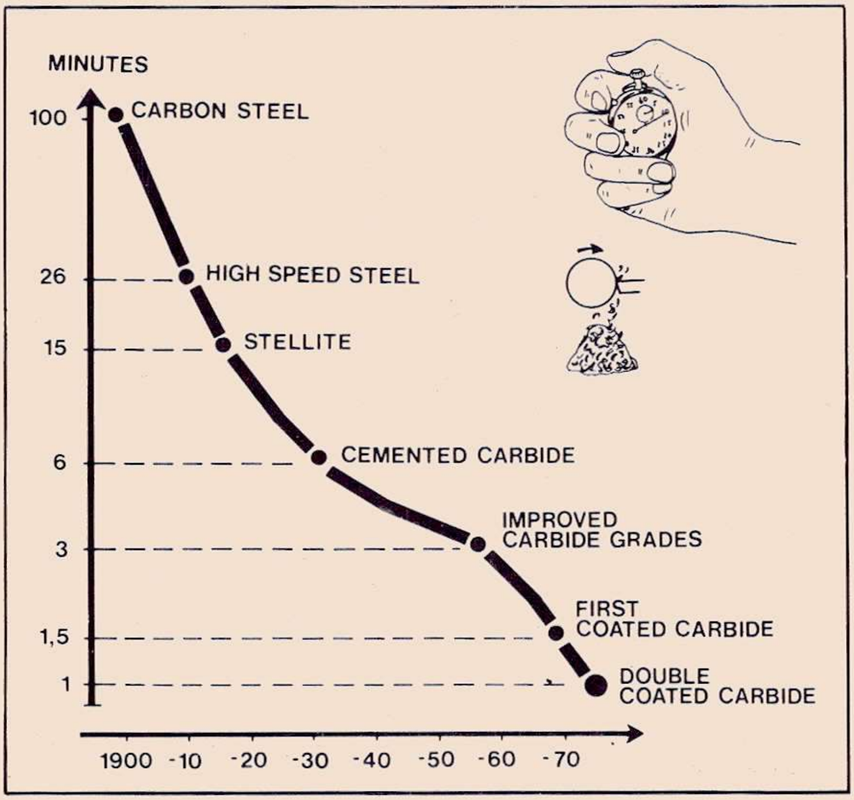
The three main components of a modern cutting tool.

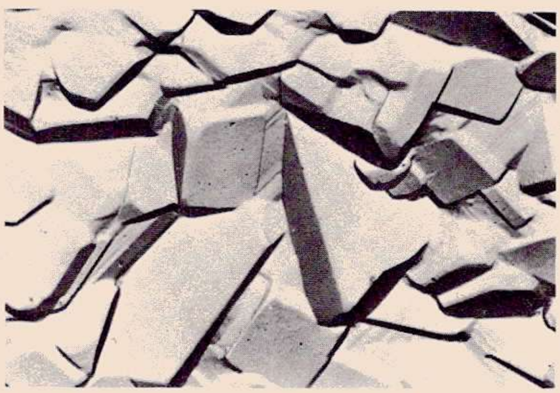






Above and below are some common high speed steel tools: drills, reamers, endmills and saw-blades. HSS is still a very widely used, and for some cutting tools often the best, tool material.





Cemented carbide is a product of powder metallurgy -- quite different from a metal alloy such as steel. This picture is of cemented carbide magnified 25,000 times and shows the two main constituents: hard particles embedded in a binder material.

The next step was to be a revolutionary one not only for metal cutting but for a number of other manufacturing processes, etc. *Cemented carbide* was first made around 1920 but was not to be used widely for metal cutting until 1930. In some ways the concept in high speed steel of including very hard particles in a binder metal was further developed in cemented carbide. However, whereas HSS is a metal alloy containing about 20% hard particles, cemented carbide is a synthetic material containing some 90% hard particles. The first carbide cutting edges reduced the machining time of the same workpiece to 6 minutes.

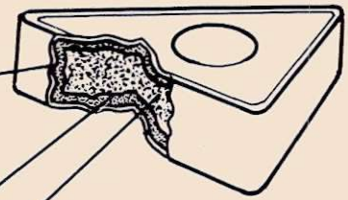
Cemented carbide was subjected to extensive research and development and since 1930 improvements have been considerable. The next marked stage was during the fifties when improved and specialized carbide grades were introduced reducing the machining time of the same workpiece to 3 minutes.

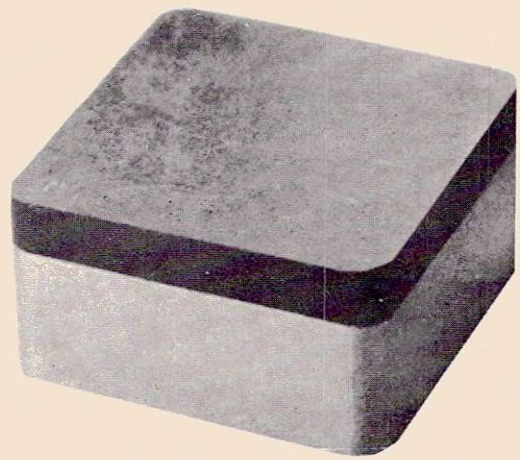
1969 saw the first *coated carbides* — another big step. In principle a conventional cemented carbide cutting edge was given a layer of hard particles in the form of carbides. This layer considerably increases the durability of the cutting edge. The process was called Gamma Coating, hence the denomination GC for the Coromant carbide grades. Also coated carbides have been subjected to a lot of development since their introduction and "generations" of coated carbide have appeared over the years. In 1976, Coromant introduced a double-coated grade. A layer of aluminium oxide was applied on top of a layer of carbide making a durable cutting edge. Ceramic cutting tool materials are to a large extent based on aluminium oxide and in the form of solid cutting edges they are relatively brittle. However, in the form of a very thin layer it was found to have a very different physical property. Double-coated grades, like GC 015, are rated to provide more than twice the metal removal rate per edge as compared to the ' first generation" coated carbides and about six times that of conventional carbide for the same application.

Ceramics are sometimes wrongly thought of as being the most "modern" of cutting tool materials. Although having been around since the 1950's, this synthetic tool material has not developed into the major cutting tool material as thought it would. The main reason for this is the unfortunate balance of wear resistance and toughness.

Ceramics are extremely wear resistant but not very tough. As such they cannot stand up to interrupted cuts and/or unstable conditions. In late years mixed ceramics have been developed with somewhat better toughness characteristics. Ceramic tool

GC 015 is a double-coated carbide. This is a greatly magnified structural view. This tool material is capable of very high speeds and covers a very large range of applications. The layers are bonded chemically through a complicated process. The carbide cutting edge has been provided with a coating of hard particles for added wear resistance.



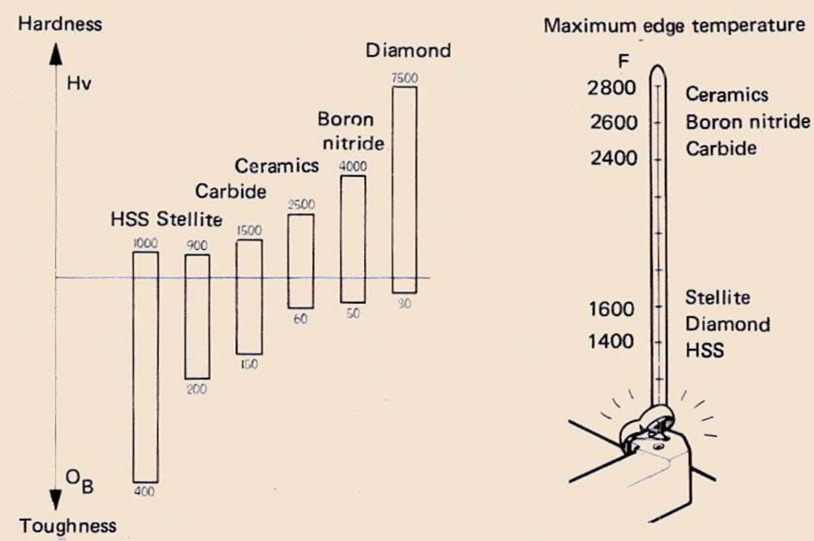


A cutting edge with a diamond layer on a carbide base. The reliability of these wear resistant but brittle cutting edges is related closely to how carefully they are manufactured.

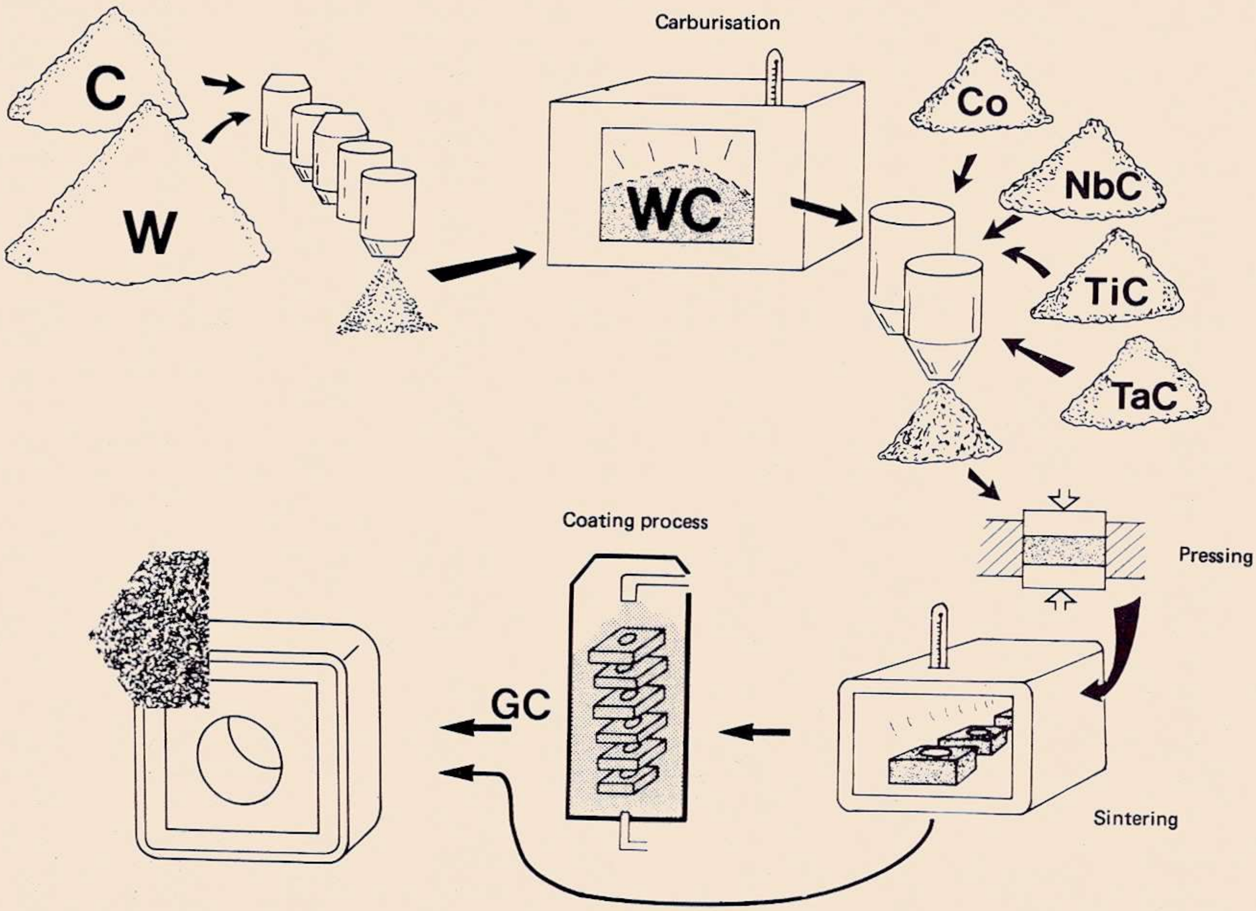
materials certainly have applications where they are of advantage such as in some light machining with very stable conditions.

Diamond and boron nitride are also synthetic tool materials with really super-hard constituents. They are described as being of polycrystalline structure. Extremely wear resistant, they are also very brittle. Usually these materials are used either as layer of around 0.4 in. on carbide or as solid cutting edge. Diamond and boron nitride tools are suitable for machining abrasive workpiece materials at cutting rates which cause a low to moderate temperature at the cutting edge.

The following graph and temperature scale indicates some vital properties for main cutting tool materials. The graph to the left is a combination of hardness (Vickers) and the bending strength of the materials which here will symbolize the toughness. Important to note is the proportion of hardness to that of toughness for each



material. High speed steel is very tough but marginally hard, diamond is extremely hard but very brittle and cemented carbide is an advantageous balance between the two. This is important for the durability of the cutting edge during machining because it means that the edge can stand up well to stresses as well as wear.



The manufacture of cemented carbide

To the left is a temperature scale where the materials have been placed according to their maximum edge temperatures. During machining extremely high temperatures are generated and this is the highest temperature which each material can stand. A combination of high values for each of the three properties is, of course, the most advantageous. In this respect, it is easy to see why cemented carbide has become such a widely-used cutting tool material. Today, ceramics, diamond and boron nitride stand for about 5% of consumed tool material reckoned in money and amount of metal removed. High speed steel stands for 65% in money but only 25% in metal removed. Cemented carbide, on the other hand, stands for about 30% of the money consumed on tool material and removes some 70% of all metal.

Cemented Carbide

The cutting tools treated throughout this course will have cutting edges made of cemented carbide. It is only fair then that we look at the manufacture of this tool material.

As a powder metallurgical product, cemented carbide is quite different to a metal alloy such as steel. The constituents at the beginning of the manufacturing process are in the form of powders. These are processed in a way that forms a material made up of hard particles embedded in a binder metal. The end-product is hard, thermally stable, relatively tough and wear-resistant enought to make it a very suitable tool material.

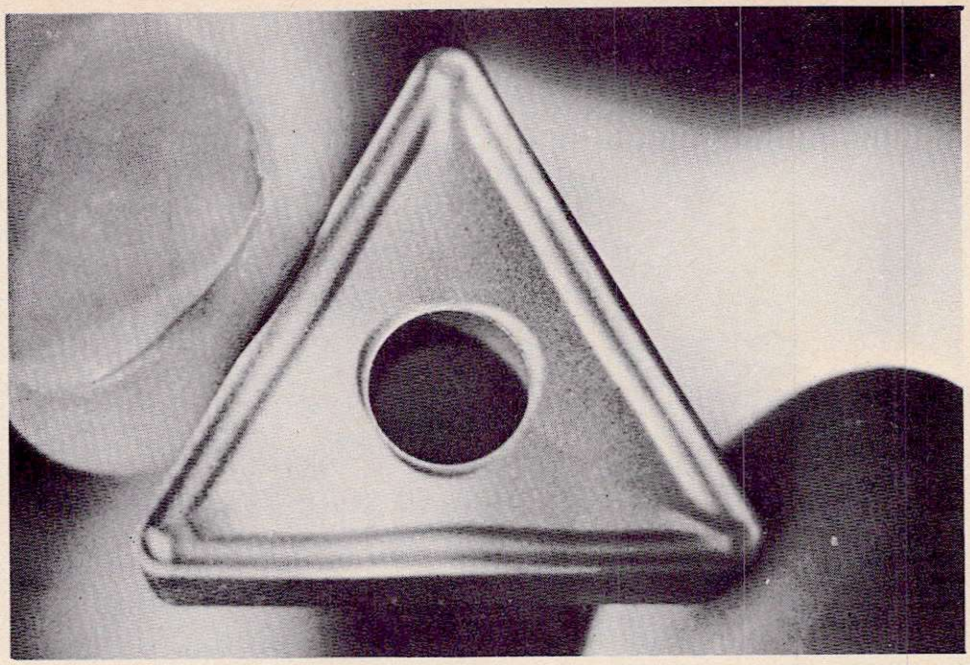
The process starts off with tungsten (W) and carbon (C) powders. These are mixed accurately and heated to a temperature of about 3400°F. This is a carburisation process which makes tungsten carbide. These are the basic hard particles of cemented carbide.

By using different types of tungsten powder and other additives it is possible to produce various combinations each with certain characteristics.

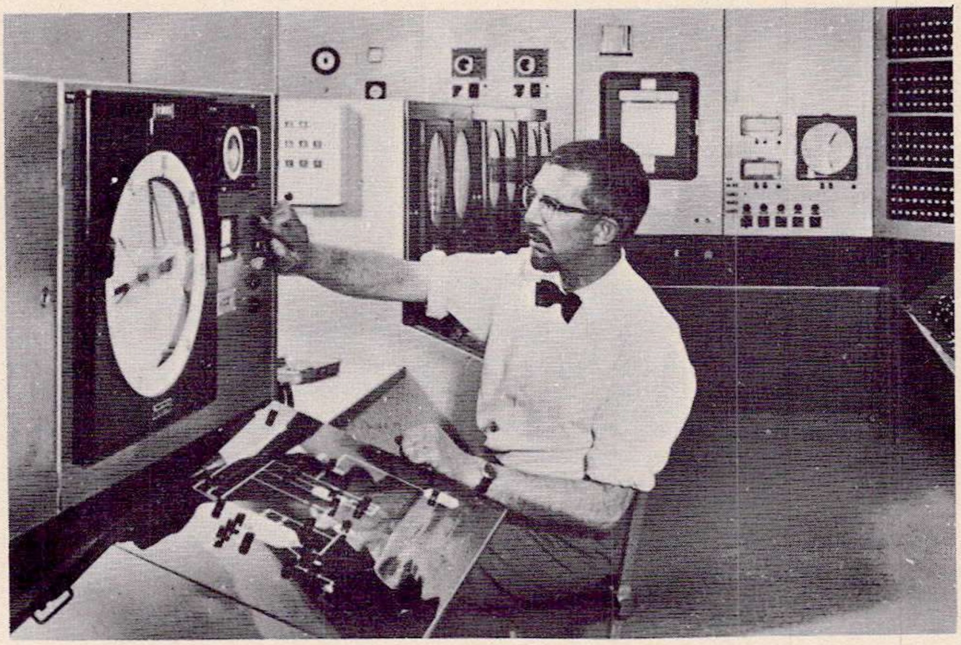
The next basic additive is the binder metal, often the metal cobalt (Co) in the form of powder. Other hard particle additives are the carbides of niobium (NbC), titanium (TiC) and tantalum (TaC). These ' raw materials' are then mixed according to which type of cemented carbide is required. They are subjected to a number of subprocesses to form a mix suitable for pressing.

For pressing the powder mix to compacts, dies have to be made up in the shape but not size of the end-product. The pressed compact is about 50% porous. The porosity disappears during the next stage, sintering. This is a "baking" process in which part of the powder mix will be in a molten state. The carbides not dissolved react with each other and change structure. A temperature of about 3000°F is used and the compact undergoes a linear shrinkage of about 20%.

GC-coating is a complicated process where the inserts are subjected to a chemical vapor in a vacuum atmosphere at a high temperature. The layers applied are only about .0004 in. thick but have a dramatic effect on the durability of the cutting edge.



The product to come out of sintering is a cemented carbide insert or tip — the edges of cutting tools. Some inserts are ready at this stage, some may require grinding and some may go to the coating process and become GC-type inserts.

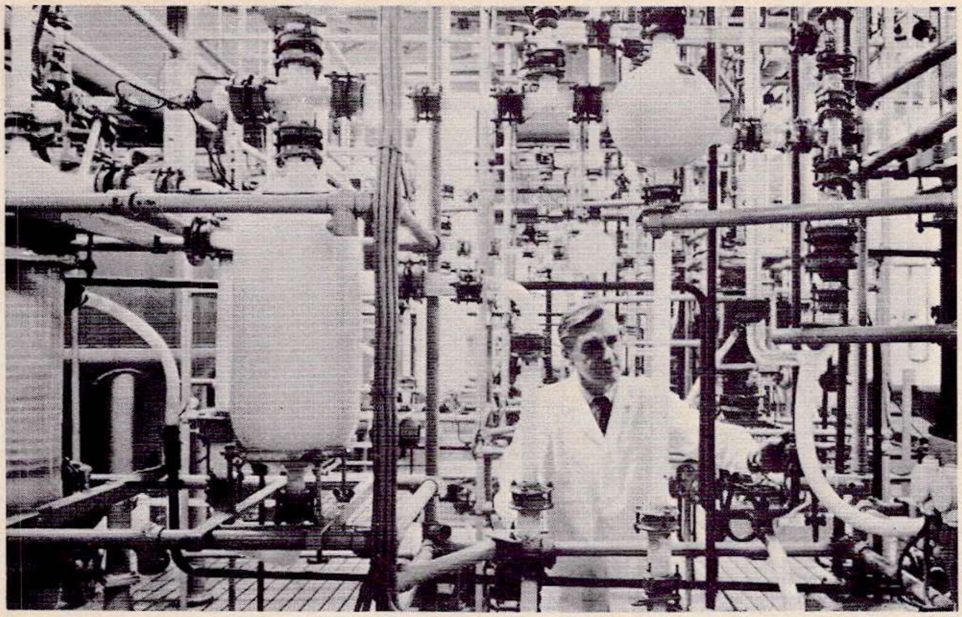


The manufacture of cemented carbide calls for specialized personnel, good equipment and very careful surveillance and control. The process is to a great extent automatic with programmed sequences and supervision from a control room.

Carbide Grades Classification

Through various mixtures of the constituents, process variables and coating, a program of carbide grades can be established to cover a range of machining of materials and working conditions. Today, there are some twenty Coromant grades of which half a dozen are coated. This program of grades changes continually in line with the rapid development of cemented carbide — a new grade is developed and being that much better than other grades in that area it either replaces or becomes an addition.

Two classification systems exist today: the ISO, used internationally and the American C-system used in the US. The systems are not very similar in structure and the ISO-system is more definitive. For this reason it is clearer to describe the



The final and pre-delivery tests are carried out on random samples taken from each charge using statistical principles. The samples are assessed with respect to their outside dimensions, porosity, structure, grain size, density, hardness and, in some cases, cutting performance.

ISO		
P	M	K

	ISO		
	P	M	K
01			
10			
20			
30			
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50			

ISO-system and then relate it to the C-system.

Three main application areas have been drawn up called P, M and K. These stand for various workpiece materials, the P-area includes principally steels that are cut in long chips, M-area many difficult alloys and K includes materials that come off in short chips or flakes like cast-iron, etc.

These areas are grouped according to the demands of the machining, heavy, light or medium as well as favourable or unfavourable conditions. Low demands for toughness at group 01 as in extreme finishing and stable conditions; and at the other end, 50 for tough demands as in roughing and unfavourable working conditions.

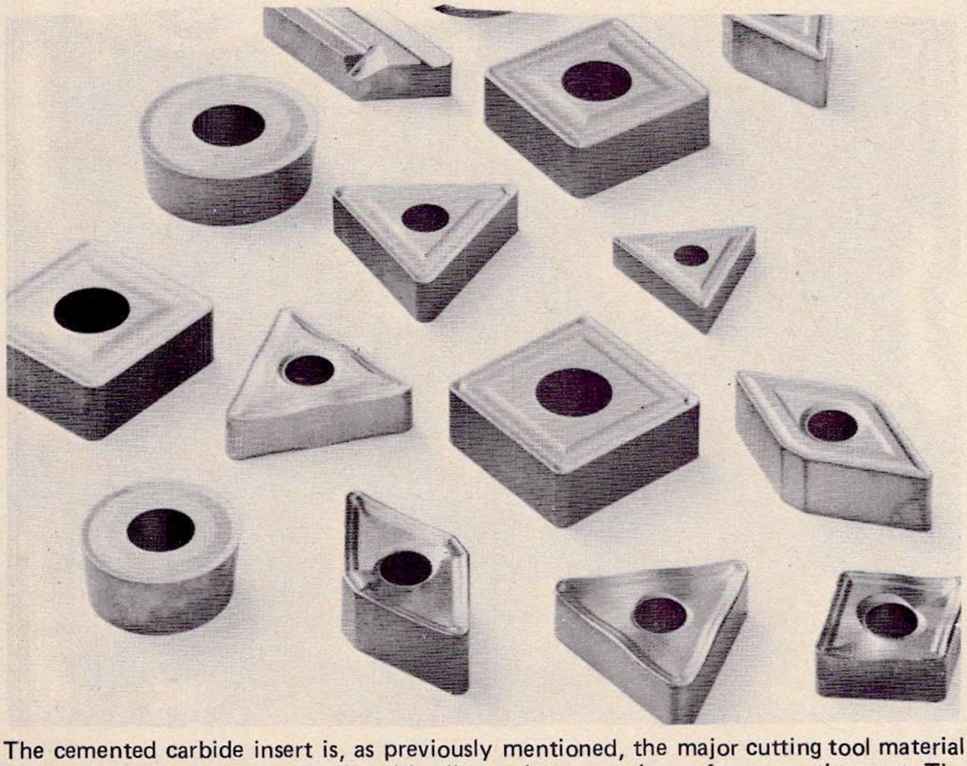
As the wear resistance generally decreases with increasing toughness, the ISO classification also indicates a scale for how these two properties vary in relation to each other. The ISO classification is concerned only with the operational conditions of metal-cutting and has nothing to do with the composition of the carbides.

The American C-system starts its grouping for cast-iron type carbide grades with C1 to C4 as in K and continues with C5 – C8 for steel grades as in P. The M range is not covered. The next page shows the ISO areas and groups and their respective materials and demands.

Also indicated is the C-system as related to ISO. The various workpiece materials mentioned will be explained in a later part.

The page after shows the Coromant carbide grade program for two metal cutting methods: turning and milling. These are the tool materials offered by Coromant as the cutting edges in their tools.

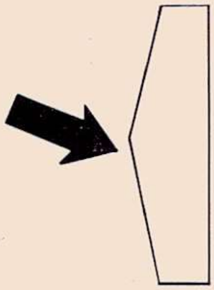
The grades have been positioned according to their ISO and C applications. The grades are also put in a priority order of choice for certain operations. Note the important roles of coated carbides and especially GC 015 in covering large application areas. This fact has great consequence in practice because it affects the number of tools needed for an operation and how much has to be kept in stock.

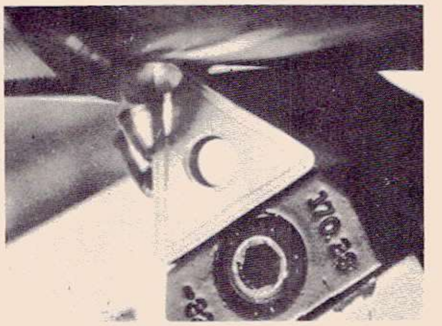


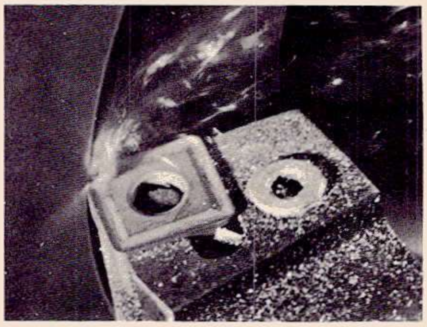
The cemented carbide insert is, as previously mentioned, the major cutting tool material in metal cutting today and will, with all certainty, remain so for some time yet. The reasons are, of course, its properties which make it such an exceptional cutting edge.

Coated grades have up to recently not been so common for milling operations but are coming into use in the K-area.

The grade is denoted by the illustrated symbol. This pin-points the optimum application area for the grade meaning that the grade is most successful there. How long the grade symbol turns out to be is determined by machining statistics indicating how the grade machines throughout the area. This is the recommended field of application.





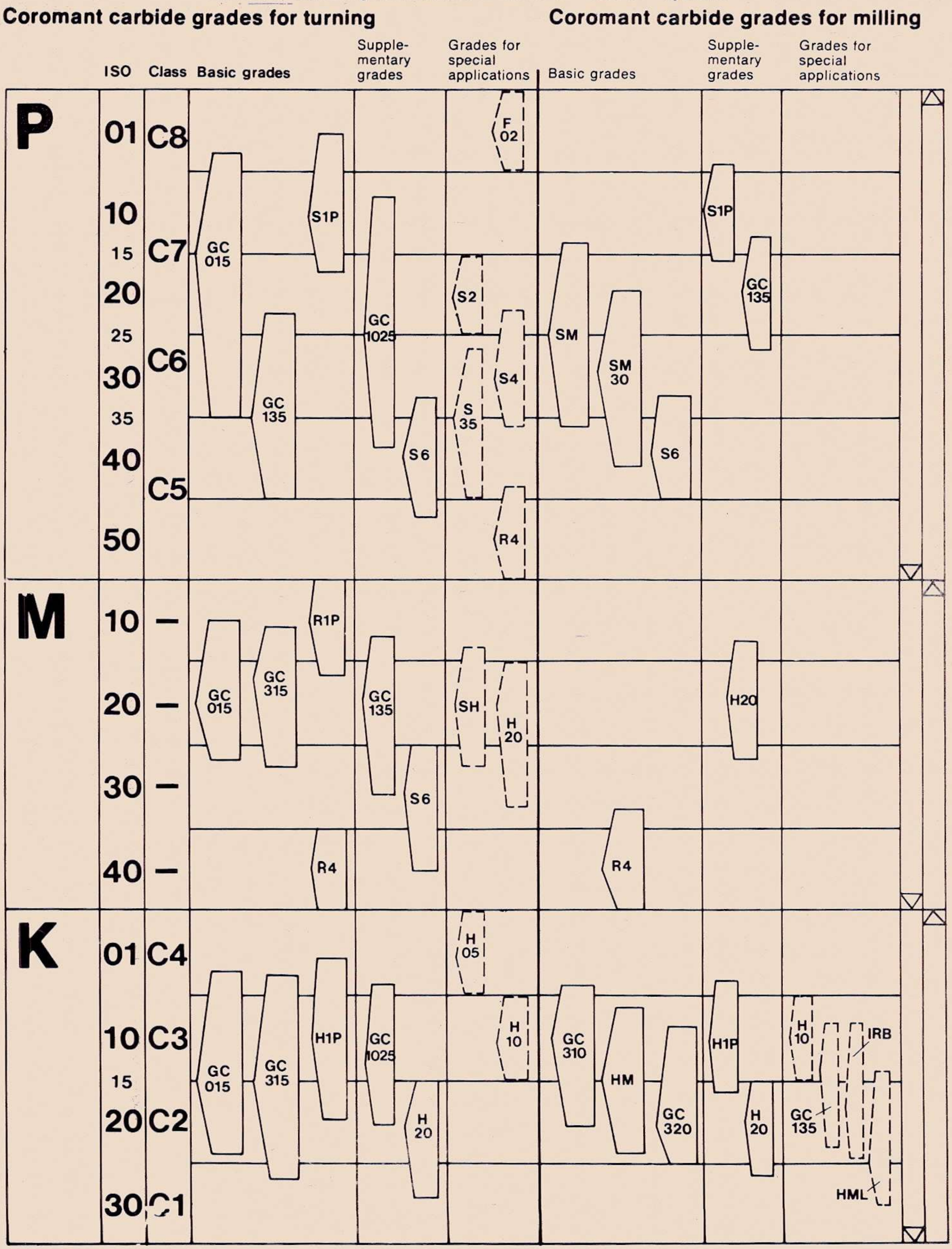


These two photos show machining as it normally appears in the P (left) and K (right) ISO application areas.

ISO Classification of cemented carbides with the US C-system

ISO	Class			
01 10 20 30 40 50	C8 C7 C6 C5	**P** Steel, cast steel long chip-ping mal-leable iron free-cutting steel.	Finishing and light roughing of steel and steel castings. Favorable conditions. High cutting speed, moderate feed. Best used without coolant. For finishing and light roughing of steel, steel castings, malleable iron and long-chipping nodular cast-iron. The extremely high wear resistance permits very high metal-removal rates for a wide application field. Light and medium roughing of steel, steel castings, malleable iron, nodular iron. High cutting speed and relatively high feed. Very high wear resistance. Medium to heavy roughing of steel, steel castings, malleable cast iron and nodular irons. Can be used under unfavorable conditions. Comparatively high cutting speed and feed. Very high wear resistance. All-round grade for machining steel. Medium to heavy roughing of steel and steel castings. Unfavorable conditions. Moderate cutting speed, heavy feed. Heavy roughing of steel, stainless steel and steel castings. Difficult conditions. Low cutting speed, heavy feed, large cutting depth. Finishing of steel and steel castings. Stable conditions. Very high cutting speed, low feed. Light to medium roughing of steel castings. Less favorable conditions. Moderate cutting speed and feed. Suitable for profiling. Heavy roughing of steel and steel castings. Very difficult conditions. Low cutting speed, heavy feed.	Developed especially for milling of steel and steel castings. Very high resistance to thermal cracking and plastic deformation. Very good wear resistance in relation to its toughness. Roughing of carbon steel, stainless steel and steel castings at low cutting speeds under difficult working conditions. Used for large cutting depths and heavy feeds. Finishing and light roughing of steel and steel castings at high cutting speeds and moderate feeds Under favorable working conditions. Can withstand very high cutting temperatures. Light to medium machining of steel, steel castings, malleable iron and nodular iron. Very high resistance to wear.
10 20 30 40	— — — —	**M** Steel, cast steel, manga-nese steel alloy cast iron, aus-tenitic steels, mal-leable iron.	Finishing and light roughing of high-temperature alloys and stainless steel, such as nuclear reactor components. High resistance to notch wear. Comparatively high cutting speed, moderate feed. Finishing and light roughing of heat resistant alloys. High cutting edge strength. Relatively high cutting speed and moderate feed. High wear resistance. Light and rough machining of heat resistant alloys. Also for difficult machining conditions. High cutting edge strength. Finishing and roughing of austenitic stainless steel castings and stainless steel with difficult rolling or casting scale. Low cutting speed, heavy feed. Very resistant to edge destruction when intermittent machining. Light and heavy roughing of rolled or forged stainless steel with an austenitic structure. Comparatively high cutting speed and feed. Suitable for certain types of free-cutting steels. Light and rough machining of austenitic stainless steels and stainless materials with rolling or casting scale. Also for difficult machining conditions. **special applications** Heavy roughing of steel and steel castings. Mn-steels and ductile alloy cast iron with a long chipping tendency. Especially suitable for returning of railway wheels.	Finishing and roughing of stainless austenitic steel castings with difficult rolling or casting scale. Low cutting speeds and heavy feeds. Very high resistance to thermal cracking. Finishing and roughing of certain types of high-alloy materials as well as of heat resistant alloys, low cutting speed, heavy feed.
01 10 20 30	C4 C3 C2 C1	**K** Cast iron chilled cast iron, short chipping mal-leable iron hardened steel, non-ferrous metals, plastics, wood.	Finishing and light roughing of cast-iron. Also for alloyed cast-iron, bronze and brass. Relatively high cutting speed and moderate feed. For finishing and light roughing of high- and low-tensile cast-iron, malleable iron and nodular cast-iron. Especially suitable for modern low-alloy cast-iron. The extremely high wear resistance allow very high metal-removal rates and provides the best results with form-sintered chipbreakers. All-round grade for machining cast iron and other short chipping materials. Less favorable conditions. Comparatively high cutting speed, heavy feed. Very high wear resistance. Light and medium roughing of primarily low-alloy cast-iron. High cutting speed and relatively high feed. Very high wear resistance. Heavy roughing of cast iron. Unfavorable conditions. Low cutting speed, heavy feed. Finishing of cast iron. Suitable for chilled cast iron, concrete, plastics, etc. Suitable for machining aluminum. Excellent edge sharpness.	Developed especially for milling of low alloy cast iron, such as castings for the automotive industry. Very high resistance to wear and plastic deformation. Roughing of cast iron under difficult working conditions. Low cutting speeds and heavy feeds. Developed especially for cutting speed areas of 165-295 ft./min. together with a self-sharpening wear pattern. Finishing and roughing of cast iron, bronze and brass. High cutting speeds and moderate feeds. Light to medium machining of cast iron and other short chipping materials. Very good wear resistance. Suitable for machining aluminum. Excellent edge sharpness. Suitable for machining low-alloy cast iron, such as castings for the automotive industry. Very good wear resistance.

Coromant carbide grades related to the ISO — and C — systems



Geometry and Edge Clamping

The three main components of a modern cutting tool is tool material, geometry and edge clamping method. We have just treated the tool material and especially cemented carbide.

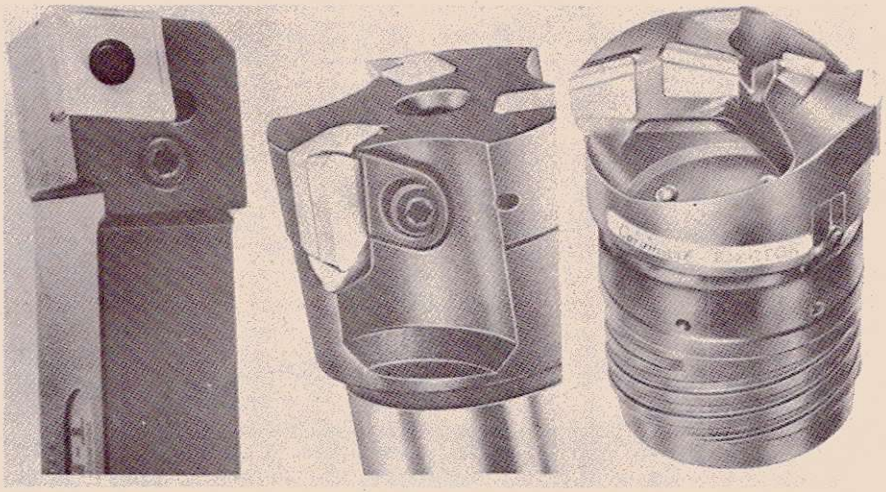
The shape of the edge is called cutting edge geometry. The tool material is subjected to careful research and development, testing and manufacturing for the outcome to be carbide grades to best suit various applications. The same applies to how the cutting edge receives its final shape — geometry.

The cutting edges of most modern carbide tools are in the form of indexable inserts. These are smaller pieces of carbide that are mechanically held in the cutting tool. They are held differently according to the machining method they have been made for. Some carbide cutting edges are brazed in the tool and are then called tips. The various edge clamping methods will be treated during the parts on machining methods.

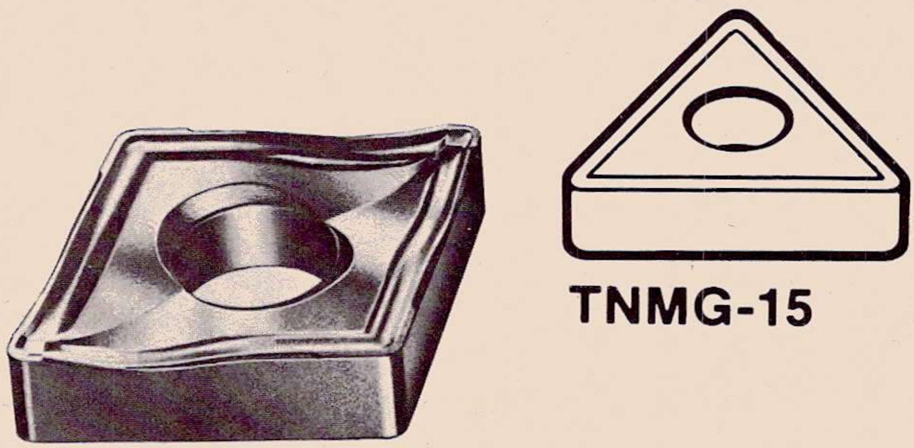
How a cutting edge cuts depends to a large extent on how it has been shaped. The edge shape is normally included in the insert shape through the pressing operation prior to sintering in the manufacturing process. Careful consideration of how the insert should be shaped is necessary as many machining factors are affected: the edge strength, tool-life, the magnitude of the forces and temperature generated, the surface finish of the machined part and the way chips are cut off and broken. Modern metal cutting involves a lot of metal removed per hour and it is important for the chips to come off in a way that they can be efficiently removed from the machining zone and not hamper machining or injure the operator. For this reason, machining methods that involve long continuous cuts, such as turning, use inserts where a chipbreaking function has been included in the cutting edge geometry. When you look at a modern indexable insert you see a well-balanced combination of angles, radii and flats that are the out-come of careful optimization of the machining factors.

Indexable inserts are denominated in a way that reflects shape, angles, size, tolerances, type and chipbreaking properties. There is an ISO method of coding inserts and an ANSI method used in the US. The latter is shown in the illustrated code key for turning inserts. Milling and drilling inserts are denoted in a similar fashion. The example shown is a turning insert TNMG-332-15 which is a triangular, negative-shaped, M-tolerance, double-sided insert with a 3/8 in. inscribed circle, .188 in. thick and 1/32 in. corner radius.

Some of the terminology might seem somewhat confusing at the moment but will be cleared up during each of the machining method parts.

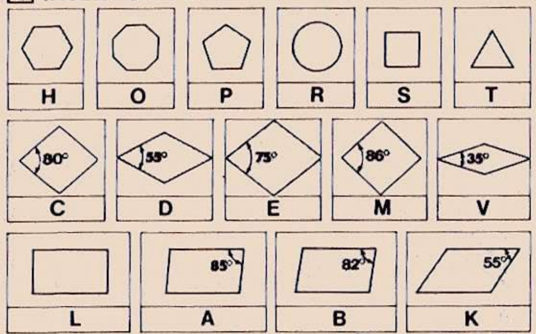


Three tools with three different ways of retaining the carbide insert in the toolholder are shown in this figure. Left, is a turning tool where the insert is held by a pin through the centre-hole and which pushes it back into the insert seat. Centre, is a milling tool where the insert is held in its seat by a wedge, which when screwed into position puts pressure on the top of the insert. Right, is a drilling tool where the cutting edges in form of tips have been brazed into seats.

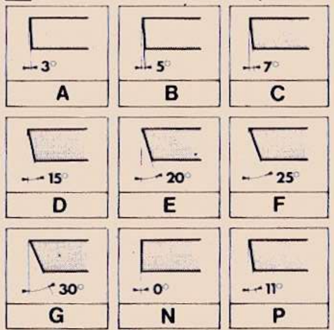


ISO CODES – Indexable inserts

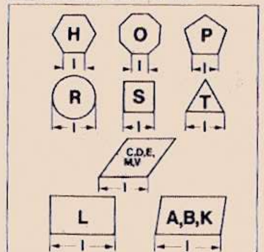
1 INSERT SHAPE



2 CLEARANCE ANGLE (INSERT)

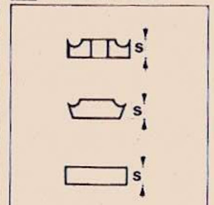


5 CUTTING EDGE LENGTH



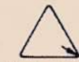
Integers to be preceded by a 0
eg.: 9,52 mm indicated by 09

6 THICKNESS



Integers to be preceded by a 0
eg.: 4,76 mm indicated by 04

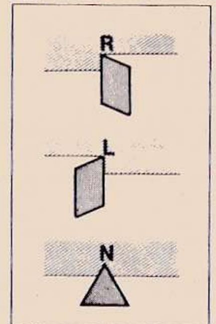
7 RADIUS



Radius in 1/10 mm

00 Round insert
00 Sharp point
02 0,2 mm
04 0,4 mm
05 0,5 mm
08 0,8 mm
10 1,0 mm
12 1,2 mm
15 1,5 mm
16 1,6 mm
24 2,4 mm
32 3,2 mm
40 4,0 mm

9 VERSION

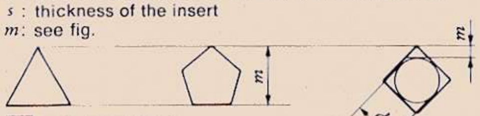


T	P	M	R	16	03	08	S	N
1	2	3	4	5	6	7	8	9

3	2	2
5	6	7

Note: The ISO designation includes the first seven symbols only. 8 and 9 are supplementary symbols.
In addition the manufacturer may add further symbols, e.g. indicating chipbreaker design and further identifications.

d : theoretical diameter of the insert inscribed circle
s : thickness of the insert
m: see fig.



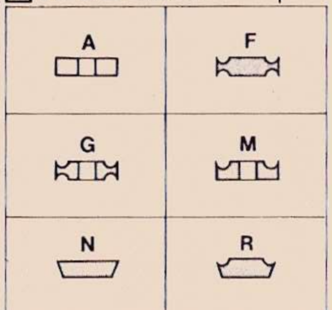
3 TOLERANCES

Letter symbol	Tolerance in millimetres ± *m*	*s*	*d*	Tolerance in inches ± *m*	*s*	*d*
A	± 0,005 [1]	± 0,025	± 0,025	± 0.000 2 [1]	± 0.001	± 0.001 0
F	± 0,005 [1]	± 0,025	± 0,013	± 0.000 2 [1]	± 0.001	± 0.000 5
C	± 0,013	± 0,025	± 0,025	± 0.000 5	± 0.001	± 0.001 0
H	± 0,013	± 0,025	± 0,013	± 0.000 5	± 0.001	± 0.000 5
E	± 0,025	± 0,025	± 0,025	± 0.001 0	± 0.001	± 0.001 0
G	± 0,025	± 0,13	± 0,025	± 0.001 0	± 0.005	± 0.001 0
J	± 0,005 [1]	± 0,025	fr ± 0,05 [2] to ± 0,13 [2]	± 0.000 2 [1]	± 0.001	fr ± 0.002 [2] to ± 0.005 [2]
K	± 0,013 [1]	± 0,025	fr ± 0,05 [2] to ± 0,13 [2]	± 0.000 5 [1]	± 0.001	fr ± 0.002 [2] to ± 0.005 [2]
L	± 0,025	± 0,025	fr ± 0,05 [2] to ± 0,13 [2]	± 0.001 0	± 0.001	fr ± 0.002 [2] to ± 0.005 [2]
M	fr ± 0,08 [2] to ± 0,18 [2]	± 0,13	fr ± 0,05 [2] to ± 0,13 [2]	fr ± 0.003 [2] to ± 0.007 [2]	± 0.005	fr ± 0.002 [2] to ± 0.005 [2]
U	fr ± 0,13 [2] to ± 0,38 [2]	± 0,13	fr ± 0,08 [2] to ± 0,25 [2]	fr ± 0.005 [2] to ± 0.015 [2]	± 0.005	fr ± 0.003 [2] to ± 0.010 [2]

1) These tolerances normally apply to inserts with ground secondary edges. (parallel lands).
2) The tolerance is dependent upon the insert size and should be indicated for each insert according to the standards on the corresponding sizes. In the case of square and triangular inserts (shapes S and T), values for tolerances classes M and U on m and d are indicated in the following table.

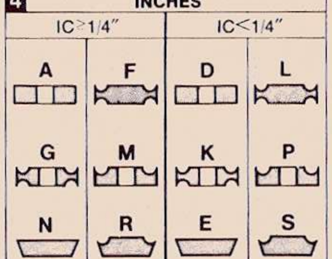
T△ S□ Diameter of inscribed circle mm	in	Tolerances on *m* ± Class M mm	in	Class U mm	in	Tolerances on *d* ± Class M mm	in	Class U mm	in
6,35	0.250	± 0,08	± 0.003	± 0,13	± 0.005	± 0,05	± 0.002	± 0,08	± 0.003
9,52	0.375	± 0,08	± 0.003	± 0,13	± 0.005	± 0,05	± 0.002	± 0,08	± 0.003
12,7	0.500	± 0,13	± 0.005	± 0,20	± 0.008	± 0,08	± 0.003	± 0,13	± 0.005
15,88	0.625	± 0,15	± 0.006	± 0,27	± 0.011	± 0,10	± 0.004	± 0,18	± 0.007
19,05	0.750	± 0,15	± 0.006	± 0,27	± 0.011	± 0,10	± 0.004	± 0,18	± 0.007
25,4	1.000	± 0,18	± 0.007	± 0,38	± 0.015	± 0,13	± 0.005	± 0,25	± 0.010

4 TYPE OF INSERT



X
Special design

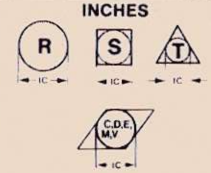
4 INCHES



X
Special design

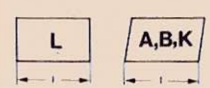
5 INSCRIBED CIRCLE

INCHES



In 1/32″ for IC<1/4″
In 1/8″ for IC≥1/4″

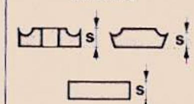
Cutting edge length



For rectangular and rhomboidal inserts cutting edge length is indicated in 1/4″

6 THICKNESS

INCHES

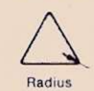


In 1/32″ for inserts of IC<1/4″.
In 1/16″ for inserts of IC≥1/4″.

For rectangular and rhomboidal inserts, width is used as reference instead of IC

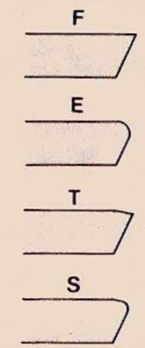
7 RADIUS

INCHES



0 Round insert
0 Sharp point
1 1/64″
2 1/32″
3 3/64″
4 1/16″
6 3/32″
8 1/8″

8 CUTTING EDGE



Comparison CUTTING EDGE LENGTH in mm (Pos. 5) — IC in inches

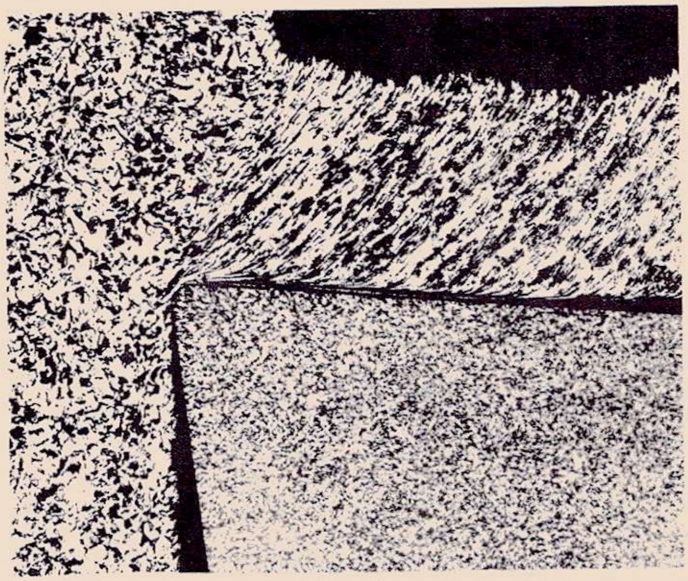
▲	06	09	11	16	22	27	33	44
● ■				09	12	15	19	25
55°			07	11	15	19	23	31
80°			06	09	12	16	19	25
IC = d	5/32″	7/32″	1/4″	3/8″	1/2″	5/8″	3/4″	1″

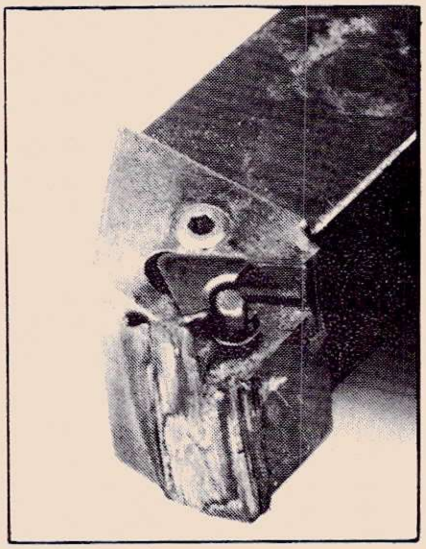
Cutting Edge Wear

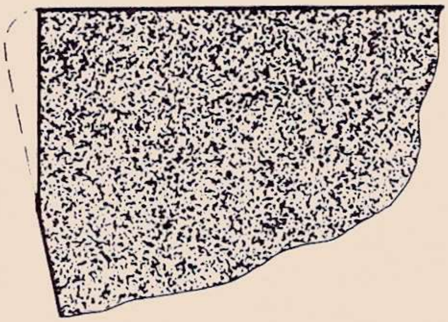
The high temperature and heavy pressure of the chip being parted from the workpiece causes wear on the cutting edge. Wear occurs through particles of the tool material being torn away by the chip, on top, and the workpiece, on the side. Cutting edge wear is a complicated phenomenon with modern cutting tools but certain *wear patterns* can be classified and provide valuable clues to whether the machining is being performed with the right tool, right machining speeds, etc.

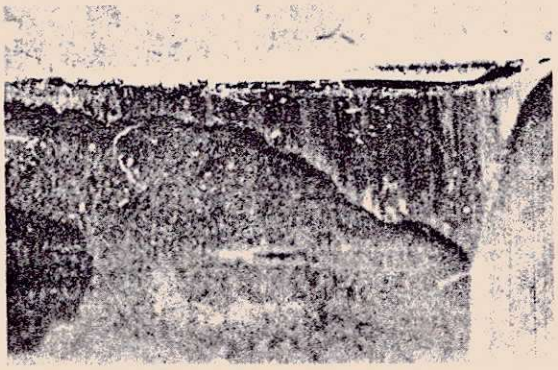
These clues are the most important instrument that a cutting tool engineer has at his disposal and they form the base for most assessments and calculations to do with machining. Obviously, wear will always take place in metal cutting but how advantageous or disadvantageous the wear develops can be of the greatest importance. The wrong tool, or the wrong machining speeds or the wrong conditions in an operation can be disastrous.

This course will not treat all types of wear or go into wear patterns very deeply. Here we shall just review some of the main definitions.





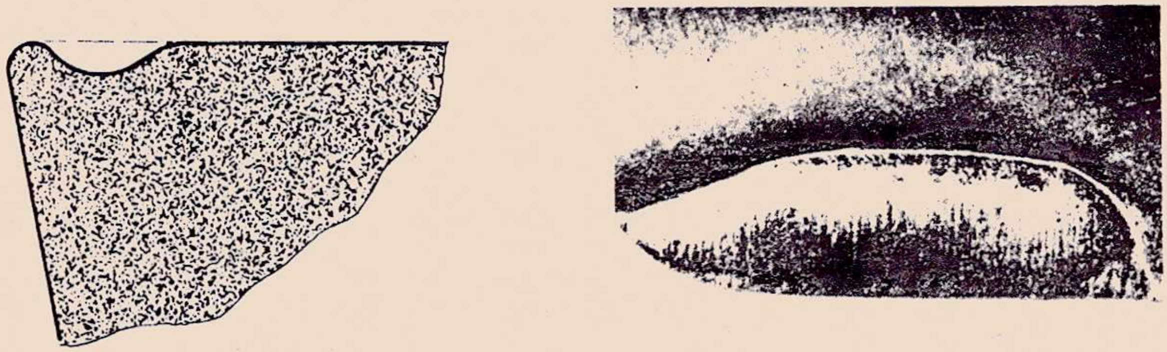




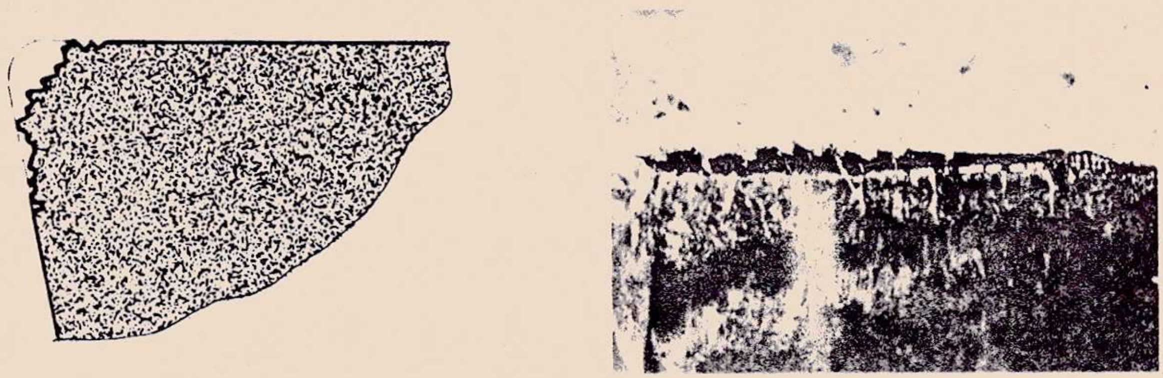
Flank wear is caused by the rubbing of the insert side against the workpiece.

There are several other variants of edge wear. Apart from the mentioned machining factors influencing the type and amount of wear, the workpiece material also has a great influence. This, of course, one cannot do much about but there are many remedies, such as changing the machining speeds, tool material of the cutting edge, geometry, improving the machining conditions, etc, which may or may not improve the wear pattern of the cutting edge. But these need specialized attention and a lot more space than can be obtained in this basic course.

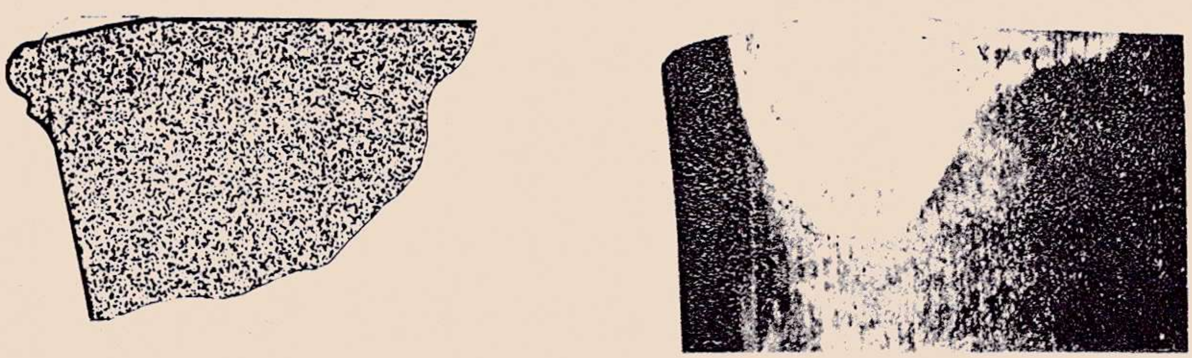
This is the end of the first part in the course of Modern Metal Cutting having treated machinability, tool materials, cemented carbide, carbide grade classification, geometry and edge clamping and cutting edge wear. PM



Crater wear is caused by the abrasive rubbing of chips on top of the insert.



Chipping or nicking: Here the tool material is too brittle for the operation or not suitable for any large temperature variations that occur.



Plastic deformation. The tool material cannot stand up to the high temperatures and heavy mechanical stresses involved in the operation.

The Testing Of Vibratory Finishing Media

JOHN B. KITTREDGE
Vice President and Technical Director
Roto-Finish Co.

ABSTRACT

This paper discusses the reasons for testing vibratory finishing media, the relevant point to be included, significant variables which control the accuracy and reliability of results, and recommendations for good testing procedures. Estimates are provided to enable the use of test data obtained at vibrational speeds other than those used, and the operational hours of life of media are predicted based on the initial and final dimensions of the media. Finally, a cautionary note on media testing is made and the more appropriate question of overall finishing economics is explored.

INTRODUCTION

Vibratory finishing is a rapidly growing process for the deburring and surface refinement of metal and other parts. It is characterized by a container equipped with a vibratory or oscillatory drive system which shakes in a controlled manner. A media is used to do work on the parts' surfaces and a compound and water system is used to control corrosion, lubricity, cleanliness, etc. In operation, the mass rotates in a desirable manner, gently scrubbing the media against the work surface and edges thereby improving surfaces or deburring the parts.

This paper is devoted to the testing of the media used in such a system.

THE PURPOSE OF TESTING VIBRATORY FINISHING MEDIA

Cost reductions, product quality improvements and process time reductions often have a bearing or the capacity of a system, or the efficiency of an operation or department. These are therefore legitimate considerations on any of the variables involved in a process. Media is an obvious variable in mass finishing. It can be changed easily. Optimization of the media, therefore, for a vibratory finishing process would ideally improve operational costs and reduce the cost of producing each part.

Testing of vibratory finishing media is normally done by measuring the wear rate or attrition rate or loss rate of the media per unit time. The faster the media wears out, the more frequently it is necessary to add to it to keep the mass up to its desired level. The cut rate or metal removal rate is also an important function of a media. Surface roughness reduction per unit time or the ultimate surface roughness capability of a media is important when the quality of the surface being finished is critical, as for example in preplate finishing. The ability of a media to develop a radius on a metal part or to deburr a metal part to a satisfactory degree may be a primary requirement of the product.

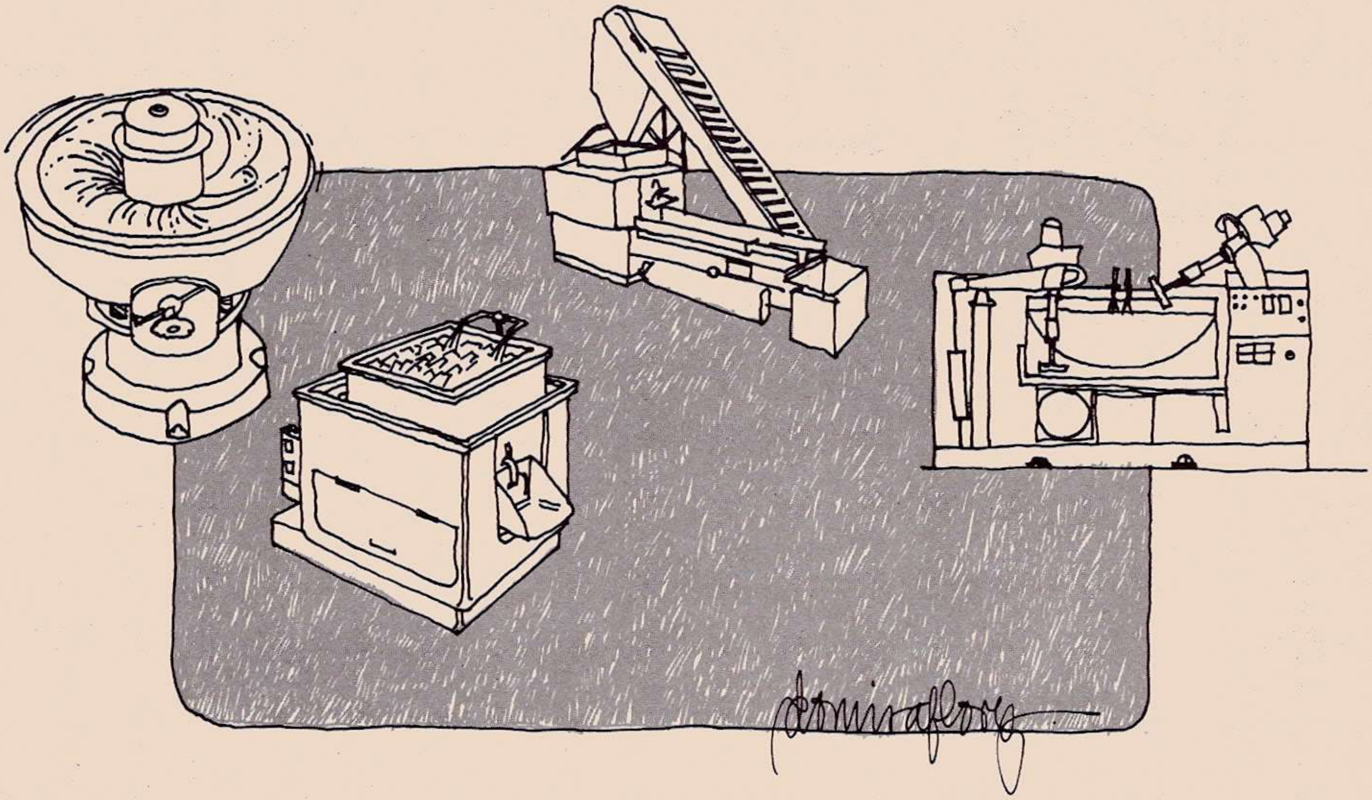
By appropriate testing then, we can conceivably maximize surface roughness reduction versus time, improve process speeds, or determine how much faster cutting a new potential media might be than an existing one. Or we can reduce media wear, thereby reducing costs.

TEST VARIABLES

The number of variables involved and of real consequence in the testing of vibratory media is rather extensive. These are discussed to provide a better understanding of their influence on the test procedure itself.

1. Media. The class or bond of the media; in other words, is it a resin-bonded or ceramic-bonded type of media; the type of media within that class: fast, intermediate, or slow cutting; the size, shape and age of the media, are all variables. The supplier's nomenclature on type, size, and shape are variables and must be known. For example, manufacturers of vibratory finishing media do not agree on the measuring system for angle cut cylinders. Many manufacturers provide diameter of the cylinder, and "cut length," while one manufacturer's lenght dimension is the overall diagonal length of the cylinder.

Age of media is critical when measuring weight loss. Brand new media normally has to be deburred just like parts. Weight loss of sharp edges and adherent fragments can



be extremely high during the first several hours of operation. This will reduce to steady state conditions in a short period of time, or should. Age of the media in operating hours, therefore, is a variable as, or more significant than, many others.

2. Media manufacturing variations. Quality control of media during manufacture is as important to the user of media as quality control of the parts the manufacturer produces. Manufacturing variations in media can account for variations in test results of large magnitudes. For example, excessive porosity or bubbles in a plastic or ceramic media reduces the mass weight of the "chip" and cause excessively high wear rates when this porosity is exposed. Cracks or fragile corners which break off create excessively high wear rates which may or may not be a characteristic of the product. The degree of cure of plastic media is significant if it is improper. Undercured material will be gummy and will not cut properly. Excessive cure reduces the integrity of the binder system, causing variations in wear rate as the chip is used because of variations in degree of cure from the external surface to the interior of the chip mass. Changes in degree of vitrification of ceramic media occur if temperature and time are not uniform in the kiln. This can cause variations within the product even though all fired at once because of temperature variations in the kiln. Lot to lot variations can be even more pronounced.

To overcome these problems, it is normally desirable to determine the specific gravity of the media, which is a good measure of the integrity of the product. A low specific gravity will imply bubbles or other internal defects. A visual inspection of the product will show cracks, fissures, "crow's feet," or other defects from extrusion of ceramic shapes or from the cutting process. Dimensional variations should also be measured because the size of the media, especially in ceramic types, is a function of the wear of the die through which the material was extruded. Normally, a brand new die is designed slightly undersize and allowed to wear slightly oversize. These limits control the dimensional allowance of the product and have an effect on the volume or size of the chip.

Boiling tests for water absoption can be used to measure the integrity of vitrified ceramic media. A combination of specific gravity and ignition of the plastic binder can be used to determine the integrity of plastic media with excellent precision.

These data can determine the type of abrasive used in plastic media:

$$(1)\ \frac{100}{C} = \frac{X}{A} + \frac{100\text{-}X}{B}$$

where X = percentage of abrasive in media
A = specific gravity of the abrasive (2.65 for silica or quartz, 3.2 for silicon carbide, 3.9 for aluminum oxide, etc.)
B = specific gravity of the resin (1.2 for most polyester systems), and
C = specific gravity of the media or chip.

Note: abrasive blends can give misleading results.

3. Equipment. The type of vibratory equipment is variable in the evaluation of media because of the wide difference in action possible with each type. The size of equipment sometimes has a bearing on results obtained on media evaluation.

Several types of vibratory equipment are available. These include the conventional tub-type vibrator, the tub-type vibratory equipment with dual shafts, the round or toroidal types (several, in fact) and other special varieties. Between these types, a considerably different action occurs due to the difference in configuration of the chamber, as well as in the orientation of the eccentric weights. Many tub-type vibratory machines, for example, are extremely poor in their mixing capability, while the round machines can be excellent (some are not). A tub-type vibratory machine with a center outlet drain, equipped with a solution system metering compound solution only in the center of the tub, will produce a clean band of media in the center of the tub, and dirty media will develop at each end. Mixing is therefore poor. This poor mixing can cause migration of parts or separation of media sizes. It is known as the "end effect," a characteristic of most tub-type vibratory machines. The round machines are better mixing devices because of the 3-dimensional influence of the eccentric weight system on the mass. Tub-type vibratory equipment is equipped with equivalent eccentric weight systems on each end of the shaft (or dual shafts as the case may be). Increasing the amount of eccentric weight on the shaft increases the amplitude or displacement of the tub. Amplitude is easily measured by an "Ampli-check" or similar device. It should be recorded as it is a fundamental characteristic of a machine's operating condition. Speed of the eccentric weight system must also be recorded. If a variable speed drive is used, a strobe light or mechanical tachometer should be used to determine speed of the eccentric weight system. Increasing speed of the eccentric weight system will also increase media depreciation rate and media cut rates.

Toroidal or "round" vibratory machines have dissimilar eccentric weights on the top and bottom ends of the shaft which must be recorded, as well as the angle between them. This angle is either a position number on the top eccentric weight or an angular difference noted on the bottom weight. Direction of the eccentric system rotation should always be opposite to that of the mass flow in this type of equipment.

Equipment that has been constructed with different lining materials can influence media depreciation rates. Larger sizes of the same design equipment sometimes do not have the power of the smaller units on a per cubic foot basis, and therefore can give lower media depreciation rates. Amplitude and speed characteristic are very helpful in these determinations. The effect of equipment drainage is discussed below.

4. Solution systems. The solution system consists of water and compound metered into the vibratory container and the removal of the spent solution from the tub. The type of compound, its flow rate, the flow rate of water, the concentration of the two, and their removal rate influence media depreciation and cut rates.

The type of compound used in any test work is dependent on the work desired. "Deburring" compounds are those designed to keep media and parts clean, to suspend soil, inhibit corrosion and the like, and therefore provide a media which is free cutting and capable of removing metal with excellent efficiency. "Burnishing" compounds, on the other hand, impede the ability of the media to cut and therefore are used to promote a lustre on the metal parts or "color" as it is sometimes called. These products, of necessity, have a significant effect on depreciation rate, reducing media losses to extremely low values.

Concentrations of compound in water depend on the particular compound in question. Most industrial grade compounds used today are effective in concentrations from roughly 1/2 to 1% by volume. Higher concentrations can impede action or reduce metal removal rates and reduce media depreciation rates. They can dampen down action with excessive foam or excessive lubricity, for example. Both effects alter results.

If drainage of the tub chamber is limited, then the solution flow rate must be reduced accordingly. If excellent drainage is provided in the tub, very fast removal rates of solution can be used to remove soil and debris more readily. By the same token, the size distribution of media also influences drainage rate.

Very small media has very small spaces between particles to allow the solution to drain. Very large media, on the other hand, has much larger void channels and therefore permits drainage to occur much more readily. Small random shaped media is worse than small preformed media in this respect. If the flow of solution is impeded by the media or by the drains, excessive solution will build up in the tub, reducing the action of the media in the vibratory container.

One experimenter wished to eliminate the variable of compound from his test procedure and therefore ran all of his tests in plain water. It was suggested that he verify these results with a very small amount of alkaline deburring compound. Because of the effect of corrosion on the test pieces, he proved that his original data, without compound, was meaningless. Vibratory finishing has the unique ability to develop very active metal surfaces. He was using this effect to his disadvantage.

5. Measurements.

A. Time or duration of test. How long should a media depreciation test be? The only answer to this kind of question is that it should be sufficiently long to provide reliable and reproducible data and short enough so that the test cost, both in materials and labor, is held to a minimum. This wonderful balance is very difficult to achieve in practice, especially in an industrial environment where this is only one of hundreds of priority projects. Time can be a significant variable in the evaluation of media. As indicated previously, the time of use of media or its age will have an influence on water rate. This will be shown in an example later. If the test time is selected to be conducted on media that is brand new and run, for example for 4 hours, very high media depreciation rates will be determined. This "break-in" period does not give reproducible weight loss data. It is less representative of the media body itself. It would only be used by a manufacturer who had to guarantee wear rates over long periods.

At the other end of the spectrum, very long test periods (weeks or longer) cause other complications. Media size deteriorates considerably. The volume of the mass is reduced appreciably and must be replenished with new media, as is done in normal commercial operations. The frequency of addition has an effect on wear rate, and the gradual reduction in average size of the particle or piece of media will cause a change in the depreciation rate.

B. Media weights. Certain techniques improve accuracy in the weighing of media before and after tests. For media evaluation time periods of less than 24 hours in duration, weighing media wet is erroneous and not reliable. These weights cannot be reproduced with sufficient accuracy to permit their use. Accordingly, media must be dried to insure accuracy and reliability of data. The use of rinse aids to sheet off water or develop a uniform film thickness of water, shaking of media X times prior to weighing, allowing it to drain for a given number of minutes and the controlled drainage procedures cannot be used on short time test because they are not reproducible. In 3 hour tests of 2 cubic feet (57 liters) quantities, a scale accuracy of ± 1/4 ounce (± 7 gms.) is required. When 200 lbs. (90 kg.) of media is involved, this type of accuracy precludes the use of wet media.

An uncommon effect, but a real one, in media testing will occur on long test periods. It is the effect of media "compact," or increase in bulk density versus time. As media wears, smaller media worn down will fill the interstices between larger media particles. The effect of this action, assisted by the deburring and radiusing of the media particles, is that the bulk density of the media will increase. More media is required to fill or maintain the level of the vibratory chamber. This media is not "lost," but it is required in order to operate the system at a full level. Media which is angular in geometry shows this effect much more prominently than media which is more rounded. Triangular media will show this more than cylinders.

Media weight losses are normally calculated in percent weight loss per hour. This term is not as easily used as the less common but more easily used "pounds loss per cubic foor per hour" (grams loss per liter per hour). These values are immediately convertible to good cost estimates.

C. Metal removal or cut rate. An important characteristic of any media is its ability to remove metal. The measurement of this phenomenon can be difficult, confusing, misleading or anything in between. The shape, size, quantity and composition of the test pieces, for example, can cause variations in results. These must be of a size compatible with the weighing mechanism. An analytical balance is preferred on small parts. Massive quantities of steel must be weighed on larger scales with perhaps much less accuracy.

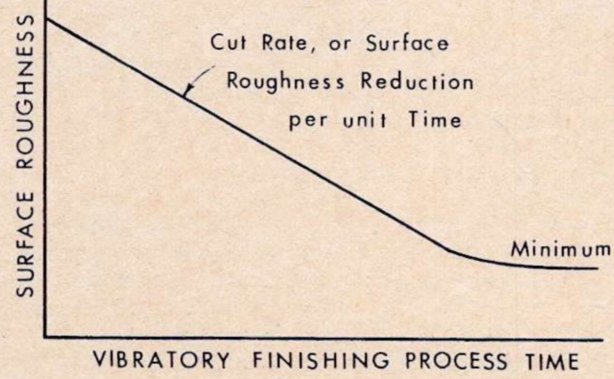
The shape of the test piece is important. One group of investigators recommend the use of spheres, and while this will eliminate any edge effects or deburring or radiusing phenomenon from occurring on the test piece, it is the poorest possible shape from the standpoint of surface area-to-volume ratio. In other words, a much longer test would have to be run on a spherical piece in order to get reproducible and accurate weight loss measurements than on a flat or angular piece which had been generously radiused beforehand. Some investigators use sheared test pieces to have a "controlled" burr or edge sharpness with which to work. But a controlled burr is difficult to produce under the best circumstances. Well deburred and radiused parts are therefore recommended with a high surface area-to-volume ratio.

It is often desirable to have more than one alloy represented. For example, weight loss measurements on aluminum, brass or copper, steel, stainless, and zinc are not always comparable. They vary in hardness and toughness. The data are converted to percentage weight losses to eliminate minor variations in initial weight loss of the test coupon. This permits use of sheared pieces, which are not dimensionally exact.

D. Surface roughness. Surface roughness can be accurately determined on metal coupons processed in media. For accuracy in these measurements, it is recommended that the initial surface of the test coupon be not too dissimilar from the final surface roughness. For example, if a belt-sanded metal surface is employed and the test time is insufficient to allow the media to remove all scratches, surface roughness readings will be useless. When possible, and because of the desirability of having well-radiused test coupons to eliminate "deburring" from overly influencing test resuts, the test coupons can be processed in the test or similar media for several hours before use. A good "ultimate" surface roughness capability of the media is then possible.

Media also reduces surface roughness per unit of vibratory finishing time, as shown in Figure 1.

Figure 1



This idealized curve also shows the minimum surface roughness charecteristic of the media under the conditions of test.

E. Deburring or radius measurements. The Society of Manufacturing Engineers has published a number of papers and a book (1) on the subject of measuring burrs. Even the definition of a burr is not yet standardized. The measuring of burrs and burr removal, therefore, still leave something to be desired. This work, however, is leading to valuable guides (2) and hopefully will become used throughout industry within the next few years.

Radius measurements can be made with radius gauges or an optical comparator. Initial radius should be as close to zero as possible. Surface ground stock, keyways and the like are economical and readily available.

RECOMMENDATIONS FOR GOOD MEDIA TEST PROCEDURES

The following recommendations are made and are listed somewhat in order of importance.

1. The test procedure must be designed to measure what is most important to the user. Comparative media cut and wear rates may be of no interest or significant value to an individual who is interested in reducing surface roughness of his parts. They could be quite erroneous.
2. Pick a media type, class, size, and shape that is typical for the type of media used in your plant. If you are a media manufacturer, be sure it is a popular and simple shape and size.
3. The quality of the media to be evaluated should be ' average."
It should not be specially made by the manufacturer if at all possible, but should fairly represent his normal manufacturing tolerances. After it has been received, it is reasonable to ask the manufacturer to recheck his quality control samples to insure that it does meet his quality control tests fairly. It would be unwise to conduct an enormous amount of test work on a batch of product of questionable quality.
4. Equipment. Equipment size should be kept relatively small. Bench type machines are not recommended because they sometimes operate at higher frequencies or with chambers dimensionally so small that interference can occur just because of the size. Two to four cubic foot (50-100 liter) machines should be considered minimum.

The size should not be too great and will depend entirely on the type of weighing equipment available for initial and final weights on the media. Two or more weighings of the media should not be used because this multiplies the error. The scale should be able to handle the entire charge at once. Media additions should be weighed in if a long time test is selected. Again, such weighings should be held to an absolute minimum.

Equipment settings should be mid-range or those normally used. Amplitude should be selected in a mid-range capability of the equipment. A "medium" amplitude is always more desirable because the equipment will most often be operated under these conditions. In round or toroidal equipment, the position of the upper weight or angular difference between the upper and lower weight should also be about mid-range or the upper weight should lead the lower weight by about 45°. If this angular difference was closer to 90°, a high "feed" rate would be developed in preference to a high "roll" rate. It is more reasonable to measure media with both effects occurring simultaneously, unless specific weight settings are required or are always used in your particular operations.

5. Compound concentration should be relatively low, on the order of 1/2 of 1%. A concentrated deburring compound capable of providing excellent corrosion inhibition on all metals present should be used. Flow rates of solution cannot exceed the drainage rate. If no other choice is available, between 1 and 2 gallons of solution per cubic foot-hour (.13 - . 27 liters/liter-hour) is recommended.

6. Media weights should always be dry. A dryer is therefore necessary. The media should be aged for 1 or more hours, depending on the duration of your test and what it was designed for. If you are looking for a good, average depreciation rate for the media, it is best to break-in that product for at least 8 hours, prior to test. A media manufacturer, for example, might select a time period for break-in of only an hour or two, so that conservative, high media depreciation rates would be developed, insuring easy compliance to these values in production. Again, the purpose of the test is paramount. Drying of media must avoid any loss of media particles during the drying or transporting operations. Through-feed cobmeal dryers can be used if cobmeal will not be carried into the media mass to a degree which would affect weight. Normally it would not be. Oven drying is also possible, but is not always available. The best way to insure accuracy in the weighing of media is to have different operators weigh the same charge of media using the same apparatus at different times. When two or three operators can agree with the result repeatedly, some assurance is then available as to the accuracy of the measurement. If a long time test is to be run, it is necessary to protect the scale used for these weights to prevent damage during that time. It is frustrating to finish up a week or so of testing, only to find out that the scale has been damaged and that no reliability can be given to the weight difference which is the important measurement we are seeking.

7. Metal removal or cut rates should be conducted on pieces which have been well broken in and which will not "nest" together during the operation of the machine for the test period involved. Flat pieces should not be used because of this and because they can stick to the walls of the vibratory container if that equipment does not have a ribbed lining. We have had good success with angular pieces, about 1/8" (3 mm.) thick, 2" (50 mm.) long and 1" (25 mm.) legs. When these metal pieces are formed to a 90° angle, they have little or no tendency to nest together. They must be broken in extensively before use and a period of 24 hours in plastic or ceramic media of moderate to good cutting speed is recommended. Surface roughness measurements on these bent angles can be done with excellent accuracy. Deburring and radius measurements should not be made on the same parts used for weight loss because of built-in inaccuracies of deburred pieces.

8. Test time must be long enough to give sufficient weight loss of material to insure an accurate differential weight with the scale available. If a great number of tests are to be run, the test time might be set up at 3 or 4 hours so that 3 or 2 tests per day can be run. Here again, the requirements of the data developed determine the procedure selected. Tests this short in time require much more accuracy in weighing.

ESTIMATES OF MEDIA WEAR RATE AND THEORETICAL HOURS OF USE

Speed is a common variable in vibratory finishing equipment. Vibratory equipment is availabe which operates at 1750 rpm, 1200 rpm, and many others. Variable speed equipment further confuse the "test" speed. Because of this, different researchers will be using different speeds. Therefore, presenting a means of estimating media depreciation rates at one speed, when the test was performed at another would be of value.

The forces supplied to a vibratory machine are centrifugal forces through the bearings. In centrifugal force determinations, speed is a squared function, as observed in the following equation:

$$(2) \quad F = \frac{WRN^2}{35{,}270}$$

where F = centrifugal force, lbs.
W = mass of the eccentric weight, lbs.
R = radius of gyrations, inches
N = speed, rpm

An estimated media wear rate can therefore be determined by the following equation:

$$(3) \quad R_e = \left[\frac{S_a}{S_t}\right]^2 \times R_t$$

Where R_e = estimated media wear rate, percent per hour
S_a = actual vibrator speed to be used, rpm
S_t = test speed for the media, rpm
R_t = media depreciation rate at the test speed, %/hr.

The formula has been used to estimate data developed by other investigators, where good agreement with user information has been found. Use of this formula permits test data developed at one speed to be used at any rate.

In many applications, media is selected as large as possible, without either damaging parts or interfering with separation from the parts. The media is then allowed to wear down to a dimension at which it must be classified out of the machine to prevent lodging. We therefore have a media life based on the dimensions of the media. If the wear rate of the media is known, or can be estimated, the number of hours of operation of the media can be predicted. This too is necessary in developing good estimates of media cost, because in this instance, the media is wholly used within the number of hours of use unless another application for the undersize material can be found. Most frequently, it is considered to have no value when it is classified out of the vibratory machine.

The hours of operational use of media therefore can be predicted using one of the following formulae:

$$(4) \quad H = \frac{\left[1 - \left(\frac{F}{I}\right)^3\right] \times 100}{R_e}, \text{ or}$$

$$(5) \quad H = \frac{\left[1 - \left(\frac{F}{I}\right)^3\right] \times 100}{\left(\frac{S_a}{S_t}\right)^2 \times R_t}$$

where H = hours of operational use
F = final (worn) dimension, inches
I = initial (new) dimension, inches
R_e = estimated media wear rate, %/hr.
S_a = actual vibrator speed, rpm
S_t = media test speed, rpm
R_t = media wear rate at test speed, %/hr.

Rearranging, we arrive at a sometimes more useful expression, where we can determine **media depreciation** rate from chip dimensional changes:

$$(6) \quad R_e = \frac{\left[1 - \left(\frac{F}{I}\right)^3\right] \times 100}{H}$$

(for lengths, width, etc.)

Note that expression (6) is based on changes in chip dimensions: length, width, height, diameter. For media wear rate from changes in chip weight, the following is used:

$$(7) \quad R_e = \frac{\left[1 - \left(\frac{f}{i}\right)\right] \times 100}{H}$$

(for weight)

where f = final chip weight, grams
i = initial chip weight, grams

To show the use, validity and potential problems with this type of analysis, three examples are given:

Example 1: RFHD ceramic media angle cut cylinder, 1" diameter x 1 – 1/2" long run 600 hours in Spiratron ST – 20:

Initial diameter, average	1.017 inches
Final diameter, average	0.758 inches
Initial chip weight, average	50.60 gms.
Final chip weight, average	20.93 gms.
Initial chip length, average	1.475 inches
Final chip length, average	1.245 inches
	Media wear rate, % / hour
Based on chip diameter	0.10 % / hour (6)*
Based on chip weight	0.10 % / hour (7)
Based on chip length	0.07 % / hour (6)

*Equation number reference.

We can then predict when this media would reach a diameter of, for example, 1/2 inch, from expression (4):

$$H = \frac{\left[1 - \left(\frac{.500}{1.017}\right)^3\right] \times 100}{0.10}$$

$= 881$ hour

Note that this is less than 300 hours beyond its existing 3/4" diameter.

Example 2: To develop a full size blend of media for high quality finishing, a Spiratron ST — 100 was filled with four sizes of RFC fast-cutting ceramic media, 5/8 x 7/8, 7/16 x 7/8, 5/16 x 5/8, and 1/4 x 1/2. These were angle cut cylinders of the given nominal diameter x cut length. Regrettably, media samples were not taken on unused material. The following presents chip diameters vs. operation hours. Standard deviations were below.0090" in all but two cases.

Variation and wear rates are higher at the 17 and 62 hour times even though media was broken in 27 hours before measuring (Table 2). A wear rate for this media blend under these conditions, of 0.21 percent per hour, is therefore reasonable.

Chip weight measurements were also made as noted in Table 3.

These data, like those in Table 2, show the characteristic reduction in media wear rate vs. time. That they compare so favorably with Table 2 lends validity to formulae (6) and (7).

Example 3: Now that we have shown such excellent results, it is time to show that vibratory finishing is also subject to "Murphy's Law." This example shows that there can be problems using these calculations: RF-90 plastic, fast-cutting, triangle, 1-1/4" nominal size. This media was run in a Spiratron ST-12 with compound. Measurements were made on length (hypotenuse), altitude, and width (between the almost-parallel faces). Initial dimensions (new media) were not obtained. Dimensions were taken at 1, 2, 3, 4, and 5 week intervals, each of 32—1/2 operating hours. The following data were obtained (Table 5):

Table 1:

TIME, HOURS	AVERAGE CHIP DIAMETER, INCHES			
	5/8	7/16	5/16	1/4
27	.6123	.4191	.3253	.2578
44	.6043	.4077	.3216	.2457
89	.5726	.3887	.3004	.2374
259	.4787	.3436	.2618	.2061

From these data for chip diameter, the following table of media depreciation rates can be developed using (6). Note that cumulative operating hours are used.

Table 2:

CUMULATIVE HOURS	MEDIA WEAR RATE, PERCENT PER HOUR 5/8	7/16	5/16	1/4	Avg.
17	.23	.47	.20	.80	.43
62	.29	.33	.34	.35	.33
232	.23	.19	.21	.21	.21

Table 3:

TIME, HOURS	AVERAGE CHIP WEIGHT, GRAMS			
	5/8	7/16	5/16	1/4
27	9.83	4.33	2.25	1.00
44	9.03	3.98	2.06	0.90
89	8.06	3.57	1.72	0.82
259	51.00	2.56	1.23	0.58

Using formula (7) and cumulative times, a table of media depreciation rates can be developed:

Table 4:

CUMULATIVE HOURS	MEDIA WEAR RATE, PERCENT PER HOUR 5/8	7/16	5/16	1/4	Avg.
17	.48	.48	.50	.60	.52
62	.29	.28	.38	.29	.31
232	.21	.18	.20	.18	.19

Table 5:

OPERATING TIME Weeks	Hours	AVERAGE DIMENSION, INCHES Length	Altitude	Width	WEIGHT, Grams
0	0	—	—	—	—
1	32-1/2	1.0840	.5290	.5818	5.50
2	65	.9746	.4874	.5556	4.34
3	97-1/2	.8306	.4070	.5024	2.78
4	130	.6936	.3319	.4589	1.78
5	162-1/2	.2935	.1050	.4054	0.20

Table 6:

TIME INTERVAL		MEDIA DEPRECIATION RATES, PERCENT/HOUR				
Week	Hours	Length	Altitude	Width	Avg.	Weight
2nd	32-1/2	.84	.67	.40	.64	.65
3rd	32-1/2	1.17	1.29	.80	1.09	1.11
4th	32-1/2	1.29	1.41	.73	1.14	1.11
5th	32-1/2	2.84	2.98	.96	2.26	2.73

Standard deviations were relatively large as can be expected for such cast products. They were greatest for length measurements and, in general, least for width. Values of standard deviations ranged between .010 and .054 inches. Measurements at 2 weeks were least in this respect.

From the data in Table 5, media wear rates were calculated according to equations (6) and (7).

The great variability noted for the 5th week in Table 6 is due to the very small chip size.

It is noted that excellent agreement exists only between the "average" depreciation rates and "weight" rates. "Length" and "altitude" values are significantly higher than "width" values as can be expected for the geometry of these edges.

Regular or simple shapes are easier to predict than complex ones.

CAUTION: IS A MEDIA TEST REALLY THE ANSWER TO YOUR PROBLEMS?

No one can fault the investigator for any attempt to reduce costs in the manufacture of his product, especially in these days of continuing inflation and cost-price squeezes. However, many investigators are asking the wrong questions. They should be attempting to determine how they can reduce cost for the deburring, surface conditioning or whatever on each part produced. When this question is asked, the savings in dollars to the user of the vibratory equipment can often be significantly greater than a change in media could ever be. The following examples will illustrate this point.

1. Are we overdoing the part? Are we doing too much burr removal? If we can reduce time cycles 10% or 20%, we should be able to reduce media use by like percentages.

2. Many times we attempt to use as large a piece of media as possible to improve its life. However, if this piece of media is so large that it impedes separation of parts from media, it may not be worth that "savings". In other words, by using a smaller piece of media to facilitate separation, we may save up to 10 to 15 minutes per cycle, every cycle.

3. Use a faster cutting media and higher or faster-wearing media to enable use of a continuous cycle, rather than a batch operation. Continuous cycles are often possible without equipment modification in cycle times up to 15 minutes or more, and up to 30 to 60 minutes with equipment modifications. If a 20 minute cycle is now being required and can be reduced to 10 or 15 minutes by use of a faster cutting media, continuous cycles could be considered if the volume of work warrants it. Machine capacity is increased 15-20% by operating round equipment, for example, with the gate up or raised at all times. The volume of media below the screen deck in these instances is then filled up to make up the increase in capacity. In addition, the "unproductive" separation time is reduced to one cycle per day. Because loading of parts is continuous, separation is continuous except for the last cycle each day, unless allowing them to remain in the media overnight will do them no harm. Continuous cycles offer the ultimate in economy of a vibratory finishing process just as in other automated processes.

4. Change compound. Improper use of compound can impede the cut or glaze media. Burnishing compounds are designed to do this to ceramic and plastic media, thereby allowing the media to develop much lower surface roughness values on metal parts. By using a deburring type of compound which will not glaze the preforms, much faster cutting is permissible. Media depreciation rates go up considerably, but the reduction in cycle times is much more prominent, and more than offsets this cost.

5. Adjust the flow rate of solution and/or use the "flow-through" solution system. A coated abrasive belt which is loaded with grease cannot possibly remove metal at the same rate as a belt that is kept clean. Grease is applied to the belt to reduce its cut rate and to develop smoother finishes. Keep it clean and use a well-designed flow-through solution system to reduce cost.

6. An expensive preform can be cheaper than river rock. Years ago, a very knowledgeable customer was setting up a new deburring process with river rock which could be delivered to his plant for about $0.08/lb. No conventional media could begin to compete with this material on a cost per pound basis. This system required that the rock had to be kept below 1.5" (38 mm.) in size and larger than about .35" (9 mm.) to prevent lodging at either of these extremes. It was a continuous process where parts were fed in automatically by conveyor belt from a rough grinding operation to the vibratory machine, processed for 30 minutes on a continuous basis, automatically separated and sent on to a final grinding operation. No operators were to be used, hence a continuous, tie rod media classification system was designed to remove media at about 1/2" (13 mm.) in size. After several days of operation of the 70 cubic ft. (2000 liter) round vibratory machine, the random rock was being removed at the rate of over 7 cubic feet (200 liters) per hour. This user then invested in special size ceramic preform in order to maximize the size of an angle cut cylinder that could be used for his application. His costs dropped remarkably. The media wore out at an orderly rate. Because it was a preform it was classified at a predictable dimension.

7. Eliminate precleaning of parts. Vibratory systems can clean metal parts very quickly. A synergistic effect is developed between an excellent cleaning compound and the scrubbing action of media to remove organic and inorganic soils from metal parts rapidly. Elimination of a precleaning step prior to vibratory finishing can more than offset the potential cost savings expected by a media change.

8. Use steel media. While media depreciation rate is an important operational cost, it can sometimes be eliminated entirely by the use of steel media. Vibratory steel finishing machines are being used for burnishing, brightening, cleaning, deburring and other applications. Steel is expensive, on the order of $300 per cubic foot as opposed to $60 per cubic foot for ceramic. But it can eliminate lodging problems and produce the cleanest parts possible when combined with an excellent compound system. This expensive media has a wear rate that is essentially zero. It reduces costs significantly and makes a beautiful part.

9. Change of process to reduce the work required on your parts. If you were preplate finishing your parts and must get down to a 3 or 4 micro-inch (0.8 or 0.10 micrometers) finish in order to permit cyanide copper to level adequately for high quality plating, a change to leveling acid copper can produce outstanding quality parts at higher micro-inch surfaces. Cycle times in vibratory equipment can be reduced and sometimes faster cutting media can be used. The savings are obvious.

10. To make a better part. Poor quality parts require more finishing time. This holds true whether the part is a diecasting, loaded with defects or a stamping made on dull die. The worse the die becomes, the greater the defects that must be removed and the longer time it will take do to it. A unique advantage of vibratory finishing is its inherent stupidity. It cannot think. It cannot do more work on parts today because they are made poorly than yesterday when they were made better. As a result, knowledgeable operators are utilizing this fact as a very simple quality control tool. Cycles on new dies are set up at 20 minutes, for example, and when the progressive deterioration of the die requires over 30 minutes of processing time, it is time to touch up the dies. The economics of this concept can easily be worked out. Electroless nickel on diecasting dies produce better surfaces. If this will reduce the initial surface roughness of a preplate zinc diecasting, it will require less finishing time and considerable cost savings.

11. Cleanliness and efficiency. Much media "wear" is not wear at all, but is media that is carried out lodged in the parts. If this is a problem, adjust the size of your media, classify it, or at least return the media to the equipment or to another piece of equipment used on other parts. Do not throw it away and do not carry it all over your plant. Carry-out losses also occur during separation. When this happens, screen design changes can be made to effect much faster and more efficient separation. Tie rod screens, for example, will orient media and allow separation of parts that cannot possibly be done on woven wire or square grid screens. Or steps can be put into the separation deck to tip over cup-shaped parts.

12. Reduce speeds. Efficiency of vibratory processes can be improved by reducing speed of the operation. If you have a variable speed machine, the tendency is to operate that equipment at a high frequency in order to get your parts done in the greatest hurry. If the capacity of the equipment is available, and if a continuous process is not being utilized, slow down your equipment. The effects of speed on media depreciation rate were shown above. They are significant. Metal removal rates, especially in the deburring type of application, is much less sensitive to speed. By reducing speed several hundred rpm, an almost insignificant change in many deburring cycles will occur plus a phenomenal reduction in media depreciation.

If we are performing deburring work on relatively short cycles and are interested in improving overall economics of our operation, we may wish to evaluate media having better wear resistance for this type of work. But we may find that only changing the size of the media will make more difference in deburring rate than by changing several grades of media.

SUMMARY

We encourage any serious investigator to test media as required to suit his purposes. Many users of vibratory finishing systems will gain knowledge of their process and valuable cost saving by such effort. We do, however, respectfully recommend that before such testing is undertaken, that the more obvious potential cost savings be explored. We have seen it happen many times with remarkable results.

ACKNOWLEDGEMENT

The author acknowledges the support of M.W. Baker in the development of these formulae and in collecting samples.

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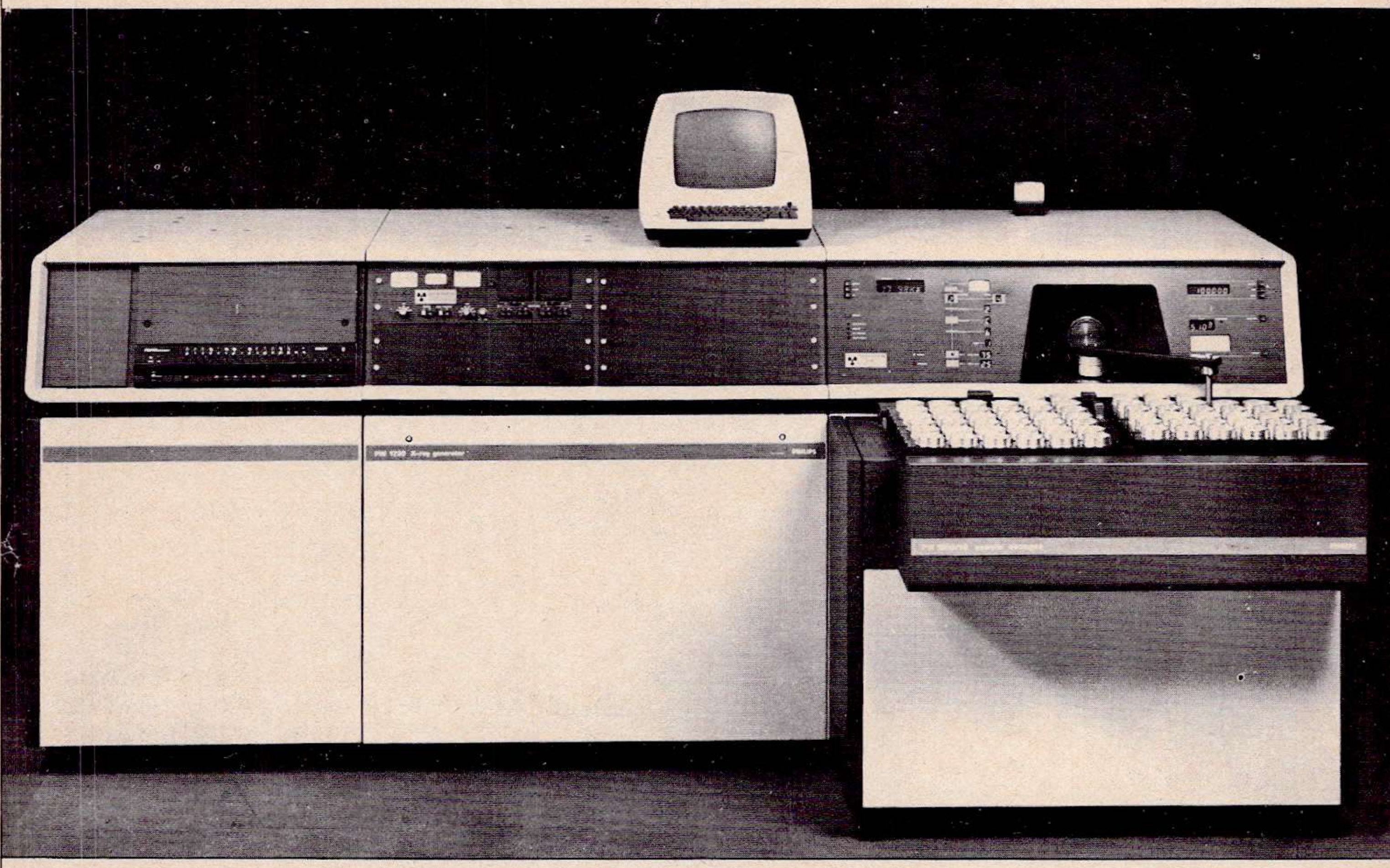

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Factors To Consider In Choosing An Oscilloscope

ELISEO SANTOS
Philippine Electronic Industries, Inc.

I. KEY SPECIFICATIONS AND FEATURES

A. AMPLIFIER CONSIDERATIONS

I. Rise Time and Bandwidth:

One vital capability generally sought in an oscilloscope is sufficient bandwidth and adequate rise time.

Although rise time is usually the more important parameter when working with faster waveforms, signal bandwidth is commonly specified for lower speeds. Constraints make the two numerically related in well-designed general-purpose oscilloscopes. Bandwidth in megahertz multiplied by rise time in nano-seconds is approximately 0.35. Therefore, if your needs are defined in terms of one factor, dividing it into 0.35 will produce the other.

Bandwidth is of course defined as the frequency range in which signals are handled with less than a 3-dB loss compared to midhand performance. Since modern oscilloscopes work well at low frequencies down to dc, bandwidth here commonly refers to the highest frequency which can be displayed with a 3-dB or less error.

Most oscilloscope designs make use of gradual roll-offs at the high-frequency end, so in many cases a scope will be useful far beyond its specified bandwidth. Waveshapes may be altered and amplitudes reduced somewhat.

In terms of rise time, scopes ideally should have a vertical system capable of responding at least five times as fast as the fastest applied step signal (thus having a rise time less than 1/5 as great). In such a case, the rise time of the signal indicated on the scope will be in error by less than 2 percent.

Using the 1/5 and 0.45 factors together, the minimal requirements for scope bandwidth for accurate rise time measurements can be estimated using the following rule of thumb:

$$\text{Bandwidth (minimal)} = \frac{1.70}{\text{Fastest Rise Time}}$$

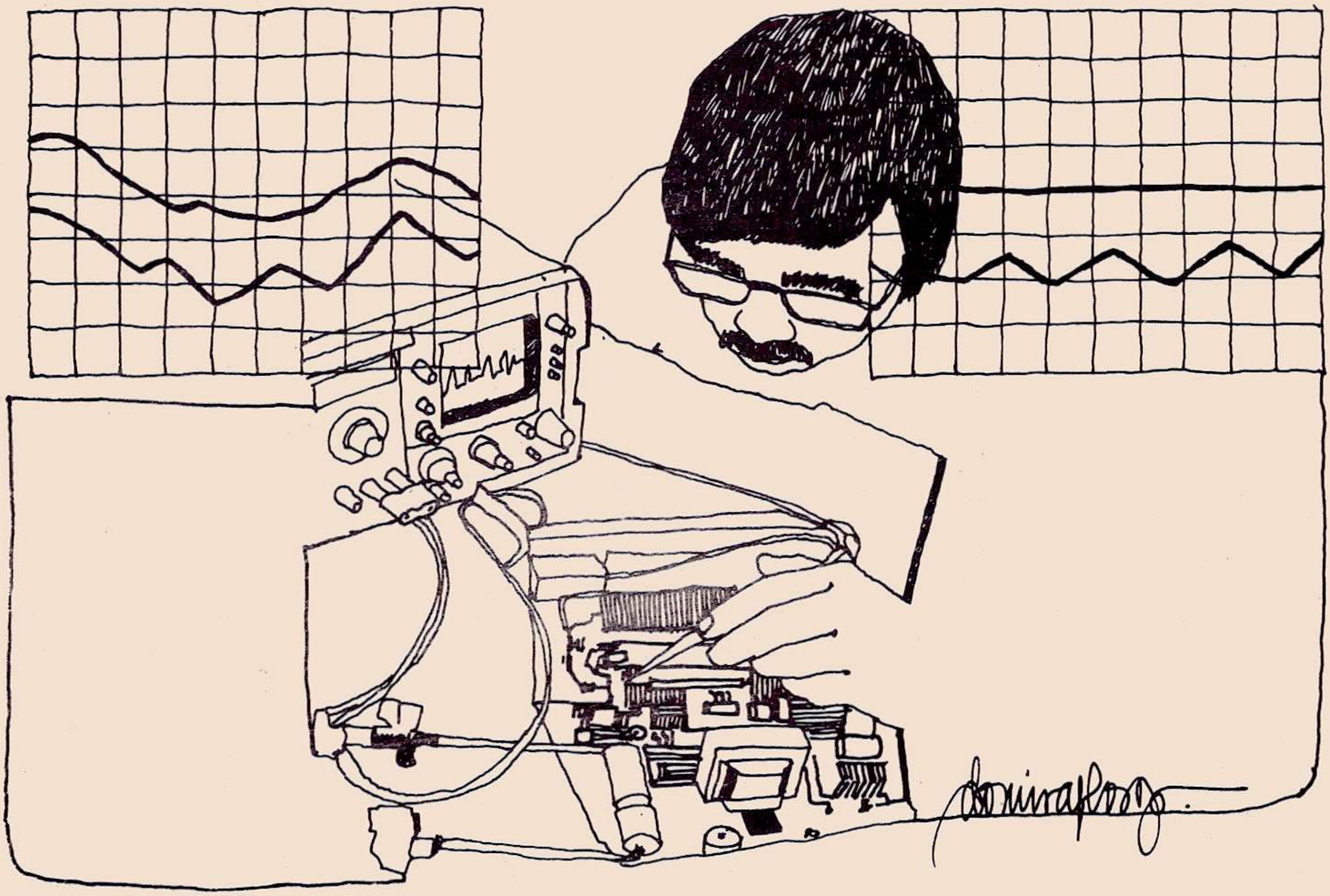
Very accurate absolute rise time measurements are not always important. When simply comparing the rise times of two signals, scopes with a rise time equal to the rise time of the signals applied are usually considered adequate.

Besides indicating bandwidth for the vertical channel, many oscilloscope specifications also include a bandwidth figure for the horizontal and trigger channels.

Bandwidth and rise time figures also apply to many other instruments. Signal sources, probes, amplifiers , TDR systems and many other test instruments are characterised in part by rise time. Frequency response figures are given for portable patient monitors, spectrum analyzers and many tv products. The specifications will indicate values where these figures are relevant.

2. Sensitivity (Deflection Factors):

Although sensitivity specifications are most often associated with oscilloscope vertical channels, specifications can also be provided for horizontal channels and trigger circuits with external inputs. Similarly, various other instruments may have a sensitivity specification relating minimum input level to some function or output level.



Sensitivity, in the case of oscilloscopes, refers to the input needed to produce a stated deflection of the spot on the crt. Specifications typically are given in millivolts per centimeter or division.

At a given state of the crt, sensitivity is a trade off with bandwidth. The small amount of noise in even the best input circuit will mask signals which are too weak. Raising the bandwidth increases the noise picked up by the amplifiers, requiring more of a signal to create a clear display.

As a consequence of this relationship, many high-sensitivity scopes provide bandwidth-limiting controls to allow you to make better low-level, moderate frequency measurements. For these and other models, a set of sensitivity specifications may be given for limited frequencies as well as over the full range.

Many times, external noise will be the problem. Differential amplifiers are often used to lessen the effects of external noise and common-mode signals, thus improving the useful measurement sensitivity range.

3. **Types of Inputs:**

   a. **Differential, Balance, or Push-pull Inputs:**
   Differential or balanced amplifiers provide a feature beyond mere accommodation of push-pull signals: they have the ability to cancel or reject, to a high degree, any signal components equal in amplitude and phase that

appear at both inputs. Such amplifiers provide a simple and accurate means of measuring the difference between two signals. They also provide a means of rejecting most unwanted signal components common to both inputs, such as power line "hum".

b. **Multiple Inputs:**

It is quite often useful to be able to view any one or several of a number of input signals without disturbing connections to the oscilloscope. Several types of multiple-input amplifiers which display more than one signal on the same crt display are available.

Common applications include input-output comparisons, checking a signal against a standard or working with complex circuits.

Two Techniques: Dual-Beam and Dual-Trace:

Two techniques, dual-trace or dual-beam circuitry, are commonly used for creating two traces on a single crt. The dual-trace scope incorporates electronic switching to alternately connect two input signals to a single deflation system. The dual-beam scope, however, has two independent deflection systems within its crt. (Some models do share horizontal systems, though). There are distinct advantages to both dual-beam and dual-scopes: a dual-beam scope can display two input signals separately and simultaneously. Therefore, it can show two nonrecurrent signals of short duration. Also, models with independent horizontal deflection can display nonrecurrent signals on different time bases.

The principal advantages of dual-trace scopes are lower cost and intrinsically better comparison capabilities. This comes from using a single horizontal amplifier and one set of deflection plates. On the other hand, since a transient event might occur on one input channel while the beam is tracing the other, dual-trace scopes are not recommended for viewing fast one-shot phenomena.

Extension of the dual-trace principles has produced newer multiple-trace oscilloscopes capable of displaying up to eight traces.

B. TIMES BASES

1. Sweep Rates:

Except in special cases, oscilloscopes have built-in sawtooth sweep generators for producing constant-speed horizontal beam deflection. In early scopes, these generators ran continuously and horizontal calibration was based on their repetition *frequency.* In most modern scopes, sweeps are calibrated in terms of a direct unit of *time* for a given distance of spot travel across the screen; hence the term. "time base".

This technique permits:

1. Direct measurement of time between events.
2. Viewing and measuring small portions of pulse trains.
3. Viewing and measuring random or aperiodic events.
4. Viewing and measuring single nonrecurrent event.

Distance representing time are measured on the scope's graticule, the ruled scale built into the display. The internal graticule built inside the crt face on modern scopes is preferable, as it eliminates parallax.

A major graticule division may be an inch, centimeter or some other length. Some instruments have different distance-units for the vertical and horizontal scales. Graticules often have small markings which subdivide the major divisions to assist in making accurate measurements. Such subdivisions should not be interpreted as the distance unit in a specification.

Strictly speaking, sweep specifications are rates properly expressed as time/length. However, the *term sweep speed* (implying length/time) is often used synonymously.

Relating Sweep Rates, High Frequencies and Rise Time

The appropriate sweep rate for frequency-specified measurements is based on the nature of the test.

Given a moderate frequency, a sweep is usually considered adequate if it is capable of displaying one cycle across the full horizontal scale. At high frequencies, however, scopes seldom have sweeps that fast. To measure rise time as accurately as possible, a step signal (square wave, rectangular pulse, etc.) should occupy most of the full vertical scale, and the rising portion of the signal should be displayed at nearly a 45^{o} slope.

This objective can be met only if the fastest sweep is able to move the beam a horizontal distance nearly equal to the full vertical scale in a time interval equal to the rise time of the vertical deflection system. Because of the compounding difficulties and cost of providing extremely fast sweeps which are both linear and accurate, this goal must be tempered somewhat in scopes having the very best vertical deflection system rise time capabilities.

In some cases rise time measurements are not made to determine actual rise time, but are done to decide whether certain limits are met or exceeded. In such cases, an adequate comparison with a standard signal of rise time can usually be made even with a sweep that provides a fairly steep display, given that the vertical deflection system rise time is good enough.

2. Sweep Types:

Delaying/Delayed Time Bases

Delaying-sweep measurements use two linear calibrated time bases.

The first time base, commonly called the delaying sweep, allows the operator to select a specific delay time. When this time is reached, the second time base, called the delayed sweep, starts.

The delayed sweep is typically set a decade or two faster than the delaying sweep and therefore offers additional resolution. The combination of these two time bases also offers increased accuracy of time interval measurement.

Sampling

Sampling is a powerful technique for examining very fast repetitive signals. It is similar, in principle, to the use of stroboscopic light to study fast mechanical motion. Progressive samples of adjacent portions of successive waveforms are taken; then they are "stretched" in time, amplified by relatively low-bandwidth amplifiers, and finally shown, all seemingly at one time, on the screen of a cathode-ray tube. The graph thus produces a replica of the sampled waveforms. The principal difference in appearance between displays made by sampling techniques and conventional displays is that those made by sampling are comprised of separate segments or dots. This technique is limited to depicting repetitive signals, since no more than a portion of the signal is captured and displayed each time the signal recurs.

The sampling method, however, provides a means of examining fast-changing signals of low amplitude that cannot be examined in any other way. The system is capable of resolving events that occur in less than 30 picoseconds on an "equivalent" time base of less than 20 picoseconds per division and less than 5 mV peak amplitude.

Tehronix uses the random sampling technique which differs from conventional sampling because it does not require a delay line or pretrigger for lead time to be visible in the display. The benefits afforded by this feature are:

1. Signals with no source of pretrigger can be observed.
2. The inherent rise time limitation of signal delay lines is eliminated.
3. It is no longer necessary to work into the 50 ohms characteristic impedance of a delay line, so high impedance can be retained.
4. External triggers may occur before, coincident with, or after the displayed signal, with lead time still visible in the display.
5. Display time jitter otherwise caused by pretrigger-to-signal is eliminated.

II. CONFIGURATION

TWO BASIC APPROACHES

There are two basic configurations for test and measurement instruments. Modular instruments, more often called plug-in or laboratory models when referring to oscilloscopes, combine a main-frame and one or more interchangeable plug-in sub-assemblies. Integrated instruments, such as monolithic oscilloscopes, are one-piece units.

Although portable instruments are traditionally designed as integrated units, not all monolithic instruments meet all the objectives of portability. On the other hand, some modular systems are designed for easy transport right into the field.

A. MODULAR DESIGN:

Versatility is the primary advantage of a modular instrument. Many more functions than could be economically or practically combined in a single unit can be made available in separate plug-ins. You can then choose the ones that serve you best.

Because a modular instrument is so versatile, it can also make use of advances in instrument design. New plug-ins or mainframes can be added that, within the basic limitations of the other units, add new functions or higher performance.

Modularity also allows plug-ins and mainframes to be shared between various uses. The same general test and measurement plug-ins used in the lab for design work can be quickly inserted into a portable mainframe and easily carried to a service problem. Alternately, where demand warrants it, the identical model plug-ins can be supplied to both field service and laboratory personnel, assuring the repeatability of measurements and minimizing training time.

Plug-ins can also extend the original instrument range to other functions. Digital multimeters, curve tracers, spectrum analyzers and logic analyzers are just a few examples of the many specialized plug-ins for modular oscilloscopes.

B. INTEGRATED AND MONOLITHIC DEVICES

Taking the other design approach to instrument design, integrated instruments are optimized for a single range of functions. One piece instrument design provides reduction in weight, increased ease of use, smaller size, and usually lower power requirements when a definite function is required.

Many oscilloscopes of this type are particularly designed for portable use, with rugged cases, environmental protection, and internal or external battery power.

To sum up, modular instruments feature versatility, opportunities for tailor-made selection of functions, and a wide range of measurement capability. Integrated designs are strongest in economy for single functions, ruggedness, and portability.

III. CRT DISPLAYS

A. CONVENTIONAL

B. STORAGE

Storage crts continue to display a waveform after the input signal ceases. The period of image retention runs from a few seconds to several hours depending on several factors mentioned below. The stored display may be erased to make way for storage of a later waveform. Storage tubes may also be operated as conventional (non-storage) tubes. Storage oscilloscopes allow easy, accurate evaluations of slowly changing phenomena that would appear only as slow moving dots. They are also needed for viewing rapidly changing non-repetitive waveforms whose images would otherwise flash across the crt too quickly to be evaluated. Storage can reduce the time to photograph scope traces by allowing you to "compose" the picture. Unwanted displays can be erased as many times as necessary before the photograph is taken.

1. Bistable:

The bistable-phosphor crt utilizes a special phosphor with two stable states: written and unwritten.

The storage mode allows waveforms to be stored and displayed a minimum of several hours (in some cases much longer) or until erased by operator.

Bistable storage is often the easiest kind of storage to use. It is also usually the most inexpensive. Some principal applications include mechanical measurements, signal comparisons, and data recording. Most bistable phosphor crts have a split-screen viewing area which allows each half to be used independently for storage displays. The split-screen feature provides many unique advantages. With this system a reference waveform can be stored on one half of the screen and the other half can be used to store the effect that calibration adjustments or the insertion of filters, etc., have on circuit operation. If desired this technique can be used where the reference portion operates in the stored mode and the other half of the display, operating in the nonstore mode, monitors an external input.

An example of the usefulness of the split-screen feature is in speech therapy. The normal speech pattern is recorded on the upper half of the storage screen and the patient's attempts to match this pattern are recorded on the lower half. With split-screen operation, the lower half showing the trial waveform can be erased as many times as desired without affecting the stored information on the upper screen.

2. Variable Persistence

Variable persistence storage allows a continuous gradation: the bright written level and the dark reference.

The variable persistence made also allows for the selection of the time a stored image will be retained. The storage persistence can be adjusted so that entire waveform can be viewed, yet the stored trace fades from view just as the new waveform is being plotted. With the save feature, an entire display can be stored for further analysis if desired.

Applications for variable persistence storage include real time, spectrum analysis, time-domain reflectometry, sampling and other measurements which require slow sweep displays. For fast repetitive sweeps, the storage persistence can be set so multiple traces are displayed before the first trace fades from view. Then you can view changes in signal response with changes in circuit conditions, time, or adjustments. This method can also be used to provide display integration so that only the coincident portions of a repetitive signal are displayed. Any aberration or jitter not common to all repetitive traces will not be stored or displayed. Low-repetition rate, fast-rise-time signals that are not discernible on convention crts can be easily viewed.

This type of storage provides the best display when storing displays with varying intensities, such as delayed sweep or with X-axis intensity modulation.

Variable persistence storage provides very good displays for photographs due to the high contrast between dark background and bright waveforms.

3. Fast Transfer

Fast transfer storage uses a tube with a special intermediate mesh target. This target, which is optimized for speed, captures the waveform and then transfers it to a slower, longer-storing electrode. The second target can be designed to offer bistable or variable persistence modes, in combination with the transfer mesh or by itself.

Digital Storage

Although not directly comparable in some respects, digital storage is also a useful technology for waveform retention. More information is given in the sections on digital oscilloscopes, logic analyzers and signal processing systems products.

Display Monitors

Image Characteristics

Elements that may be important to you in obtaining the best image from a display monitor include the brightness of the image, the resolution or spot diameter, the size of the image and the phosphor type used and its characteristics.

Brightness depends on the type of crt used, the phosphor and the accelerating voltage.

In general, higher brightness can only be obtained at the cost of lower resolution or slower writing speed. On some monitors, a separate intensity or Z-axis input is available to modulate the brightness of the beam. Resolution is specified either by spot size or by number of line pairs in a given distance. Smaller spot sizes or greater numbers of line pairs in general mean a more detailed image can be displayed.

Screen size and the size of the graticule on conventional monitors is normally comparable to that offered on laboratory oscilloscopes (up to 8 by 10 cm). Phosphor characteristics can be selected to optimize viewing or photography and to match desired image decay rates.

Storage

Storage is an essential feature on monitors when the information to be presented is transitory or the image to be built up is too complex for the source to communicate all at one time.

Vertical and Horizontal Amplifiers

The amplifiers in display monitors must faithfully translate the input signal to a deflection on the crt screen. Two important characteristics are the bandwidth of the amplifier and the linearity, each of which contributes to how faithfully the signal will be reproduced on the screen. The phase difference and the common-mode rejection ratio determine how closely two signals can be graphed against one another and how well they can be extracted from extraneous background noise.

IV. CATHODE-RAY TUBE PHOSPHOR DATA HUMAN EYE RESPONSE

An important factor in selecting a phosphor is the color or radiant energy distribution of the light output. The human eye responds in varying degrees to light wavelength from deep red to violet. The human eye is most sensitive to the yellow-green region; however, its responsiveness diminishes on either side in the orange-yellow area and the blue-violet region. The eye is not very receptive to deep blue or red.

If the quantity of light falling on the eye is doubled, the brightness "seen" by the eye does not double. The brightness of a color tone as seen is approximately proportional to the log of energy of the stimulus.

The term **luminance** is the photometric equivalent of brightness. It is based on measurements made with a sensor having a spectral sensitivity curve corrected to that of the average human eye.

Phosphor	Fluorescence	Phosphorescence Where Different from Fluorescence	Relative Luminance	Relative Photographic Writing Speed[2]	Decay to 10%	Decay to 1%	Decay to 0.1% (in ms)	Relative Burn Resistance	Comments	Ordering Information Option
P1	Yellowish-green	–	50%	20%	24 ms	48 ms	95	Medium	Replaced by P31 in most applications	Special Order
P2	Bluish-green	Yellowish-green	55%	40%	75 us	–	120[3]	Medium	Good compromise for high- and low-speed applications Replaced by P31 in most applications	Special Order
P4	White	–	50%	40%	60 us	470 us	20	Medium high	Television displays	74
P7	Blue	Yellowish-green	35%	75%	0.3 s	3 s	8 sec	Medium	Long decay, double-layer screen	76
P11	Purplish-blue	–	15%	100%	80 us	–	20	Medium	For photographic applications	78
P31	Yellowish-green	–	100%	50%	38 us	250 us	32	High	General purposes, brightest available phosphor	80
P39	Yellowish-green	–	27%	NA[4]	36	203	1250	NA[4]	Photographic applications	40
P45	White	–	32%	NA[4]	7	1.9	5	NA[4]	Monochrom TV displays	

[1]Measured with J16 photometer and J6523 luminance probe which incorporates a CIE standard eye filter. Representative of 10 kV aluminized screens. P31 as ref.

[2]P11 as reference with Polaroid 410 film. Representative of 10 kV aluminized screens.

[3]Low level lasts over one minute conditions of low ambient illumination.

[4]Not available.

The SI (international metric standard) units for luminance are candelas per meter squared, but the English footlamberts are still used extensively in the U.S. One footlambert = 0.2919 candelas/M^2.

The term luminance implies that data has been measured or corrected to incorporate the CIE standard eye response curve for the human eye. CIE is an abbreviation for "Commission Internationale de L'Eclairage" (International Commission on Illumination). The luminance graphs and tables are therefore useful only when the phosphor is being viewed.

PHOSPHOR PROTECTION

When a phosphor is excited by an electron beam with an excessively high current density, a permanent loss of phosphor efficiency may occur. The light output of the damaged phosphor will be reduced, and in extreme cases complete destruction of the phosphor may result. Darkening or burning occurs when the heat developed by electron bombardment cannot be dissipated rapidly enough by the phosphor.

The two most important and controllable factors affecting the occurrence of burning are beam-current density (controllable with the Intensity, Focus, and Astigmatism controls) and the length of time the beam excites a given section of the phosphor (controllable with the Time/Div control). Of the total energy from the beam, 90% is converted to heat and 10% to light. A phoshor must radiate the light and dissipate the heat, or like any other substance, it will burn. Remember, burning is a function of intensity and time. Keeping the intensity down or the time short will save the screen.

SELECTING A PHOSPHOR

The catalog description of each oscilloscope indicates the phosphor normally supplied or offered as an option. Special phosphors are available for applications which require different characterlstics.

For example, P11 is excellent for waveform photography but due to its short persistence it is not well suited for applications requiring visual observation of low-speed phenomena.

Phosphors are rated in several parameters, such as color of fluorescence or phosphorescence, decay, etc.

V. OTHERS

A. PORTABILITY

Any instrument not actually permanently bolted down is in some sense portable, but by "portable" we mean something more.

Portable Oscilloscopes:

For oscilloscopes, a combination of factors must be considered. Small size and light weight are obviously important, but the degree depends on the application and the uses. Similarly, ruggedized cases or dust covers may be required.

For many applications, internal battery power is often essential. On the other hand, the weight of internal batteries can be a disadvantage if they are rarely needed. In some applications power is always available, since it must be provided to the equipment being tested.

B. ENVIRONMENTAL CHARACTERISTICS

The environmental characteristics listed in instrument specifications may include some or all of the following: temperature, altitude, humidity, vibration, shock, and electromagnetic compatibility (emc, previously rfl or emi).

The specifications for humidity, vibration, shock, and transportation are intended to be beyond what can be expected in use, and operation at these extremes may cause minor physical deterioration. Such operation, however, should not cause electrical performance to deteriorate outside specifications.

The specifications for temperature and altitude are such that continual use at the limits will not cause significant short-term deterioration. Naturally, higher temperature operation can be expected to reduce longterm reliability and should be avoided if possible. The emc test is completely nondestructive.

Sample production instruments are tested periodically as part of a continual quality-control process. Complete tests on every production instrument are undesirable as well as uneconomical.

C. POWER SOURCE CONSIDERATIONS

In general, instruments are factory wired for the nominal voltage of the country of manufacture. Most instruments provide wide-range regulated supplies, or line-voltage operating range. Transformer taps in other instruments can be changed to accomodate specific line-voltage operating ranges or can be factory wired for a specific range if specified on the purchase order.

Most instruments are designed for operation from a power source with its neutral at or near ground (earth) potential. They are not intended for operation from two phases of a multiphase system or across the legs of a single-phase three-wire system (220V).

Except for some double-insulated instruments, most instruments are equipped with either a three-conductor attached power cord or a three-terminal power-cord receptacle. The third wire or terminal is connected directly to the instrument chassis to protect operating personnel. pm

Making Technology Forecasts Come True

FRANK DALEY, JR.
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ABSTRACT

The 1977 Delphi Forecast of Manufacturing Technology is reviewed. Some of the more significant predictions are identified and exceptions are noted to some of the questionable ones. Obstacles to achievement of the forecast are discussed. These include deficiencies in R & D community credibility, limited investment incentives, and problems of technology transfer. Several strategies for overcoming these obstacles are presented. Among them are tracking the time value of money, understanding the production environment, clear communication with management, and cooperative R & D.

Prophecy is not an easy route to popularity. If, at the time a prediction is made, it is generally believed, then it is often considered trivial. The prophet consequently suffers from a shrunken ego. If the forecast is not widely believed, the prophet may be considered eccentric for uttering it, and becomes a social outcast. If the prophecy is pessimistic, we must keep in mind that in some social groups of ancient times the bearer of very unpleasant news has been put to death. Today he might be revered as a consumer advocate. On the other hand, if the prophecy is glowingly optimistic, there is a strong tendency for people to relax, sit back, and wait for the prediction to happen, without doing anything to help it along. If results don't materialize, the outcome is a demand for an explanation of what went wrong, but relatively little actual progress.

Zeuxis about 300 BC pointed out that "Criticism comes easier than Craftmanship" so I am going to take the easy way out on the topic to be reviewed, and criticize rather than create. However, I hope the offerings will be constructive since proposals to consider are stated in advance of the actual game, and not as observations of a Monday morning quarterback. Fortunately, the prophets I will engage today are anonymous, so they may breathe easily, but I hope they pay close attention nonetheless. My topic is the 1977 Delphi Forecast of Manufacturing Technology conducted by the Society of Manufacturing Engineers and the University of Michigan. The responses offered represent the collected thoughts and judgments of the seasoned and experienced people in the Manufacturing Development organization with which I am privileged to work.

The only winners in the game of prophecy are those who go to work to make their forecasts come true. With this in mind, let us single out certain of the events predicted in the Delphi forecast and indicate those which I doubt can be realized. But let us pay more attention to a few that we as manufacturing engineers ought to try to make happen. Then, let us identify some of the obstacles that need to be overcome if the forecasts are to work out. Finally, we can review some strategies which appear to be important in gaining our objectives.

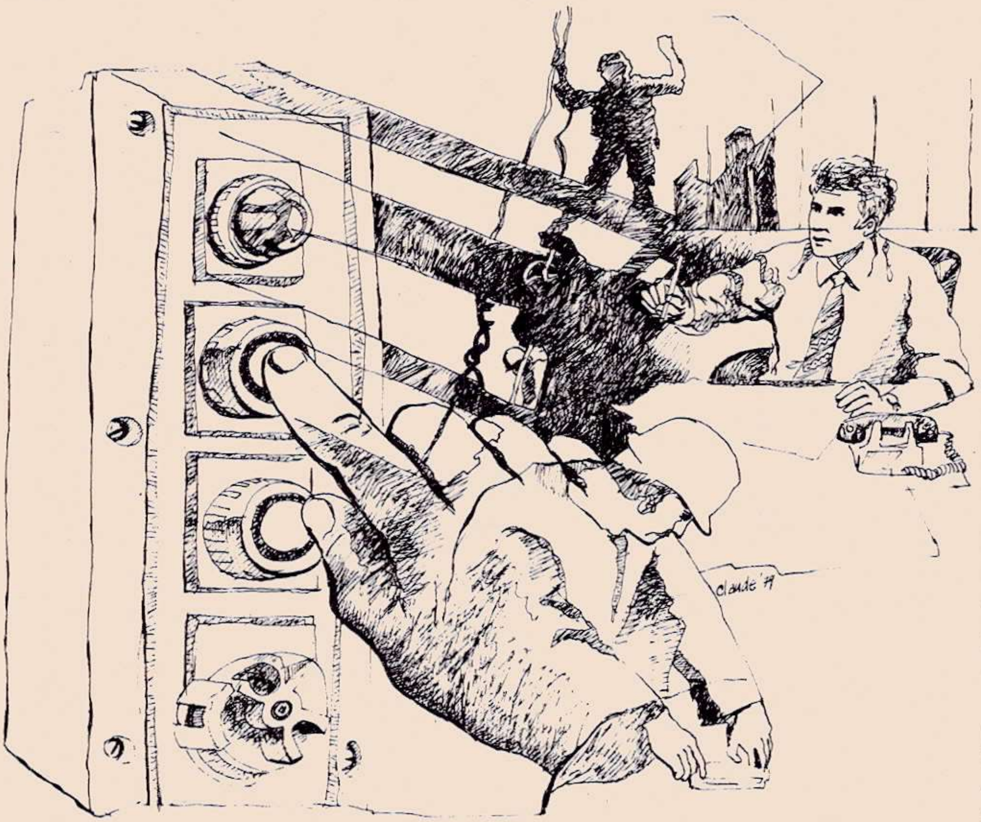
ASSESSMENT OF THE FORECAST

Two major criteria are important in assessing the significance of a predicted industrial event. These are order of its deviation from the popular belief and its probable impact on industry in general.

There is a popular misconception, for example, that the Laser is about to become a dominant tool for metal removal. Three questions in the Material Removal Forecast deal with this topic. The collective response can properly be interpreted, I think, to say that Lasers will not replace spindles for most operations.

On the contrary conventional chip-making will be with us as far ahead as we can see. Cutting speeds on the order of 20 to 30 meters/sec. for production operations are predicted by 1984.

Since an increase of this magnitude would significantly impact the entire metal working industry, it is important that work to move this technology into everyday use should be vigorously pursued.



The forecast also predicts that 1985 will see a breakthrough in the machining of plastics and other non-metallic materials. For this to happen we need a good idea and probably several years of intense process development. I seriously question the accuracy of this prediction. I think it deserves the "wish" label.

On the other hand, the forecast seems unduly timid with respect to robotics. The direct question "will automatic decision-making robots be used by at least 25% of the firms in your industry?" is answered as "Yes, by 1990".

Robots with tracking capability, visual and tactile sensing, adapting to variable conditions are in the final stages of development today. Certainly they will be used by 100% of the firms in the auto industry by 1990 and probably well before that. It is well to point out, however, that their sensory capabilities will still be very primitive and their decision making capability, while properly termed logical, could certainly not be considered intelligent.

A number of the survey questions deal with the degree of automation – with how much in the way of integrated manufacturing systems can be expected. It is safe to conclude, from the responses, that the automatic factory is not imminent. At least not in our kind of economy. Most free market plants produce a changing variety of products. They must adapt daily to many unexpected events. Automatic systems combining this degree of adaptability with a high level of over-all reliability at acceptable investment cost are a long way off. Current design sources do not yet have the ability to create cost effective total systems and financial resources are not yet prepared to pay for their development.

We can, however, create systems which perform all the machining operations for a part. A number of them are in operation today. This shows that in some cases we can also pay the bill. The forecast predicts substantial increases in the use of such integrated machining systems, over the next 15 years.

I believe that this projection holds for my company as well. But identifying appropriate applications and justifying them is a complex job to be done, without which technology by itself probably won't sell.

Whether or not integrated machining systems achieve importance in manufacturing depends partly on their ability to adapt to material variation and to recover quickly from failures. These two modes of adapting to the manufacturing environment are also important for individual machine tools. The forecast treats the topics of adaptive control and diagnostic sensing in some detail, and each of these possibilities represents a zone which must be actively probed for potential benefit.

The forecast tells us that we can expect practical adaptive control systems by 1985. It also predicts that the use of diagnostic and recovery systems will be significant within about the same time frame.

These capabilities will determine to a great degree whether or not the people in our plants can operate complex machining systems well enough to achieve the productivity which those systems promise.

Up to this point, we have talked about the survey opinions regarding the automation of individual processes and complete processing systems. The emphasis has been on what fully automatic equipment will be able to do. Clearly, there are some very tall steps leading us toward the future. One of the trickiest to negotiate, yet having early promise and great potential is concerned with the mixture of human and machine capabilities called computer aided manufacturing.

From this aspect, we see the planning of products and processes and the control of manufacturing operations being carried out to a large extent by responsible people in relatively constant communication with computers.

From now through the end of the century, computer aided manufacturing will be influencing us more and more. It will tend to proceed from product design, into the process planning and tooling activities. Not until the end of this period, however, will it begin to have a significant impact on most day to day shop operations. That's too bad, because that's where a lot of benefit is.

Recent achievements in planning and design areas have been due to the forced evolution produced by vigorous R & D effort, substantial funding and a considerable degree of cooperative effort. The use of computers in automotive product design has reached the point where further penetration in industry is assured. I am not at all sure, however, that the same is true in tooling, shop operations or even process planning – unless we make some definite moves to accomplish the promise of this forecast. Those who know the potential must identify it to management and sell the benefit of investment, then get busy to build sound foundations for the structure to come.

OBSTACLES TO ACHIEVEMENT

There are many obstacles which may prevent the attainment of all or parts of this Delphi Forecast. There are technical problems to be overcome. Some require knowledge we do not yet command. We need to find answers to questions about material properties, surface texture, formability, machinability, tool wear, and other phenomena. In other cases, we have the basic information at hand, but we need to solve hundreds of problems to design and build machines and systems that will perform reliably and efficiently.

These are all difficult technical challenges. Difficult as they may be, I am confident that our base of talented people is adequate to meet them. The real limit to progress will be our ability to gain understanding, acceptance, and support of development and adoption of new technology by both the work force and management.

We must recognize first of all that a big drawback is the lack of credibility of the R & D community. People often don't believe what we say. Our managers often don't have faith in our promises, thinking we may be motivated by hunger for technical achievement without bothering to evaluate its real utility.

The possibility of failure accompanies all development that really reaches for progress. This contravenes most upward moves managers want for progress, so fear of failure often becomes a stump in the road. We need to say in plain language what new technology is good for, and avoid making so many qualifications to an assertion that it seems to be totally buried in negatives. These confidence killers can become serious obstacles because when management or operating people don't realize true potential they resist committing the resources to do the job.

Many of the Delphi survey questions ask about the rate of penetration of technology.

There are a number of factors which can combine to impede transition to practical use. Putting a new process, machine or system to work in a plant requires a decision to do so and a set of actions to implement the decision.

This second problem area of technology transfer is concerned with how we make and carry out the decision to adopt new technology.

Integrated machining systems, computer aided design methods, N/C tooling systems, and computer aided shop control systems are complex and expensive. This means that the decisions as to when and where to use them usually take a good deal of management. Those who make the decisions to go ahead on an expensive new system are scientific gamblers, but Russian roulette is not their game.

In many cases it requires gathering information not traditionally recorded in any one place. Sound perspective in analysis of the situation almost always requires the assignment of real values to many resources over and above direct labor and material.

In spite of the widely discussed Risk Analysis routines, we need to develop convincing decision making tools that are convenient to use.

When a decision is made to go, more problems lie ahead, and management is already aware that CAM systems are not simply bolted down, plugged in, and turned on.

But it is the melding of the system with the organization of people which can create major problems of technology transfer. Making a CAM system work involves rearrangement of the working roles of managers and supervisors, as well as operators and support people. It will involve new standards of performance and the redistribution of budgets and authority. It will create significant responsibilities and make obsolete some old established ones. The planning, training, learning and mind changing which must take place for new technology to be accepted is perhaps the major challenge for manufacturing engineers.

A third area of concern about the achievement of these forecasts has to do with factors outside the technology itself. The realization of many of the events forecasted will require tremendous capital investment. Machine tools, material transport system, and robots and computers are major expenditures. These will be in sharp competition with other needs of the national economy for resources of all kinds. We have already discussed some of the problems of making specific investment decisions for a particular plant within a given company. Focusing, on the economy as a whole, it is clear that public policies can have significant effect on decisions regarding the attainment of the Delphi predictions of improvement in national productivity. Private efforts at cooperative R & D in manufacturing technology are often thwarted by anti-rust constraints, forcing many groups to do duplicate work which is wasteful. Threading through the quagmire of regulations and competing agencies of government is difficult. The RANN projects of the National Science Foundation, NASA supported efforts such as IPAD and air force ICAM program are all examples of positive attempts to collectively assist in improving the technical basis for higher productivity. On the other hand, the propagation of the technology seems to be impeded by difficulty in finding sound investment incentives, especially for smaller companies where the cost of a significant development failure could sink the company financially.

STRATEGIES FOR OVERCOMING OBSTACLES

To make the Delphi forecast come true, we need to reduce the impedance of the obstacles I have cited. There are four specific strategies that I believe will help. These are better modelling of cash flows and risks, improving our understanding of the work environment, clearing up our management communications, and providing better foundation for cooperative R & D.

Traditionally, investment proposals have been rated by their first year's return on investment. This is an excellent measure for the short term or even for a longer horizon when relatively constant conditions are anticipated. Short term ROI, however, ignores completely any gain or loss derived from a system's adaptability to changing conditions as well as other benefits customarily rejected from consideration as intangible to ordinary accounting methods.

The strongest characteristic of many CAM systems and the various types of programmable automation is their general purpose utility.

They are designed to serve a long and varied life in a changing environment. If we are indeed living in such a changing environment, then we need to place a value on a systems suitability to produce in the face of change. We need a way to show ourselves and management the real bottom line in a world where failure to keep up competitively is the certain road to failure. The flaws in customary analytical procedure are like trying to apply ordinary criteria of percent of time usage when thinking of purchasing a fire extinguisher.

Fortunately, there are financial models which can relate the size of the bank account to the adaptability to change. Discounted cash flow analysis combined with simulation techniques can make it possible to evaluate the effect on the corporate pocket book over several years of variable manufacturing conditions. This method can be used to examine the financial impact of a fixed sequence of expected future events – that is, to answer "what if" questions. It can also be used to provide an overall "financial expectation", if we are willing to assign probabilities to the time and likelihood of occurrence of the events. It can even produce a figure for present cash value of a potential future benefit.

I believe that manufacturing engineers must begin to apply these kinds of more realistic financial models. They will provide the best available means for convincing ourselves and our managers of the value of an investment proposal. It is not as easy as an ROI calculation, but given the computing power generally at our disposal, it is entirely practical.

In addition to a truer picture of the financial consequences of our technical proposals, we need a better understanding of how the people in the system will react to them. We need to understand more thoroughly the environment in which a new system will operate. It is too simple to just deal with the technical facts. We have not completed the definition of the system until we describe the functions, feelings and fulfillments of the individual human participants as well as those of the machines and computers.

The new roles of operators, supervisors, programmers, maintenance and other support personnel along with their individual reactions to changes in domains and jurisdiction must be considered and put in order.

Not only individual people but the relations among them may be important. An organization works effectively because of a complex set of habits and procedures of interaction. Some of these are formalized and some of them are not. It is essential to know all that goes on in a manufacturing situation if our changes are to really make it better.

The overall strategy for properly taking the environment into account is simple enough. We have to learn about it by observing and measuring it and by listening to the people who live in it. At all stages, from system concept to end use, we need to involve people from the using organization. If we follow this approach, we have a better chance that the scenarios derived from the Delphi forecast will be accomplished, possibly even to finish on time.

In many cases, whether they will start on time, depends upon the clarity and efficiency of our dialog with management.

The rate at which R & D ventures are initiated and their rate of progress depends significantly on the effectiveness of its communication channel to the source of corporate direction.

There are a thousand communication tactics all based on the axions of clarity, brevity and timeness which could be used to extend this paragraph into a volume, but my subject is strategy, not tactics. I believe we can solve this communication problem, if we develop and apply a general strategy consistent with the importance of the problem. For every major R & D effort, we need to openly assess the effect of delays inherent in management communications as a specific part of the job. Then we need to budget enough attention and resources to sell the job as well as simply to do it.

For a final note, I would like to comment on one of the ways we might stretch the R & D dollar through cooperative research and development. In the U.S., we have been experimenting in recent years in establishing R & D projects jointly supported by a number of private commercial companies. This is an approach to cooperation which is available only for basic R & D where the final results are made publicly available. The development of the APT system for numerical control programming and the recent efforts of CAM-I on the CAPP system for process planning are outstanding examples.

Our batting average in utilizing this approach has been relatively poor but might be improved by a change in thinking about cooperative joint projects.

Often a participating company cheerfully contributes its allotted monies yet, because of current business pressures, reluctantly supplies a project representative who cannot really give full attention or commit resources to the task. As a result, the gap is often filled by government and university people who try to do things without a good hearing of the voice of industry in the councils. Perhaps better definitions to management of the benefits of new technology will help here also.

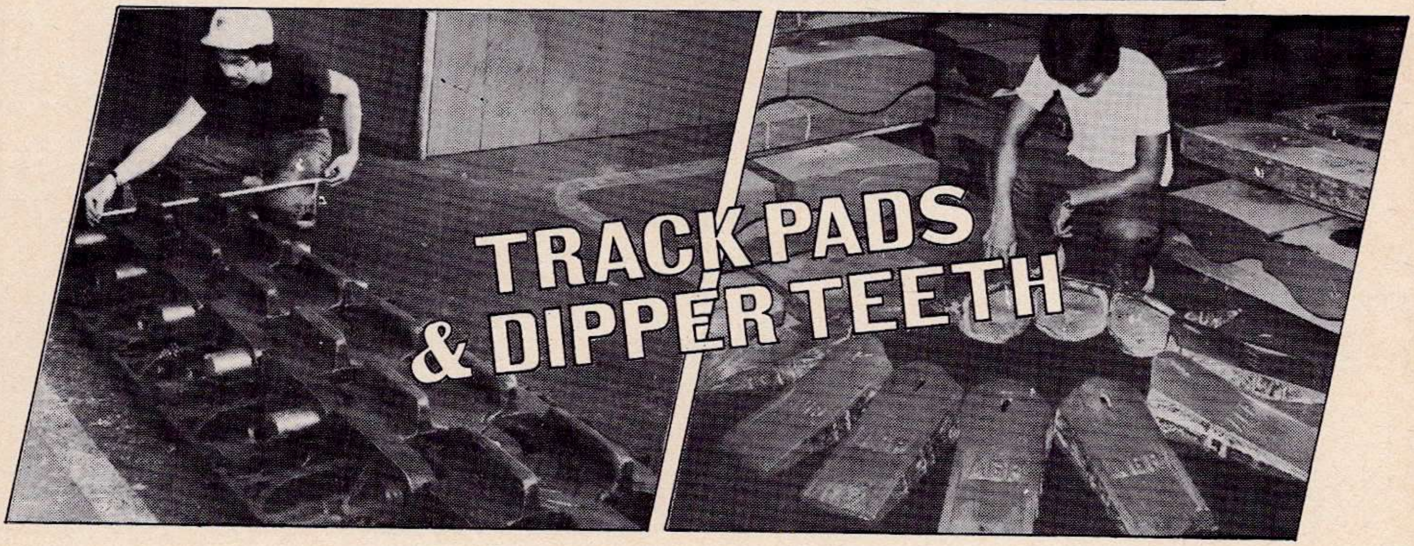
Cooperative R & D may well be essential for some of the CAM systems which the Delphi survey forecasts. Responsible and vigorous participation in these ventures will therefore be one of the ways of making this forecast come true.

In any event, we cannot just sit back and wait for somebody to do something. Deliberate specific action is needed. While recently visiting Greece, I learned several things about the Oracle at Delphi. I pondered one result of a prediction as I walked over the ruins of a once magnificent theatre and forum on the plain at Phillipi. Croesus, commander of a mighty army, put all his faith in what the Oracle said, and neglected to make suitable preparations for battle which was certain to come. The campaign he lost through overconfidence overwhelmed him. The Oracle was in error, and fell into disrepute.

1990 isn't that far away. We have quit living in a fairyland of dreams that technology will take root just from its own intrinsic merit without tilling the soil and giving the seedlings a fair start. R & D people romancing each other at meetings is not enough. We need hard technical work and informed management commitment to solidify the gains our country must have in productive capability.

The new Oracle of Delphi has thrown us a challenge by saying that good minds judge great things to be possible. Let us now join efforts to make them actually happen. pm

BUILT TOUGH FOR RUGGED USE



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Automated Blasting Processes For Scale Removal And Finishing

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ABSTRACT

Automation is a word that is much bandied around these days and when applied to blasting processes requires the integration of a material handling system and a blast system. The result of this should produce a product faster or better than a non-automated process. There are various types of blasting systems and each have their advantages and disadvantages. The same applies to the material handling methods that can be employed. The various aspects of finish, handling methods, and blast systems are presented.

INTRODUCTION

In an effort to cover this subject, it is felt that it is necessary to define the area in which we will be working and then to see how they apply to each other. Automation will therefore be covered as to what it is and why it might be implemented. What blasting processes are available and under what conditions they might be used, and what should be considered when a requirement for scale removal and/or finishing arises.

BLASTING PROCESSES

Two basic blasting processes are available:

a. Wet blasting, in which abrasive particles suspended in a treated water to form a slurry are either forced by air pressure or drawn by air into a mixing head then through a nozzle at the work piece.

b. Dry blasting, consisting of either airless blasting in which the abrasive is propelled by the centrifugal force generated by a rotating wheel or air blasting in which the abrasive is propelled by compressed air through a nozzle.

The application of these processes depend greatly on the actual job that must be done and the automation hardware differs only slightly regardless of which process is chosen. The choice of one process over another will usually depend on either economic reasons or specific capabilities of the individual process. If one wishes to de-scale four foot wide sheet steel at a rate of twenty feet per minute, an air blast system would require three to four thousand CFM of air and would therefore be impractical when compared with an airless system. On the other hand if one had to de-scale the inside of a four inch diameter shaft, six feet long, an airless system would find this imposible.

SCALE AND RUST REMOVAL

Surface preparation specifications have been established by the National Association of Corrosion Engineers. These specifications establish and define initial surface conditions including the method by which they were treated. The initial conditions are divided into four categories:

A. Steel surface covered completely with adherent mill scale with little, if any rust.
B. Steel surface which has begun to rust, and from which the mill scale has begun to flake.
C. Steel surface from which most of the mill scale has rusted away or from which it can be scrapped, but with little pitting visible to the naked eye.
D. Steel surface where the mill scale has rusted away and where pitting is visible to the naked eye.

The degrees of cleaning are also divided into four basic categories with intermediates:

0 — No preparation of the surface
1 — Light or Brush-Off Blast Cleaning
2 — Thorough or Commercial Blast Cleaning
2½— Very thorough or Near-White Blast Cleaning
3 — Extremely thorough or White Metal Blast Cleaning.

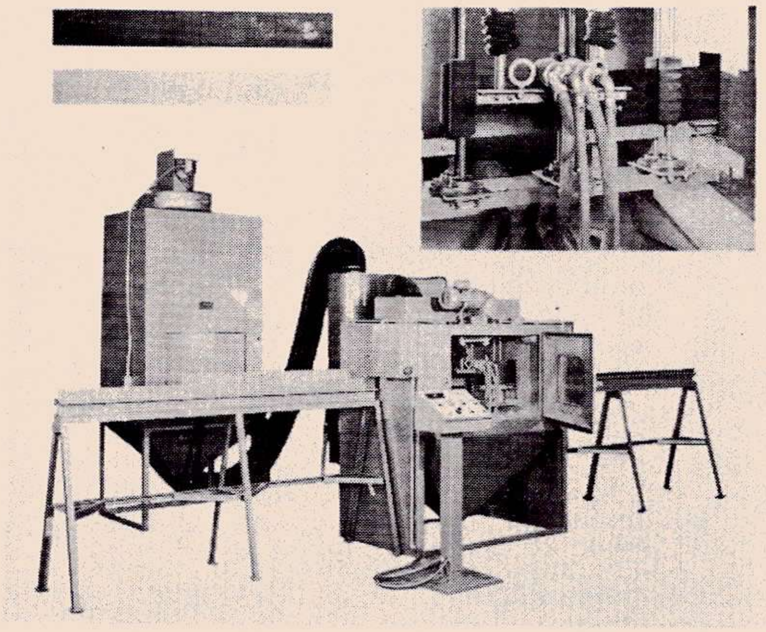

Figure 1

The indicator Sa is used to show Blast Cleaning. A complete designation might then read CSa2 and means that a surface with an initial condition defined in C above was blast cleaned to Commercial finish number 2. To further define these surfaces, photographic references are available developed by the Swedish IVA Corrosion Committee and have been almost universally adopted.

The amount of effort, time and therefore cost required to produce a particular surface condition will be dependent to the initial condition. Since an automated system cannot sense the condition of the surface, it is cleaning the system that must be designed and set to accomodate the worst case and deliver the best. For economy reasons, etc. it is therefore very important that the final surface condition required be defined so that excessive cleaning that would result in lower cleaning rates and higher abrasive media consumption will not be encountered.

AUTOMATION

Automation, in general, is the process of having a machine perform a task that is being performed or could be performed by a manual operator. It therefore takes the responsibilities to perform the actual task from the man and asks him to perform one that is either less critical, physically easier, or more within his capability in the time frame allowed.

When one examines the reasons for automation they fall into three categories. First, to increase production without an attendant increase in cost. Usually this is done by the more efficient use of available manpower. Second, the production of a uniform product. In many instances uniformity of finish, complete, 100% removal of scale or rust, or consistent performance when left in the hands of a manual operator falls far short of the required goal. In some cases this causes a reject and a rework rate that if reduced will increase the overall profitability of the operation. In some cases it might cause complete rejection at a point in production where the money invested in the component is extremely high and its loss is an untenable situation for the company. The third category involves parts or material that requires some type of automation because it is almost impossible to be handled or manipulated by hand.

The automation of blasting processes falls into two areas: a) material handling and b) maneuvering the abrasive propellant means.

Scale and oxides are primarily found on raw material from the mill or on castings. Since raw material usually takes the form of long rolled stock it can most easily be processed by passing it through the blast enclosure equipped with appropriate support structure and conveying mechanics. (See Fig. 1) This type of equipment is ideal for "I" beams, angles, channel and other rolled, formed shapes. Since the blasting process is very detrimental to the material handling means, it is desirable that the parts span any mechanism in the blasting area. This also enables the blast to have access to all areas of the part so that complete coverage can be gained in one pass through the blast chamber. If the parts are too short to leave a gap in the conveying means it will be them necessary to pass the part through the blast twice, exposing different areas each time.

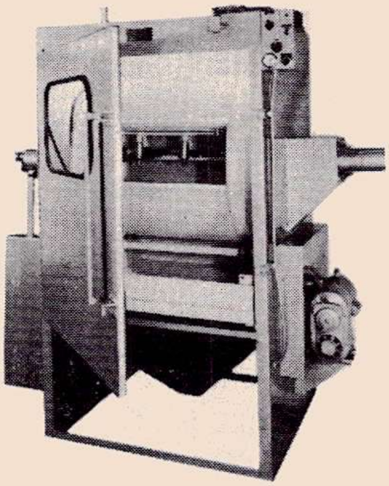

Figure 2

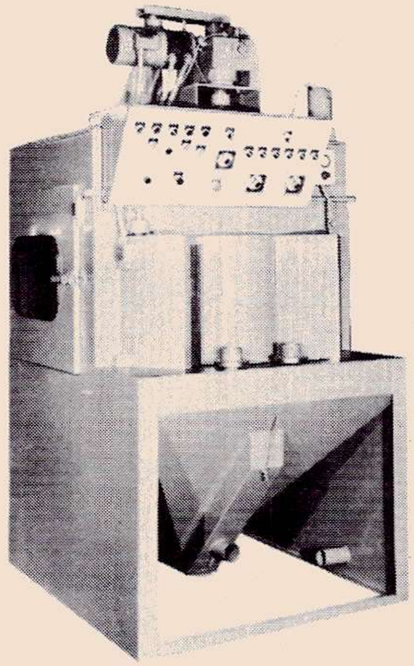

Figure 3

Cylindrical parts can be handled by a skew conveyor. This type of the material handling system will take shape such as gas bottles and rotate and translate the part through the blasting area. This will allow complete coverage of the part with only one pass through the chamber.

Castings, as they come from the foundry will usually have large quantities of sand adhering to the surface and/or cores that must be removed before final machining is started or for inspection purposes so that bad casting can be more easily identified and rejected before expensive machining is done. Forgings fall into this similar category except it is scale formed during the forging process that must be removed. In both of the above cases we are looking for total overall coverage of the part. When working with larger parts this type of coverage can be obtained by hanging the parts from an overhead conveyor and in some cases the part can be rotated as it goes through the blast area assuring that all surfaces are exposed to the blast. When working with smaller castings or forgings, a tumbling basket or barrel can be used. (See Fig. 2) It is very important when looking at this method to be sure that the parts are capable of being subjected to the hard knocks they are going to give each other when loaded into the basket and rotated against one another. Another caution that must be observed is to assure oneself that the parts will not interlock or nest. Massive interlocking can occur resulting in the complete load being useless. Nesting will occur with particular shapes and masking and therefore incomplete blast coverage will result.

The overhead conveyor or any process where each part is handled on an individual basis has the advantage that particular areas of the part can be concentrated upon, those areas where excessive foreign material must be removed. Basket blasting is all over and random in nature and competes with acid baths and caustics as a cleaning method since it is also a batch process.

Standard material handling methods are generally avoided, with belt conveyors and roller tables, since these must be placed directly in the blast environment and no matter how well designed will be subject to rapid wear and premature failure.

There is a class of parts in which scale removal is a finishing process and in many cases the removal of this scale is for cosmetic reasons only. These are heat treated parts and since heat treating is usually performed after all machining is complete the configuration of these parts and therefore the automation equipment can cover the complete spectrum of automatic equipment. Hack saw and band saw blades are passed through a blast cabinet handled by rubber pinch rollers. These rollers are powered by a variable speed drive that allows the equipment that feeds it or to the equipment that must process its output. Heat treated rivets are cleaned in a basket tumbler. Springs are conveyed along a ramp and grinding burrs and heat treat discoloration are removed to prevent contamination of hydraulic system. Wheel hubs and turbine blades are processed on an indexing turntable, (See Fig. 3) where the part is rotated and the blast nozzles oscillated removing heat treat scale and rust so that further coatings can be applied and retained by the parts.

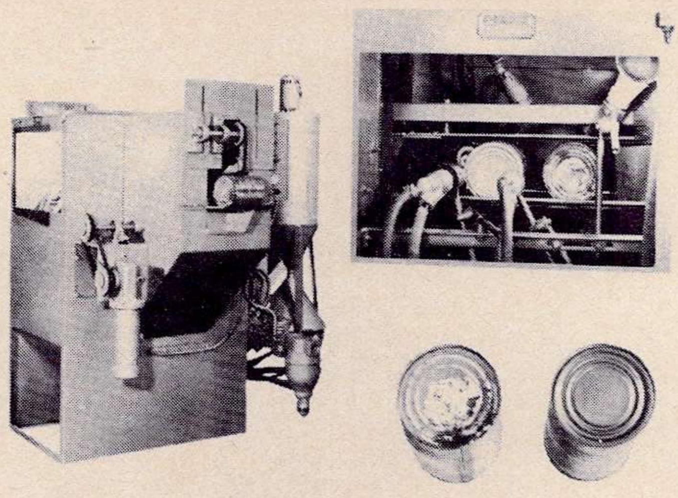

Figure 4

Other unique handling methods can be used to expose the proper surface of the parts to the blasted. (See Fig. 4)

These handling methods are used to expose the required areas of the part to the media propellant means. Airless blasting equipment is relatively gross in its area of coverage and is therefore ideally suited for large parts. The wheel can be rotated to swing the blast pattern across the part as it translates therefore expanding the area of coverage and eliminating the need for additional wheels. In air blast systems, manipulation of the nozzles is very important to match the air consumption with the required production rate. It would be relatively easy to set up ten nozzles along the length of the ten inch splined shaft and blast one every six seconds. But if the required production rate is only one every sixty seconds it would be much more economical to oscillate one nozzle over the ten inches and reduce the air consumption to one tenth. Nozzle manipulation also allows the proper directing of a nozzle towards a non uniform surface. A hemisphere can be covered by rotating it while rotating the nozzle in a ninety degree arch over the part. All of these manipulations are done to obtain the desired coverage at the required production rate for the minimum original and running cost.

SUPPORT EQUIPMENT

When the design of an automatic blast system is undertaken, special consideration must be given to the support equipment normally involved with the standard machines available. This will not normally apply to airless blasting equipment since this type of blast system is always automated in some fashion. Manual systems are not available, therefore the media handling and ventilation systems are always considered with the system requirements in mind. Air and water blast systems are a different story. A standard three foot manual cabinet will require sufficient air flow through it to maintain good visibility for the operator. This quantity of air will be more than satisfactory to convey the media from the cabinet to a reclaimer. An automatic system may use a cabinet of the same size but will contain as many as twenty blast guns. Visibility is not the question here since the operator has been removed from the actual blasting process. The handling of the blast media is now of more concern. If pneumatic conveying is being used a sufficient volume at the correct velocity must be employed to ensure complete removal of the spent media from the cabinet and proper debris separation in the reclaimer. If mechanical methods of media conveying are used, such as bucket elevators and screw conveyors these must also be designed to be able to handle the larger quantities of media that usually are encountered in the automatic system.

Along with the increased amount of media there will be much larger quantities of debris which must be handled by the dust collector. To maintain proper air flow and dust collecting capability, the filtration area must be sufficiently large so that as the bags pick up more and more debris the air flow is not so restricted that media will no longer be transferred out of the cabinet. If the dust collector is too small for the system, it will be necessary to shake them very often and in a standard set-up this will mean that the whole system must be shut down for this operation. There are dust collectors on the market today that continuously shake the bags and therefore allow the use of a much smaller (less bag area) unit than would normally be employed. These systems operate by closing off one or more bags from the air flow and while the remaining bags perform their filtering functions the closed off bags are shaken either by mechanical means or by a high velocity jet of air. This process is continuous and therefore maintains the bags at a fairly clean level. In addition to the bag area consideration, the dust hopper size must be sufficient to hold the debris that comes from the bags. The amount of dust that is generated by a system will come from two sources: from the rust and scale being removed from the product and from blast media break-down. Metal grit has the lowest breakdown rate but after use, the cleaning rate will drop. Media such as aluminum oxide tend to fracture exposing new cutting rates throughout their life but this type of media is frangible and will create ten times the volume of dust as metal grit.

Separation of this dust from good media is usually accomplished by either a cyclone reclaimer or an air wash. The cyclone is being used when the media is conveyed pneumatically and the air wash when mechanical conveying means is employed.

An automated blasting system usually must be tailored to do the job required. Selection must be made as to: what blasting process is to be used; the number of blast nozzles or wheels to give proper coverage and production rate; the material handling method; and what type of fixturing to hold the parts and in some cases integration with other processes either before or after the blast processing. With careful consideration given to the integration of all these areas, fast, economical cleaning and deburring of the required parts can be accomplished by blasting in the most reliable fashion. pm

VEN O. DUCAT

In 1974, when Ven O. Ducat became president of Engineering Equipment, Inc., the company's position among the "Top 1000 Corporations" was only way down to 95th. Less than four years later, the company rose meteorically to the 36th position, and Ducat, the man who remarkably held the major reins of the company, became a celebrity within the business community, a recognized business leader, a man of success.

Twenty six years ago, in 1953, Ducat was only a struggling third year engineering student of Mapua. He entered the company, then called Engineering Equipment and Supply Co., as a draftsman helper. In a year and a half, the young apprentice was promoted to Chief Draftsman. Being an undergraduate, however, he enjoyed lesser privileges than his own men. He thus persevered hard to finish his studies, going to school in the morning and working in the afternoon till eleven in the evening, until finally he completed his BSCE degree in 1955.

But he wouldn't be able to completely practice his field because his job was confined to correspondence and office work. His request for a new assignment as project engineer was turned down. He was indispensably needed in the training office. This turned out to be a blessing in disguise, for he learned little by little the principles of industrial management and human relation.

In handling people, Ducat acquired a keen sensitivity to their needs and feelings. His management style put utmost priority to the welfare of the employees. He made it a point *"to give a man something commensurate to his ability." "Whenever I approve a promotion,"* he said, *"I always ask myself how it would feel to be in the man's shoes."*

Ducat also learned the value of hard work and of direct communication with his men, so much so that he often went beyond the assignments he was supposed to do. *"I just don't sit down here and make estimates,"* he said. *"I go down to the people and get facts from them. By doing this you learn things, you give importance to people, and you earn their respect."*

When a project in Binga was set up, his desire to work in the field haunted him. He again requested for a new assignment, only to be turned down for the second time. But he persisted, until he was allowed and given one month to prove his worth.

Ducat established his reputation in Binga by completing the project on time. He also became very popular among the local folk, joining them in all community activities, and acquiring fame for his expertise in dancing. When his wife visited him, she was so impressed by how he has become so famous in Binga.

In 1958, Ducat was pulled out from the field to work as sales engineer. Again, he made an outstanding feat: his sales exceeded the total sales made by eight other sales engineers who were supposed to be more experienced than him. He became an *"overnight super salesman"* and in a little more time he became the most famous salesman of all.

In July 1974, Ducat was made president of Engineering Equipment, Inc. Among the first things he did was look for and penetrate new markets. He went to Saudi Arabia where he found great opportunities for job contracts. Two years later, Ducat signed a joint venture agreement with Sheik Mohammad Al-Mojil, chairman of M. Al-Mojil Establishment (MME), to undertake construction projects for the Arabian American Oil Company (ARAMCO) in Saudi Arabia.

The joint venture with MME was a major breakthrough. It proved, among other things, that an all-Filipino outfit could very well compete with foreign outfits. How he achieved such a feat, Ducat attributed to his business philosophy which says: *"Always be one step ahead of others."*

"In this business, if you don't win the bidding, you have nothing," Ducat comments.

Fierce ambition, a sense of responsibility, and loyalty provided Ducat's inner strength. For him, the latter is quite basic. *"In order to be effective, you have to build loyalty to the company,"* he explains.

But, viewing all from a distance, it was his patience which was instrumental for his success. He never hurries, unlike those executives who often transfer from one company to another. For Ducat, these executives *"are ambitious guys who are in a hurry, who overrate themselves, and don't realize they have weaknesses in themselves."*

Success, of course, can be everything but fun, and Ducat knows this. Looking back, he says he was much happier during his selling days, when he could often watch a movie with his wife. He used to enjoy riding jeepneys, which he couldn't do anymore now. There were things that had to go, things he had known and used to enjoy in the past, in exchange for success.

But there were things that were never lost. Like his simplicity: *"I am a simple guy. I want to keep a low profile."* or his willingness to share: *"If I learn anything from our operations, I am willing to share it with others, for the benefit of the country."* And his ardent desire to help others: *"I find happiness in helping people. Right now, I'm trying to improve the plight of my own people."*

Ducat hails from Masantol, Pampanga, where he is presently building a chapel *"so that the people can go there for prayers and other special congregation".* He is also proud to have helped many young people from his hometown to find employment. *"My dream is to make Masantol a model town,"* he says.

From draftsman to company president is indeed a long road. Much of the man has been transformed, but Ducat remains true to himself and to everyone who has been part of his success. *"I am grateful to all,"* he said.

Q. After the 1977 labor problem, how were you able to bring back EEI to its present prestigious footing?

A. We didn't have any labor problem in the company. It was an outside activist group who wanted to penetrate EEI. That group was run by labor leaders who were after some position in government, and they wanted to catch the government's attention. What I did was I talked with them and said we have done our best for the interest of our people.

Q. Regarding foundry activities, what do you think of the quality castings in the Philippines as compared with other countries?

A. Compared with Japan, the Philippines is admittedly behind. But to keep up with international standards, EEI sends one man every year to ESCO's Research & Development Section for training. ESCO is an internationally known American foundry with which EEI has a license agreement. Whatever they develop there, we are licensed to make them here.

Quality castings can be produced in this country for the needs of the mining industry. We are presently exporting to the U.S., Canada, Australia, Japan, New Guinea, Malaysia and other Asian countries. EEI is exporting approximately 50 per cent of its total sales volume.

Q. What problems have you encountered in your Foundry Division?

A. We used to produce poor quality castings and there were many rejects. Molding should be properly tested, you know, but some of our men were not very careful. For that we had to fire some workers.

I believe that quality serves for itself. With proper coordination and cooperation, we were able to retrieve the division's losses.

Q. How does the government support the development of the Foundry Industry?

A. Government support is minimal. There is no concrete program directed to the industry.

Q. With regards to your construction activities, what steps have you done so far to uplift the industry?

A. We are **submitting to the** *Philippine Contractors Association a position paper which calls for a move to look into the plight of domestic contractors who face stiff competition from direct contractors abroad. The potentials in the Middle East are unlimited, but Filipino contractors could not compete with those of other countries. We are hoping that the government would ban direct recruiters.*

Q. How is EEI affected by high rate of workers' migration to other countries?

A. EEI is not at all affected by this. We have long anticipated this problem and we have solved it by establishing training centers all over the country. All in all we have estblished 13 training centers. These centers produce an average of 100 skilled workers a month. We have plenty of people, and right now there are 1000 workers waiting for their job assignments.

Q. How do you see the future of our national economy?

A. I am afraid there will be much problem in the next three years if we cannot resolve our oil import bill. One hope of our country is to find oil. Based on oil drilling reports, it may be easy to find the commodity here.

Q. How about the future of your company?

A. We have set up a program with the objective of maintaining 20 per cent growth for the next five years. We are diversifying into other fields and pursuing the acquisition of other firms. Among our major interests are: the development of solar energy and of mini-hydro equipment which are suitable for the country because of our climate and our water resources. PM


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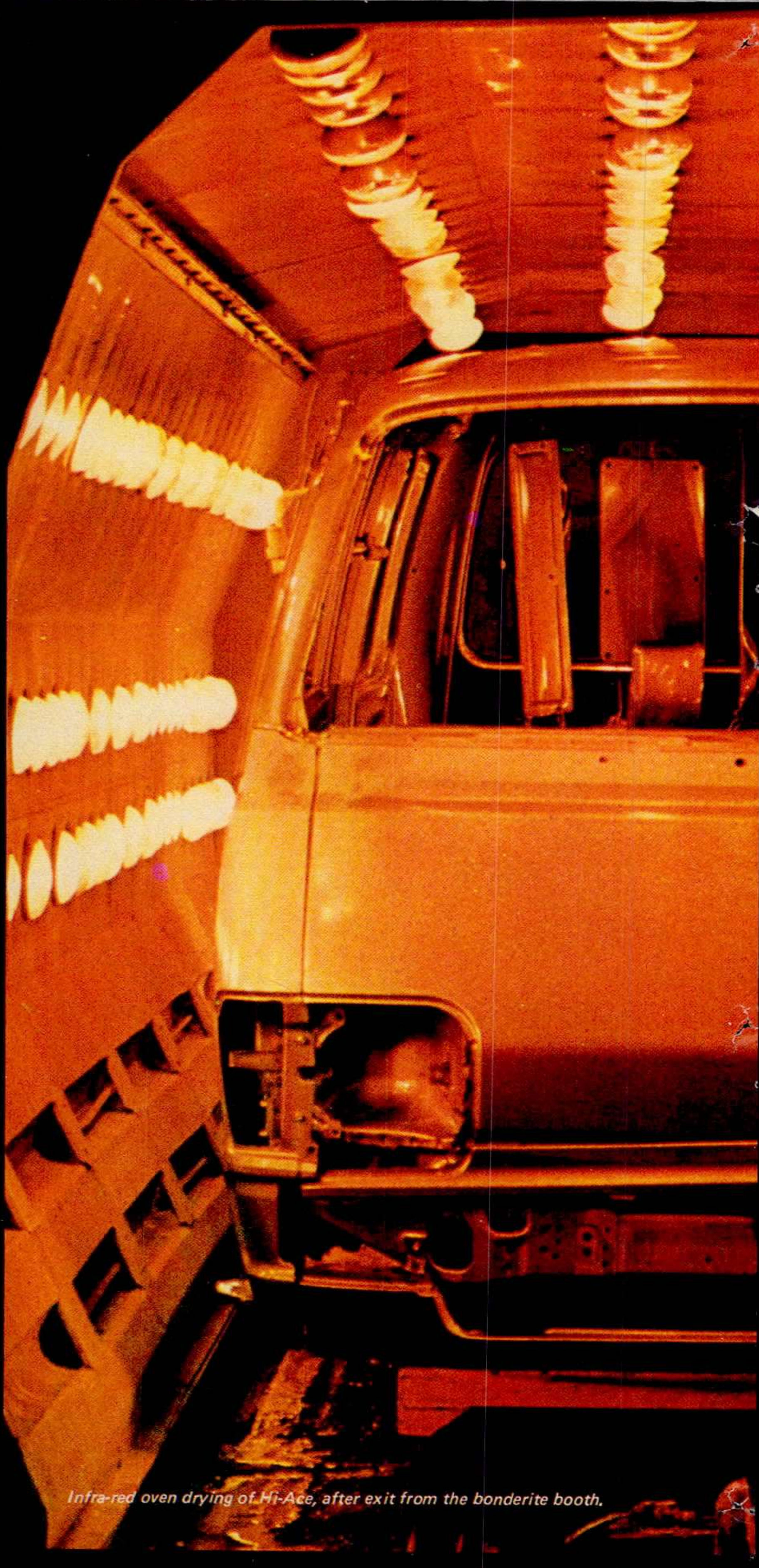


Infra-red oven drying of Hi-Ace, after exit from the bonderite booth.

cover story

The mere mention of Toyota connotes, at the drop of a coin, Delta Motor Corporation — by the most widely known car manufacturer in the Philippines. Despite its enjoying a big share the automotive industry, the company is still proud of having come from very humble beginni

It all began in 1961, when a group of young Filipino entrepreneurs led by Ricardo C. Silve set out to stake a claim in an automobile business then domin by American and European mod After being granted an authoriza tion as Toyota Overseas Distribu in the Philippines, the company immediately took advantage of growing market through CKD (completely knock-down) assem of Toyota vehicles.

Housed in a single building, bankrolled at 1.6 million pesos a employing a work force of 27, Delta Motor Corporation modes started turning out the first 53 Toyotas at a makeshift plant in Intramuros. Seven years later determination paid off, and the Delta Motor banner was hoisted right on top of the local passeng car market. To cap these achievements, the company finalized a technical agreement with Toyota Motor Corp. of Jap covering the assembly of automo vehicles as welll as the manufactu of Toyota 12R engines.

Ricardo C. Silverio has masterfully influenced his group through all the turbulent years, and his able leadership has since then been the source of inspiratio in making Delta Motor Corporati number one.

Today Delta Motor ranks as th 11th largest corporation in the Philippines. Its total assets exceed 1.2 billion pesos. Employment ha soared from a mere 27 in 1961 to over 3,000. Where before it used sell 53 pasenger cars worth 0.6 million pesos, Delta Motor has pulled far away from its 1961 production record to sell annually more than 27,000 passenger cars and commercial vehicles valued at more than 1 billion pesos. The product mix has gone beyond passenger cars to include the Basi Utility Vehicle (BUV), commerci and industrial vehicles, and milita vehicles. Delta Motor has also spu off companies that are now amon the industry leaders in package an unit air conditioning, refrigeration television sets, stereophonic equipment, and car air conditioni

L-R: Corona on the trim line being subjected to gas brazing of roof and quarter panel; a Hi-Ace viewed right after treatment in primer EDP; and body drop of Toyota Corona.

Delta Motor Corporation is the biggest of a family of companies known as the SILCOR Group. Though Delta Motor itself is concerned almost entirely with the assembly and manufacture of parts for Toyota cars, trucks and jeeps, the range of goods and services provided by other companies in the SILCOR Group runs the economic gamut.

The most closely associated of the sister companies are the three units which were formerly grouped together in Delta Motor as the Division of Electronics, Airconditioning and Refrigeration, or DEAR. These sections within DEAR were made independent units in 1976, namely: Nippondenso (Phils.) Corp., manufacturer and distributor of Nippondenso car coolers, automotive electrical parts and heat exchangers; Daikin (Phils.) Inc., makers of Daikin air conditioners and Hasegawa ice-plant equipment; and the Delta Motor Sharp Division, manufacturer and distributor of Sharp home appliances — television and stereophonic sets, room air conditioners, refrigerators, gas stoves and electric fans.

Since Delta Motor began, production and sales have escalated, with the only reverse in the upward sales curve registered in 1970, when the Central Bank restricted imports of completely knockdown motor vehicles in the face of a recession and an acute foreign exchange shortage. By 1971 things started to brighten up. Delta Motor began to increase its share of the passenger-car market.

In 1975 the company unveiled the Toyota Mini-Cruiser, a four-wheel drive vehicle developed by the company in cooperation with the Research and Development Center of the Armed Forces of the Philippines. These sturdy, multi-purpose Vehicle designed for rugged cross-country driving are now the standard military vehicles used for civic operations and maintenance of law and order. of law and order.

Nineteen seventy-seven marked Delta Motor's seventh successive year of leadership in passenger-car sales in the country, with a registered market share of 41.2 percent. For the second successive year the company retained its leadership in sales of cars and commercial vehicles with a volume of 20,475 units and a growth rate of 52.1 percent against an industry average of 14 percent. Entering the Asian Utility Vehicle (A.U.V) market late in 1976, Delta Motor ranked a close second in sales. In the same year the company received a prestigious award for achieving the highest productivity level per square meter of plant space in the Oceania & South East Asia region. At the same time, Toyota of Japan honored President Ricardo C. Silverio, and through him Delta Motor Corporation, with the Outstanding Distributor Award.

This was also the time when, in recognition of Delta Motor's technological and marketing leadership, Maschinenfabrik Augsburg Nurnberg (M.A.N.) of the Federal Republic of Germany signed a distributorship and licensing agreement with Delta Motor to assemble and sell M.A.N. buses and commercial vehicles.

During the Toyota Oceania-Southeast Asia Distributors Conference held on January 30, 1978 in Tokyo, Japan, Delta Motor was conferred a "Special Award for Outstanding Performance in Production and Marketing" by Toyota Motor Co. Another 1972, and of those which did, none company was having the "Highest Productivity in Terms of Space Utilization."

At this time Delta Motor bolstered its premier position in the Philippine automotive market by scoring its first sales grandslam in all categories. The PMCP sales performance chart from January to December 1978 showed the company outselling all the other PCMP participants in all areas. For the eighth consecutive year, Delta Motor has maintained sole leadership in passenger car sales, selling a total of 14,154 units which accounted for a 41.2 percent share of the market.

It is in the A.U.V. category that Delta Motor attained a significant achievement. A total of 8,895 units of Toyota Tamaraws were sold last year, making the company the new leader in the A.U.V. market with an overwhelming 44.6 percent market share, another first for Delta Motor.

DELTA MOTOR AND THE ECONOMY

Delta Motor Corporation is dedicated not only to improving and expanding its role in the national economy but to improving and expanding the economy itself.

Delta Motor's contributions have been significant since the beginning of the Progressive Car Manufacturing Program. The PCMP requirement of an ever-increasing local content for cars (and later, trucks) assembled in the Philippines gave a tremendous boost to the small and medium-sized industries which could supply the needed components. In 1972, for example, a year before the PCMP, the five registered PCMP participants purchased only 9 million pesos worth of locally-made parts; today, purchases exceed 150 million pesos. This is spread among more than 200 firms (up from the first 20 suppliers in 1972). Some of the firms which now rank as important PCMP suppliers didn't even exist in 1972, and of those which did, none enjoyed the volume of sales or the increased technological know how they now experience.

Since it joined the PCMP program, Delta Motor has created over 1,000 new jobs, and has pumped over 100 million pesos to local supply companies as part of its goal to support the horizontal integration of the automotive industry. The company has always exceeded PCMP targets for locally made components for use in the cars it assembles. In fact, it was the first PCMP participant to comply with a major manufacturing commitment. This was achieved by equipping the Toyota Coronas with Philippine-manufactured engines. Delta Motor's engine-manufacturing plant is one of the most modern industrial operations in the country.

As local technology further develops and the local content of Toyota cars and trucks continues to increase, Delta Motor's contributions to the economy are aimed to grow both qualitatively and quantitatively.

MARKETING & EXPORTS

Delta Motor's extensive marketing and distribution network has placed Toyota vehicles all over the Philippines. From the austere coastal roads of Ilocos and the high, winding trails of the Mountain Province all the way down to the small but vital market roads that link small farming villages to trading towns in Mindanao, Toyota vehicles are a familiar and welcome sight.

Soon, Philippine-made Toyota vehicles will be making waves in foreign markets as well, with the introduction of the "Traka" (or Tamaraw, as it is popularly known locally) in Papua New Guinea. Sixty-two (62) units have already been sent to the local distributor, Ela Motors Ltd. Three sample units have likewise been sent to Iran. Aside from these two countries, the highly adaptable Tamaraw is expected to make remarkable breakthroughs in Pakistan, Fiji, New Hebrides, Tonga, Western Samoa, Greece, and Colombia. To accommodate these demands, 500 units/months have been allocated for exports in 1980.

The ASEAN vehicle, marketed here as the Mini-Cruiser, is now on test runs in Saudi Arabia, Qatar, Kuwait and Malaysia. Possible markets are being studied in Yemen, Colombia, Cyprus, Greece, Indonesia and Thailand.

High precision castings, mainly alternator pulleys, and cast iron rings have been exported to Toyota Motor Co. of Japan, which alone consumes a third of Delta Motor's total production tonnage. An American company has only recently sent feelers for the importation of transmission castings. This venture is still in its preliminary stages, with the final negotiations to be carried out early next year.

The largest Delta Motor dealerships are, quite naturally, in Metro Manila, the biggest single market for automobiles anywhere in the country. The six dealers in Metro Manila are Delta Motor Sales Corporation, Fabar Sales Inc., Autosphere, Inc., Ambassador Trading, and Corona Motor Corp.

The phenomenal growth of DMC's dealership network for the past 15 years indicates both the corporation's commitment to nationwide development and the ever-increasing number who find Toyota vehicles best suited to their needs. Delta Motor currently has 25 official dealers dispersed over Central and Southern Luzon, the Visayas, and Mindanao.

Since it is part of the Delta Motor philosophy that service should not stop once the sale has been effected, the company has service and repair facilities all over the Philippines. The company is particularly proud of its Electronic Diagnosis Center. More popularly known as the Car Clinic, the multi-million peso center in Pasong Tamo Extension, Makati, consists of five major stations, which systematically subject the car to a thorough checkup from simple leaks in fuel lines, electrical and lubrication systems to tests of transmission and brake performance, fuel consumption and wheel alignment. Based on the electrical findings, the service adviser makes his recommendations to the customer as to which repairs are immediately required and which may be deferred without risk.

Delta Motor Corporation also sponsors regular training seminars for its technical and sales personnel. These seminars, aimed at upgrading the knowledge and efficiency of Toyota dealers and service personnel, are held at the main office in Makati. They are the Delta Motor Guarantee that no matter where one buys or has a Toyota vehicle repaired, he will receive the same competent service.

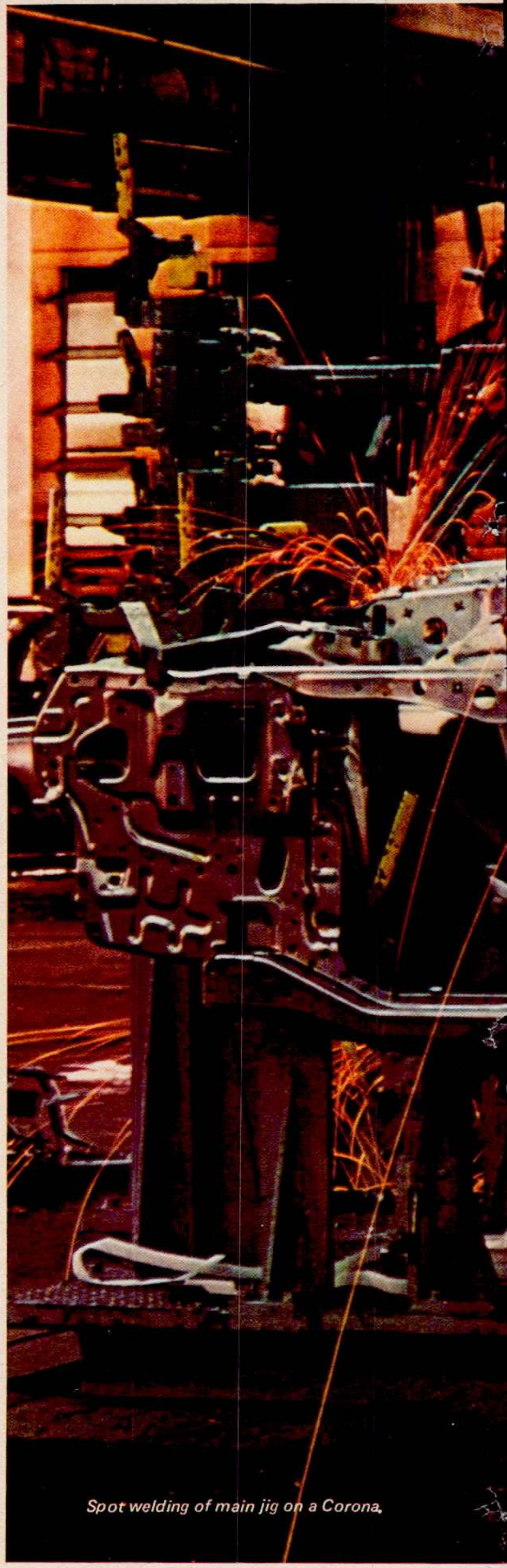
THE BASIC UTILITY VEHICLE

The Basic Utility Vehicle (B.U.V.) made an immediate hit when introduced in the Philippine market in 1972. But as more units were produced, demand changed to better performance, quality, durability, and riding comfort.

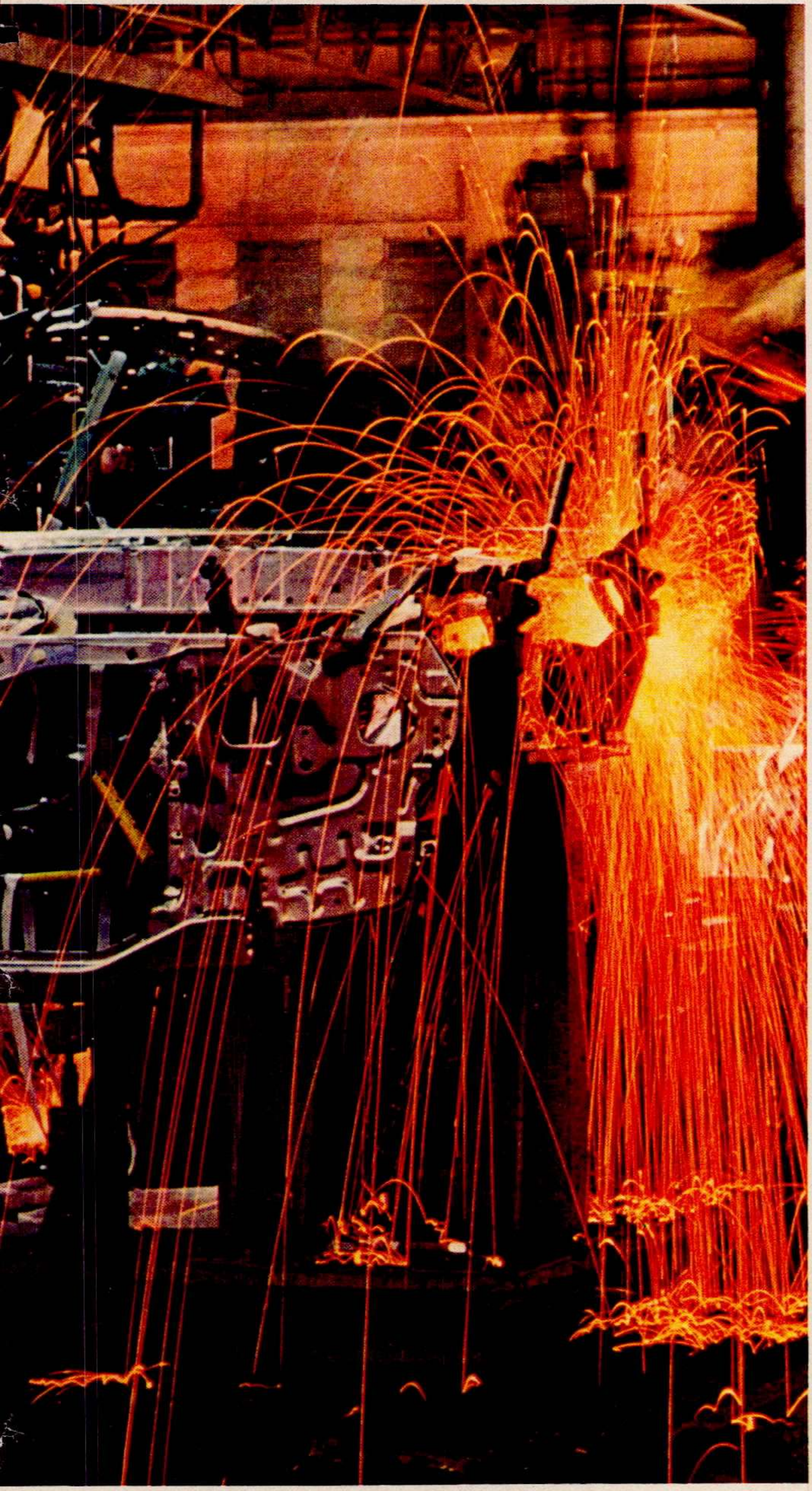
But even long before this, Toyota Japan had already begun conducting basic research on the Asian transportation system. Finally, this research included joint studies with Delta Motor to develop and produce a utility vehicle for Philippine conditions.

The joint project team of the two countries determined from the outset that quality should come first in the design of the B.U.V., through Toyota technology and know-how. In August 1975, the first prototype was completed and sent to the Philippines where it underwent various tests. Following the tests, design of Prototype II started with working models built both in the Philippines and Japan.

Prototype II vehicles made by Delta Motor were subjected to punishing tests. A 10,000-km test run included bad road driving, hill climbing, sudden accelerations, and stops. A non-stop 30,000-km run was also made testing the vehicle's performance.



Spot welding of main jig on a Corona.



The Toyota Tamaraw, Delta Motor's answer to the need for a reliable B.U.V., has been designed for the Philippines' need for a low-cost, multi-purpose superwork vehicle. With its low center of gravity, the Tamaraw's riding comfort is almost equal to that of a passenger car. Its other features include big loading space, fuel economy, good styling, and easy handling.

MANUFACTURING OPERATIONS

More than 24,000 vehicles roll from the Delta Motor manufacturing and assembly plant each year. The product line has expanded from the original Toyota Crown and Corona sedans to Corona two-door hardtop lift-backs and station wagons, Corolla sedans and coupes, five commercial vehicles – Land Cruisers, Hi-Ace Commuters and vans, Hi Lux pick-ups, diesel trucks and the Tamaraw – and the military vehicle, the Delta Mini-Cruiser.

The Delta Motor complex in Parañaque consists of five big buildings and a host of smaller ones. The heart of the operation is, as it has always been, the Automotive Assembly Plant. Here, in a building with a floor space of over 7,000 square meters, the Toyota-to-be enters the factory at one end as no more than 30 pieces of steel body frame and emerges at the other as a complete car, ready to be driven off the lot to a Toyota dealer. A new vehicle rolls from the plant every 10 minutes, after passing through the assembly process.

The car frame is first built up and welded together. The shell is bonderized, primed and sealed employing Delta Motor's sophisticated Electrolytic Deposition Process (EDP). This involves the process wherein water soluble paint is deposited to the dipped body shell through direct current. The unit is then painted and dried. The prepared frame passes through fitting of specially prepared interior assembly, and the windows are installed.

The car, having taken shape, goes through a quality check and is delivered to a drop station, where the assembled chassis is fitted, the carpets laid and the seats installed. After going through a series of seven other checks for safety and reliability, the car is ready to be taken out on the road.

While the heart of the Delta Motor operation is in its Automotive Assembly Plant, in essence it is divided among three others: the Casting Plant, the Engine Machining Plant and the Parts Fabrication Plant. These three plants – along with the Tool and Die Division – have made the greatest use of Filipino engineering know-how and are now able to provide locally much of what goes into a finished car, jeep or utility vehicle.

The impetus for much of the work of the Casting and Engine Machining Plants and the Parts Fabrication Plant came from the introduction in 1973 by the Philippine government of the Progressive Car Manufacturing Program (PCMP). Before this, car assembling in the Philippines had been a wide-open field. At the end of the 1960s, 19 companies were assembling more than 60 passenger car models. The market was fragmented and this situation, combined with a tax and tariff system that tended to inhibit rather than encourage manufacturing investments,dampened whatever little interest there was in producing components locally.

All that changed in 1973. To rationalize the operations of the automotive industry, to create and stimulate manufacturing of automotive components by local small – and medium-sized enterprises (and thereby upgrade skills as well as save foreign exchange which would normally be spent for the importation of such components), and to earn foreign exchange by exporting automotive components, the Philippine government, through the Board of Investments, initiated the PCMP. The program allowed only five companies to assemble cars in the Philippines. Delta Motor was one of the five selected.

Besides limiting the number of car assemblers, PCMP required a semester-by-semester percentage increase in the domestic content of the cars assembled. In the years since the program was launched, Delta Motor has consistently exceeded PCMP requirements. Credit for this goes to Delta Motor's Casting, Machining, Parts Fabrication Plants as well as the DMC Certified Suppliers' Group.

The Casting Plant produces major engine parts, all of which had to be imported before 1972. These include cylinder blocks and heads, flywheels, camshafts, bearing caps, exhaust and intake manifolds, water outlets and timing gear covers. The only major engine components which still have to be imported are crankshafts and piston rings, and soon even these may no longer have to be imported.

All raw materials and supplies for the Casting Plant are analyzed to ensure they are of the highest quality. New samples from new suppliers are tested for elemental composition, actual line performance and many other factors that determine or affect quality. Materials from old suppliers are periodically retested to make sure high standards are maintained.

About 55 percent of what the Delta Motor foundry produces goes next door to the Engine Machining Plant. (The rest of the foundry's production goes to other PCMP participants, to Delta Motor's associated companies and exports.) Though all items leaving the foundry go through a standard specifications check, all of the components that will be used in building up the Toyota 12R engine are rechecked in the Machining Plant for casting defects. Approved parts go through a series of machining processes – milling, drilling, tapping, reaming, honing and grinding – to prepare them for use in the engine. These machine parts are periodically checked in a special Quality Control Room according to a set of instructions using precision equipment. Precise and accurate dimensions, tolerances and limits up to 0.001 millimeters are well maintained.

The Machining Plant is at present composed of the following production lines: bearing cap and engine block, intake manifold, exhaust manifold, camshaft, flywheel, water outlet, and timing gear cover.

Once the machine parts have passed the series of quality checks, they are returned to the plant floor, where they are assembled into car and light commercial vehicle engines according to Toyota specifications. Each completed engine undergoes a 20-minute firing bench test, during which the final tune-up is made. Selected engines undergo further checks: a six-hour performance test and a 100-hour endurance test. Machines that withstand this treatment will be ready for anything they are subjected to on the road.

Just as the car's body must be sturdy and its engine strong, so must its interior be comfortable and good-looking. This is the job of the Parts Fabrication Plant, which makes car seats, soft trims and roof linings for Toyota vehicles. In the past, virtually all the material for car seats were imported. Today only the steel wires and tubes, reclining mechanism and seat-track adjustment are imported. Here again Delta Motor technicians exercise quality control from the time the raw materials are brought in from foreign and local suppliers until the last component is laid in place.

QUALITY CONTROL CIRLES

Quality control at Delta Motor Corporation is an in-process operation. To further improve the workability of operations, the company established Quality Control Circles in 1976, designed to motivate quality techniques within the plant. From its modest beginnings in Japan in 1962, the Quality Control Circle concept has grown by mid-1972 to an estimated 0.5 million units with a total membership of about 5 million in Japan.

Quality Control Circles are composed of groups of six to twelve workers and leadmen who meet regularly to study quality control problems and improve overall quality. The scope of QC Circles have been expanded to include productivity improvement, cost reduction, safety and maintenance.

A prerequisite to every group meeting is the QC Circle Form, filled up on a particular subject and used until a project is completed up to a period of six months. The contents of the form based on the Toyota Motor Co. pattern are as follows:

1. Subject – this contains the title of the project to be tackled by the group. The source of the subject is also indicated. It can be a quality, maintenance, cost reduction, safety or productivity improvement project. An example of a quality improvement project is the reduction of casting defects due to chills.

2. Present Condition – the statistical data from Quality Control Department is used to show the present condition of the subject taken. Histograms and pareto charts are used. Customer complaints and external rejection rates are also used.

Top L-R: Inspection of machine exhaust manifold, camshafts grindings, and machining line for cylinder wheels. Bottom L-R: Flywheel balancing, firing bench tests for 12R engines being carried out in background, and engines prepared for storage after testing and adjustments, and precision drilling [illegible]

3. Analysis – the cause and effect or "Ishikawa" diagram is used in analysing the subject. The 4 M's of production, namely, Man, Material, Method, and Machine are the usual factors considered in the analysis of the problem.

4. Action – the countermeasures to solve the problems are itemized based on the analysis. The person in charge of this countermeasure is assigned by the team leader during their meeting. Target dates and actual dates of completion are logged in as well as the results obtained.

5. Objective – the target compared to the present condition. For example, the present casting rejects due to chills is 20% and the target set by the group is 8%. The actual rejection rate obtained by the group after the duration of the subject is also recorded.

The first QC Circle in Delta Motor met in February, 1977, with members oriented initially on the QC Circle method. At first, the only incentives given to QC Circle members were overtime pay during the one to two-hour weekly meetings and free snacks. However, the workers responded to this new technique enthusiastically because of its grassroots approach. Whereas before, all countermeasures to production problems were solved by management and handed down the line, now the lowly line worker has been given the channel with which to communicate his suggestions in solving line problems to management and implement these himself. After all, it is the worker who spends time in the line, and is more knowledgeable about his work.

Aware of the contribution of QC Circles to manufacturing operations, the management granted additional incentives in 1977, composed of: cash award of ₱2,000 for the QC Circle of the Month; and group picture, group certificate and publication of the group's winning subject in the Delta Motor Technical Bulletin.

Several modifications on QC Circle procedures have been made to improve the system. The duration of the subject was extended to a minimum of four months and maximum of six months to give more leadtime and achieve a lasting effect to the subjects taken. The QC Circle form was revised accordingly to implement the change of time period.

The company effected another improvement last year, with the delivery of a video tape recorder (VTR) and camera for the use of QC Circles. The VTR is used to film line operations of each QC Circle focusing on the subject taken. Members are shown the film during their meeting to discuss countermeasures in improving operating methods. Workers seen performing processes the wrong way are tactfully corrected by the team leader.

Membership to QC Circles is not limited to line workers and QC inspectors. Depending on the subject taken, "specialists" from Industrial Engineering, Product Engineering, Maintenance and Safety Department are invited to participate. Subjects taken by a circle are suggested by management or by members. A quality defect having a high percentage of occurrence in the pareto chart will have a high priority in being chosen as the circle's subject. Statistical data such as pareto charts and histograms are supplied by the Quality Control Department.

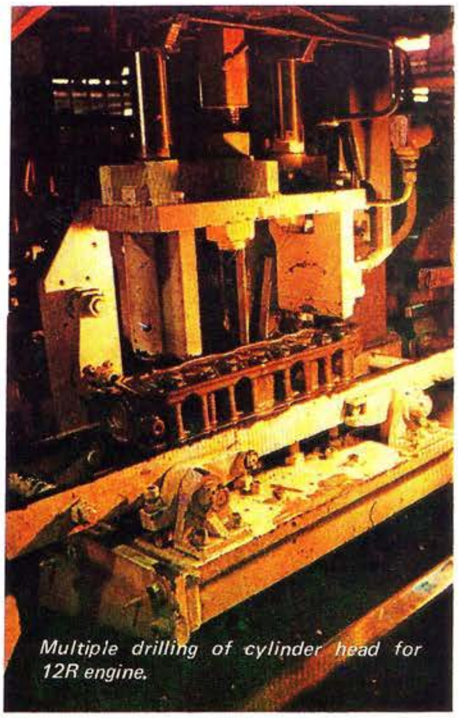
Continuing improvement of QC Circle activities is made possible by having review meetings every six months with all circle leaders to discuss their comments and problems about the activities. Being a synergistic approach to problem solving, the QC Circle could not have achieved its present success without management support, the cooperation and enthusiasm of the line workers and the immediate response and dedication of its coordinators to feedbacks from the QC Circle members.

MANPOWER BENEFITS

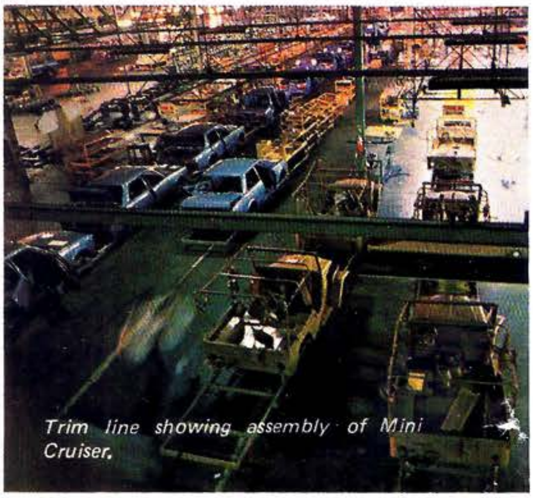
The welfare of employees is a continuing concern at Delta Motor, forming an integral part of its yearly program to maintain harmonious internal relations. Aside from the periodic wage and allowance increases to better enable them to cope with rising costs of living, employees are provided with free bus service and subsidized meals. Group incentives include annual cash awards for cost reduction team of the year, individual productivity, and monthly productivity bonus. The last one is based on the monthly production targets as compared with actual output, with the bonus computed on a percentage of salary.

Delta Motor also operates a training school where twice a year employees undergo further training.

Leak test for cylinder heads.



Multiple drilling of cylinder head for 12R engine.



Trim line showing assembly of Mini Cruiser.

Key personnel of the service division go on periodic tours of company dealers throughout the country, and from time to time, the company sends groups of technicians to Japan for additional training in technical schools and manufacturing plants of Toyota Motor Co., Ltd. Since its tie-up with M.A.N., key personnel have been sent on extensive studies and observation tours to Germany. These personnel in turn conduct seminars worked out by the manpower development division.

A recently introduced program is of great benefit to key personnel, as it was especially structured in consonance with the needs of Delta Motor and SILCOR companies. The ten-month management development program leading to a master's degree in business administration is in consortium with the Ateneo de Manila University Graduate School of Business.

SOCIAL INVOLVEMENT

Delta Motor's commitment to the community is an enduring one. Throughout the years the company has substantially supported a number of social and community development projects, and this involvement is programmed to grow in the years ahead.

Foremost among the company's endeavors is the Kabataang Barangay's Batarisan Training Program designed for out-of-school youths. Delta Motor supports the program by accepting applicants recruited by the National Manpower and Youth Council (NMYC) and the Kabataang Barangay. Trainees undergo actual shop floor practice on machining, automotive mechanics work, and foundry operations. Some of the trainees are absorbed by the company after passing their chosen course or study.

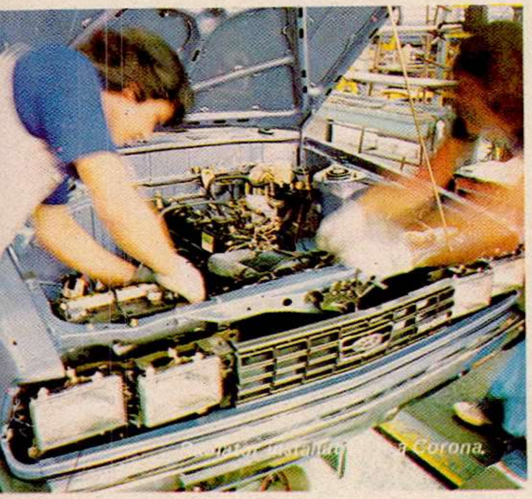
Fuel economy has been another main interest. In cooperation with the Philippine National Oil Corp. (PNOC), Delta Motor conducted alcogas tests as early as January 1978. Results clearly showed that anhydrous alcogas can be utilized with Toyota vehicles, without any modifications whatsoever. Using a mixture of 15% anhydrous alcohol and 85% premium gasoline, successful test drives have been conducted to Baguio City and back.

Equally, Delta Motor is widely known in the Philippines for its patronage of the arts and sports. As a result of the company's sponsorship and assistance, the Filipino sporting community has been treated to many international sporting events, the latest being the "Battle of Champions" One-On-One Bowling Classic between Norway's Arne Stroem and the Philippines' Paeng Nepomuceno. Other classics were the 8th Men's World Basketball Championship, the Little League Baseball Championship, the Sierra Madre 500 International Motor Rally, and the 1978 RP Open Golf Championship.

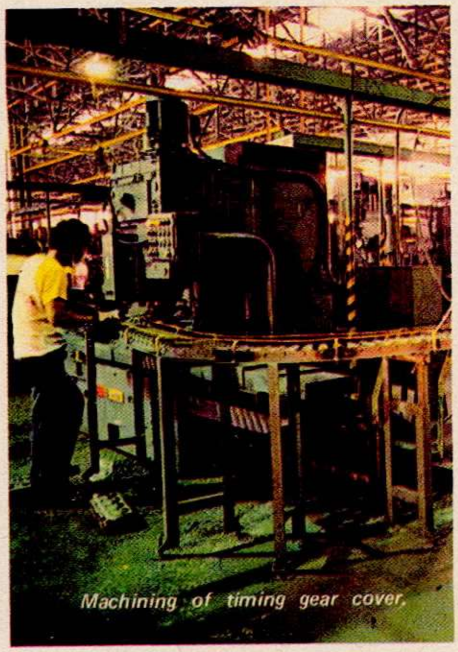
The object of this sponsorship is as much to help elevate the standard of national sports as to bring to the Filipino people sports of international quality. These events provide young people an opportunity to learn and observe at first hand the techniques and disciplines which have helped to develop world-class exponents in various sports.

While it is Delta Motor's belief that the young can learn by precept and example, it also thinks that much more needs to be done to encourage the development of sports through local competitions. To this end, the company supports local competitions not only in golf, bowling and tennis, but in basketball, chess, shooting, swimming, baseball, softball, football, polo, table tennis and a variety of native sports. **pm**

Trim line showing brake booster installation.



[illegible] installation [illegible] a Corona.



Machining of timing gear cover.

Control area of the Delta Motor plant showing managers monitoring the production control board.

Corona for delivery.

METALWORKING INDUSTRIES ASSOCIATION OF THE PHILIPPINES

THE INDUSTRY

The metalworking industry, commonly known as the engineering industry, represents the entire field of metal manufacture. It is primarily concerned with the change of the shapes of metals to yield useful products and machine elements. The industry is divided into fourteen major groups (comprising 93 branches), as follows:

a) Manufacture of metal products;
b) Machine tool industry;
c) Power engine and general industrial machinery;
d) Transportation-equipment industry;
e) Farm machinery and equipment industry;
f) Heavy-machine building industry;
g) Construction and mining machinery;
h) Electrical machinery and electronic equipment industry;
i) Chemical processing machinery and equipment industry;
j) Food product machinery and equipment industry;
k) Textile and shoemaking machinery industry;
l) Office-machine industry;
m) Appliance industry; and
n) Service industry.

Prior to World II, the local metalworking industry was composed merely of small-scale sheet-metal fabricating shops, foundries, blacksmith shops, smelting shops and a few machine shops. The pioneers in the industry were those which provided services for maintenance and repair to the transport, sugar, and mining industries. From such early beginnings, the country's metalworking industry, whose growth and development assumed significance only in the last decade, has evolved into bigger manufacturing complexes and support industries.

To date, there are approximately 1,900 metalworking firms in the country with a total labor force of 49,520. They are actively engaged in the manufacture of metal products, equipment and machinery or in the repair and servicing of different industry requirements. Although there is a heavy concentration of these firms in the Metro Manila area constituting about 59 percent of the total number of establishments, the resulting growth imbalance is being resolved through the gradual dispersal of the engineering sector throughout the country.

Inasmuch as most of these plants are not only lacking in technology and financial resources but are also greatly dependent on imported raw materials, which are continuously getting expensive, profit margins have been very low and progress rather delayed. For the metalworking industry to serve as the base of the country's industrialization, it has to strive hard to overcome such handicaps as inability to utilize indigenous raw materials, lack of competence of most establishments to adopt rigid manufacturing standards thereby undermining product quality, shortage of high-level technical know-how, and absence of certain assistance from government, like tax concessions and protection against unfair foreign competition.

The metalworking industry actually started as a small business industry, representing a majority of entities with at least twenty employees, or about 76 percent of the total existing establishments. Firms with more than fifty employees comprised only 10 percent.

As a supplier of basic components and equipment, the Philippine metalworking industry is chiefly characterized by linkages with other industries. Activity is essentially of the jobbing type. Although a certain degree of sophistication has been achieved in certain sectors, as in the manufacture of some metal products and in the automotive and appliance industries, technological levels in most establishments generally range from low to average.

In spite of the numerous problems plaguing the industry, it has managed to grow in terms of sales and assets. Acute shortages of funds, coupled with increasing cost of imported raw materials, did not discourage investors from pouring more capital into the industry.

THE ASSOCIATION

Aware of the disunified state of the metalworking and other allied engineering industries today, a group of men from various metalworking corporations met on June 2, 1978, to discuss the need of forming such an industrial consolidation. This unifying concept has been spurred by the fact that many firms involved in metalworking do not stand united when occasions call for them to act as one. More significantly, these men believed that the horizontal integration of these corporations would greatly enhance the growth and development of the metalworking industry. On a larger scale, moreover, they carried the conviction that by working together as partners in the industry, they would help contribute to the development of the national economy.

From this crucial meeting arose the Metalworking Industries Association of the Philippines (MIAP), which was granted official sanction on December 11, 1978. Still in its initial stages of development, the pioneering men behind MIAP are embarking on an intensive membership campaign, calling on all metalworking firms, particularly the small and medium-scale industries.

The association's primary aim is to work for the advancement of the industry, technologically and economically. This shall be achieved by:

a) Working for the market stabilization and rationalization of metalworking machinery and metal products;

b) Establishing standards in cooperation with the Metals Industry Research and Development Center, the Philippine Bureau of Standards, accredited technical and progressive societies, and other related government agencies;

c) Promoting exports, through the development of the industry's export potentials;

d) Providing technical services to members in cooperation with government agencies; and

e) Serving as agent for the dissemination of information on the industry.

A greater challenge which MIAP seeks to face is the proposed establishment of a Metalworking Industry Board. The association hopes to do justice to its establishment by eventually becoming an institution which can grant accreditation to metal-working firms.

ACTIVITIES

In the pursuit of its objectives, MIAP's activities are primarily geared towards public dissemination of information on the industry through organized lectures and seminars, a technical publication, and a compilation of statistical data through surveys and research. It aims to participate in both local and international conventions where metalworking and other engineering industries are concerned. Likewise, it shall organize or participate in exhibitions or trade fairs. Lastly, it shall conduct educational activities in cooperation with colleges and universities.

Such educational activities started last October 18 to 24, when MIAP, in cooperation with the Philippine Foundry Society, the Society of Manufacturing Engineers — Manila Chapter 165, and the Metals Industry Research and Development Center, conducted a joint symposium for technical instructors on "Metal Manufacturing Processes: A System". This well-attended affair was held at the Pamantasan ng Lungsod ng Maynila.

An earlier activity participated in by MIAP was the "First Metals Industry Show" held last May, a highly successful industrial exhibition jointly ventured by the Metals Industry Research and Development Center, the Philippine Iron and Steel Institute, the Philippine Foundry Society, the Society of Manufacturing Engineers, the Philippine Instrumentation and Controls Society, and MIAP.

MIAP DIRECTORY

Recently, MIAP embarked on the publication of a Metalworking Industry Directory design to give a profile of the industry. Cognizant of the importance of a metalworking complementation scheme in the development of the industry in the country and the region, MIAP aims to promote this endeavor by initially paving the way for the manufactured products or services of one company to fulfill the needs of another through the directory. Communicating the demand and the supply situations relative to the metalworking equipment and services, it is expected, would usher in a more rational use of available resources.

The directory will be offered to all private industrial firms and government agencies, directly or indirectly affected by the industry. MIAP hopes to improve upon this initial undertaking and develop the directory into a more comprehensive and organized data bank.

OFFICERS

The association is strongly supported by the expertise of its founding members, composed of:

Raul M. Consunji — Machine Tools Mfg. Co. of the Phils. (Matools)
Bienvenido Juan — Northstar Industrial Mfg. Co., Inc.
Leonardo B. Santiago — Philparts Mfg. Co., Inc.
Tomas C. Uy — Albert Metalcraft
Francisco S. Recto — R & S Mfg. Corp. (RASMACOR)
Simplicio Capule — Welldone Metal Industries, Inc.
Emilio S. Cuyugan E.S.C. Mfg. Corp. (ESMCA)
Benjamin Ma. Aycardo — Philippine Appliance Corp.
Ramon C. Cura — R. Cura Engineering
Pacificador C. Directo — Directric Industries, Inc.
Alfred Sabra — Crims Manufacturing & Trading Corp.
Alex Li — Mackay Machinery, Inc.
Marcial Aniag — Engineering Products Industries Corp.

On its Annual General Meeting held last October 26 at the Manila Garden Hotel, the following set of officers was elected:

President	— Raul M. Consunji
Vice-President	— Pacificador C. Directo
Secretary	— Leonardo B. Santiago
Treasurer	— Tomas C. Uy
PRO	— Rafael Barrera
Directors:	— Bienvenido Juan Ramon Cura Alfred L. Sabra Francisco S. Recto Alfredo L. Blanco Benjamin Ma. Aycardo

Equipped with officers who are in themselves highly respected members of the industrial community, MIAP is fast gaining impetus on its second year of service to the metalworking sector. The association is now seen as a great boost towards the progress of the metalworking industry, which up to now has been chained to such perennial problems as financing, shortage of skilled manpower, lack of technology, rising input prices, raw materials shortages, product diversification, underutilization of capacity, local competition, and inability to meet export markets.

With the continued cooperation between the government and the metalworking sector, as worked out by MIAP, the industry is headed for greater improvements as it acquires more resources and develops better technical know-how to overcome its problems. PM

technical abstracts

METALCASTING REVIEW – 1978

Interesting and challenging contrasts characterized the metalcasting industry in 1978. On one hand, new cast materials offer expanded market opportunities. On the other, new competitive materials and processes threaten some existing markets.

Recent developments that have come into their own in 1978 include the following:

1. A rotary ladle to plunge magnesium or "mag coke" in the production of ductile iron. (This vessel is fundamentally different from the Fischer converter.)
2. More effective welding of ductile iron.
3. A tendency, especially but not entirely in high-production operations, to use robots of various types.
4. Automatic pouring specifically designed for job-type iron foundries.
5. Improved thermal analysis procedures.
6. Computer design of cores, molds, and castings, known as interactive computer graphics, and used successfully in England and by American automotive designers.
7. The AOD (argon-oxygen decarburization) process, originally developed for stainless steel castings, but now used for other types of steel castings also.
8. A continuous arc melter with charge feeder and induction-heated forehearth.

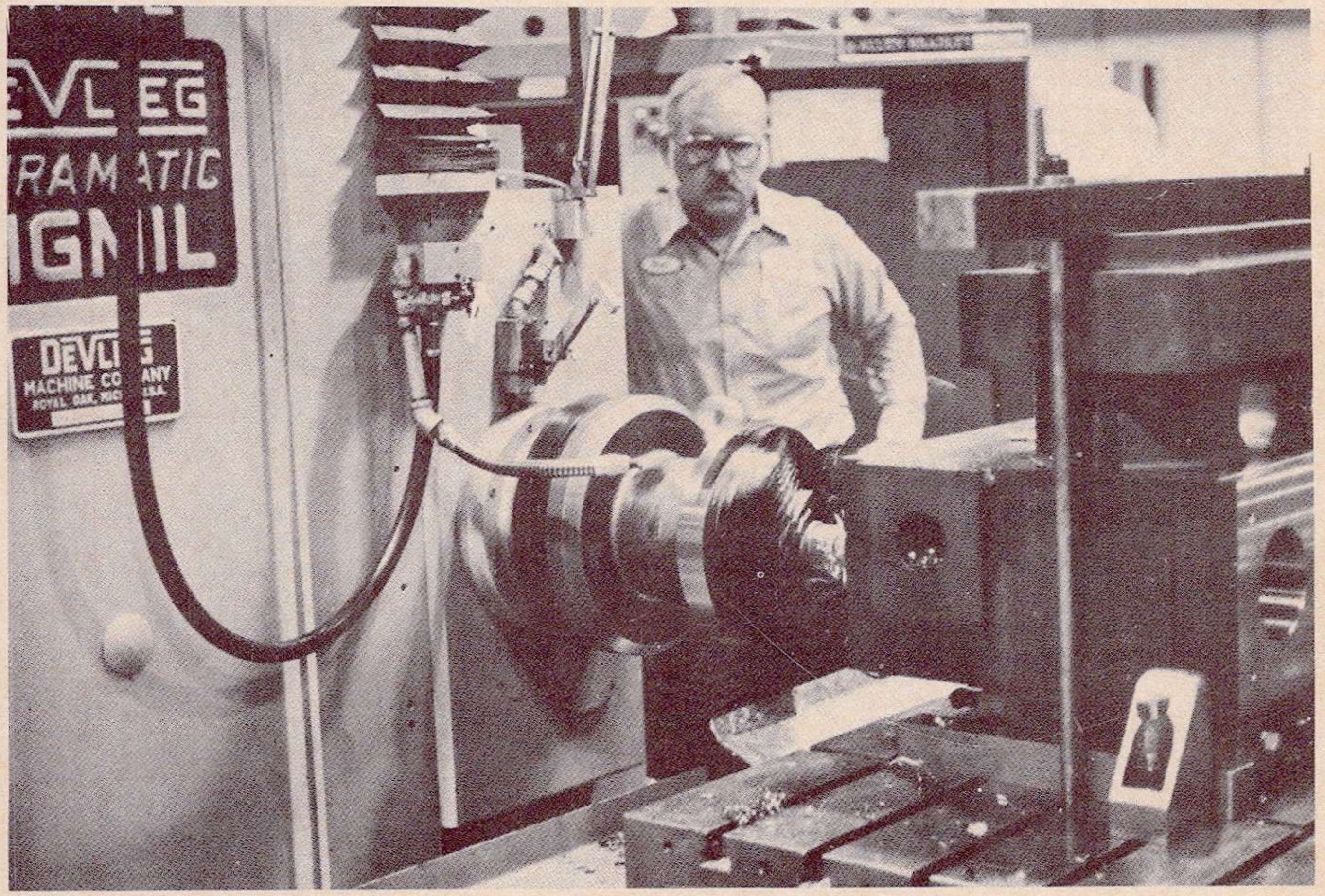
No other facet of casting production has undergone more changes and been the subject of more exposure in technical literature during 1978 than chemically bonded sand. The development of fast setting binder systems has spawned a third generation of mixers that permit the full potential of these binder systems to be exploited fully. Three types of units can be distinguished: the turbo – disc mixer, high-speed mixers, and continuous mixers with a vapor-inhibitor cleaning system. *Foundry Management & Technology, December 1978.*

SINTERING MIXES OF VARIOUS GRADINGS

In sintering mixes of different size granules, the finer fractions are heated faster in non-stationary thermal conditions than coarser ones. From the heat-technological viewpoint, these are under more favorable conditions for melting. This explains why a mix bed with a lower initial gas permeability sinters in an almost identical manner to a bed consisting of single size granules with higher initial gas permeability. The only difference is a somewhat higher fuel consumption, since the carbon buried in coarse granules burns under unfavorable conditions.

Data on the variation of air consumption during sintering confirmed the fact that a high initial bed gas permeability does not always guarantee good results. Instances were recorded when the air consumption 5-8 minutes after the start of sintering was indeed higher than those experiments in which the initial gas permeability was the lowest.

It may be assumed that, if the fine fractions of a mix are lower melting than the coarse fractions owing to their chemical composition, liquid-phase formation will occur considerably faster. This is bound to improve the aerodynamic structure of the high-temperature zone. This will secure an intensification of the whole sintering process even when the initial bed gas permeability is lower than in the sintering of single – size mixes. *Steel in the USSR, November 1978.*



Serrated slide on the face of the new NC/TP head and simple Allen-head actuated clamping permits tool blocks carrying Microbore cartridges to be quickly installed and removed.

CONTOUR BORE WITH PROGRAMMABLE TOOL HEAD

De Vlieg Machine Co. has developed the NC Tool Point (NC/TP) System, which features an optional cross feed facing head that can be mounted on the spindle sleeve of 4-axis CNC JIGMILS. This allows a broad range of operations which include taper boring, internal and external threading, turning, chamfering, grooving, recessing, profiling, facing and undercutting. A serrated slide on the face of the NC/TP head permits tool blocks to be quickly installed and removed with just two Allen-head actuators. A ground thread adjusting screw provides accurate tool presetting of diameter and repeatable location of tool blocks on the slide.

An essential part of the software system is actually a lathe programming language called Compact II. A special technique allows it to be used in conjunction with De Vlieg's post processor routine via a time-sharing terminal. Thus, this unique programming package, in conjunction with the radial travel range of the new cross-feed head, provides full threading and contour boring capability. One prerequisite for this special mode, however, is that the machine be fitted with a speed encoder on the spindle so that rpm can be tracked and the in-and-out table travel dynamically synchronized during a thread chasing cut.

The system has several inherent advantages, including: a) savings on tooling – thread mills, form tools, feedout heads and boring bars; b) modular design of the head permits preset tool blocks to freely interchange, providing a new level of flexibility to further reduce tooling investment; c) low, automatic thread cutting times; and d) high quality threads as a result of positioning from the centerline of the bore on each successive chase. *MESCO Press Release.*

ALUMINUM CASTINGS

For semipermanent mold castings, shell cores are substituted for metal cores to produce castings with complex internal configurations or contours. Automatic machines are used to produce the shell cores to a variety of customer specifications. Fast cycle machines are capable of producing large-volume single cores per day. Sand and phenolic resin binders are mixed to individual job specifications.

Flaskless molding with vertical parting and gating can produce thin-walled castings requiring a high degree of dimensional accuracy for high-production parts. However, sand control must not be neglected because it is vital for casting accuracy and good surface finish. Flaskless vertical molding with the converted NF machine has made it possible to reduce wall thicknesses and accomplish substantial reductions in unit weight.

The New Forming (NF) aluminum casting process was developed by Metallgieserei Kamm GmbH, and is a unique method of using a modified flaskless molding machine with vertical parting to produce high-quality aluminum castings in quantities up to 300 molds/hr from one pattern. For high-volume production, the process is said to offer additional benefits over other traditional aluminum casting methods. *Foundry Management & Technology, December 1978.*

SAND DISCHARGES ON DEMAND

Because of its characteristic stickiness and tendency to lump, green molding sand created problems of bridging and ratholing in a square storage bin. Discharge of sand from the bin onto a conveyor belt was erratic, resulting in poor feed, slowed production, and molds of unacceptable quality.

To eliminate those problems, Berlin Foundry of Berlin, Wisconsin, selected a vibratory bin activator manufactured by VibraScrew Inc. The activator is a vibrated bin bottom suspended flexibly from a storage bin, 16 x 16 x 27 ft with transition from 16 ft square to 8 ft diameter and a capacity of 3,480 cu ft. An oil-lubricated gyrator vibrates the unit and the contained material, but not the bin structure itself.

An internal baffle directs vibrational forces high up into the storage bin while relieving headload at the outlet. The gyrator produces powerful horizontal thrusts, which insure sand mobility. As a result, positive sand discharge reportedly has been achieved without bridging or ratholing. *Foundry Management & Technology, December 1978.*

HEAT LOSSES IN STEELMAKING UNITS

As the number of heats per campaign increases, the growth rate of heat losses through the furnace roof diminishes, but these losses increase with lengthening of roof life. Speeding up the steelmaking process requires a considerable improvement in roof life, for which roof design with artifical cooling are most suitable.

Average heat losses through the brick roof of a steelmaking furnace increase towards the end of the campaign. An increase in the life of the brick roof diminishes the supplementary heat losses. Consequently, the losses through the roof approach those through a water-cooled roof. Long life of a furnace roof of any design is ensured by additional power consumption. The relationship between roof life and this consumption is determined by roof design. It has been found that an increase in roof life in an arc furnace by a factor of 30 is attained by increasing the specific consumption of electricity by 7-8%. Minimum heat losses through the roof are achieved with minimum life. If the roof is changed every 10-20 heats, losses will be at a minimum.

An analysis of the economic efficiency of using roofs with artificial cooling shows that the greatest savings may be obtained on high-productivity steelmaking units, since the level of additional heat losses per ton of steel diminishes with an increase in the specific productivity of the furnace. *Steel in the USSR, November 1978.*

AN APPROACH TO VOLUME PRODUCTION OF STAINLESS STEEL SINKS

As the popularity of sink units has continued to grow, the need to look for more effective production techniques has increased. This has been of particular importance in the development of processing procedures, where the ability to deep draw a one-piece stainless steel sink unit from a single sheet can have advantages over the alternative system of welding separate pressings into an assembled sink unit, with all the attendant finishing problems.

The objective of Rovetta Presse SpA of Italy in developing the new concept was to produce stainless steel sinks from blanked sheets, complying with DIN 4465, with particular emphasis on the 160 mm depth dimension. The new process is based on the following operations: material preparation (lubrication), bowl drawing, and sliding ways drawing and forming. These are followed by blanking and profiling operations, using traditional techniques. However, these simple but important operations are carried out by specially designed Rovetta machinery.

Because of the severe work-hardening experienced during the first pressing operation and the need to avoid an expensive intermediate anneal, it is necessary to use extra high pressing capacities. To achieve this, the Rovetta system employs a single-action press with a blank-holder cushion. As in the case of the double-action press used for drawing the sink bowl, both slides on the single-action machine can be locked together to give a total forming capacity of 12,0000kn. *Sheet Metal Industries, January 1979.*

STEEL TANK CONSTRUCTION

Tanks used in plating and metal finishing operations are generally square or rectangular in shape and consist of four tank walls and a tank bottom. While this cubical shape reflects the type of tank used in approximately 98% of metal finishing operations, it is possible to use — with some imagination — round, pie-shaped, triangular or elliptical open-top tanks in plant layouts to more efficiently utilize space. However, tanks with square corners are easier to fabricate and offer nooks and crannies for water, steam and air inlets, for filters and other accessories that are so often a part of a processing tank. Some tanks now enjoying widespread use may be made of stainless steel, fiberglass, polypropylene, PVC, polyethylene, and in rare cases, wood.

Electric welding of the metallic arc type is used extensively for steel tank fabrication. In this welding process, which uses DC power, a flux-coated filler rod is made the positive electrode of a welding machine and the steel parts to be welded together are connected to the negative pole of the welder. When the correct current is selected on the welder and the positively connected filler rod is applied to the negatively charged steel plates, an arc is formed which melts the filler rod, causing it to flow into the joint and produce a strong weld. A properly applied fusion weld using this method will be stronger than any other part of the metal.

In the field of engineering drawing, weld symbols are used to designate the type of weld, the size, the length and other characteristics that are required on the fabricated product. In the field of tank engineering, it is seldom that the characteristics of a welded joint is specified beyond the following terms: single weld, double weld, tack or stitch weld, continuous weld. Rather, it is demanded that welding of a tank that is to hold an aqueous solution must be watertight and strong enough to withstand the pressures exerted outward by the heavy solutions contained in the tank. *Metal Finishing, June 1979.*

PROTECTING ELECTRIC MOTORS IN STORAGE

An electric motor is considered to be in storage when: it is waiting installation at the jobsite; it has been installed, but operation is delayed pending completion of plant construction; there are long, idle periods between operating cycles; the plant or department is shut dowh; or the motor is a spare intended for emergency use.

The first step in determining proper care is to define the storage environment. The motor will need protection from the weather, moisture condensation, dust, damaging fumes, chemicals that might be spilled accidentally, salt air, fungus growth, and mice, birds, snakes, and other unwelcome intruders.

For DC and wound-rotor AC motors containing commutators and slip rings, brushes should be raised in, or removed from, the brush-holders, to prevent them from contacting the commutator or slip ring while the motor is in storage. Slip rings and commutators should also be sealed individually to prevent corrosion. *Plant Engineering, May 1979.*

SUPERPLASTIC DEFORMATION PROCESS

Superplastic forming is an advanced novel method of forming components from sheet metal. It facilitates the production of complex shapes which are not obtainable by conventional forming methods and it is more economical than conventional routes in producing less complex shapes in quantities of a few tens to a few thousands. It takes advantage of the ability of certain alloys to accept large amounts of plastic deformation under relatively low stress.

Superplastic forming in stainless steel can offer both economic and technical advantages over existing methods. The main economic advantage is that tooling costs are very much lower for superplastic forming. This is because conventional tooling has to be machined from solid and requires a pair of dies which have to be carefully matched and fitted, even for simple shapes, and then hardened and finished.

Although the cycle time for superplastic forming is long compared with conventional pressing, the process is a "one-shot" operation and where deep draws are required, multistage deep drawing with interstage annealing is eliminated. This helps to reduce the cost of production. Furthermore, there are minimal, if any, residual stresses in the article and stress relieving or final annealing is not needed. This leads to greater consistency with the product. *Sheet Metal Industries, January 1979.*

NON - METALLIC INCLUSIONS IN STEELS

It is impossible to remove non-metallic inclusions in steel but reductions can be made to their size, frequency and modifications to their shape. The inclusions are an integral part of the steel, formed as a result of the steelmaking procedure. The total volume of non-metallics permissible in a steel depends on its end use. Typically there are approximately 10^{12} to 10^{13} inclusions per ton of steel with 98% being too small to resolve in the optical microscope. The 2% that are visible make up the overwhelming portion of the total volume present.

Inclusions in rolled products tend to fall into two broad types, stringer or globular. The reason for this can be partly answered by the resistance of the inclusions, relative to both the steel and other varieties of inclusion, to deformation. For example, at 900°C there is a crossover point in the deformation resistance of sulphides and silicates found in steel.

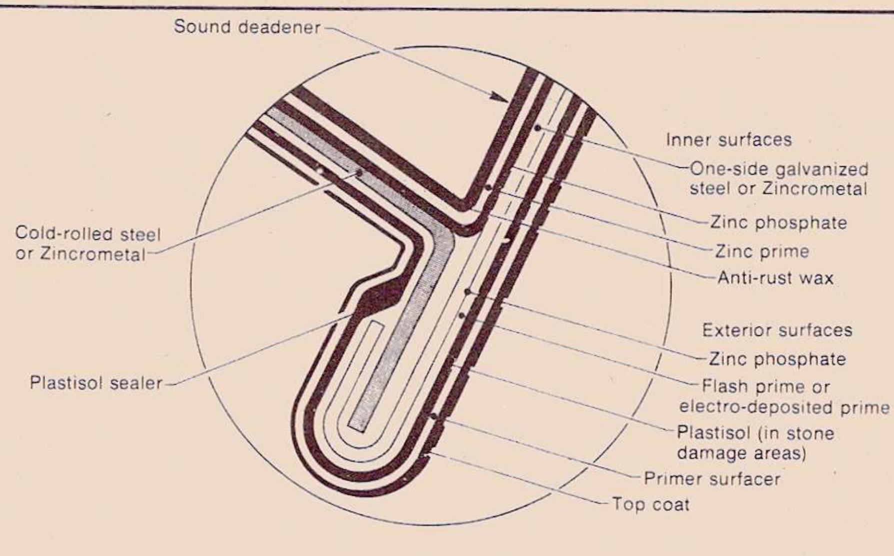
The addition of cerium as a sulphide fixer modifies the final form of any sulphide by increasing their deformation resistance. Cerium modified steels typically have globular sulphide inclusions. The presence of inclusions obviously modifies the mechanical properties of a steel but it has always been something of a problem just how to quantify the effect. *Metals Australasia, September 1978.*

COIL BANDING AND PACKAGING SYSTEMS

The introduction of a coil banding and packaging line offers a number of significant advantages to overcome the inherent problems, and these can be listed as follows: increased output of the finished product from the plant; reduced manpower requirement; improvement in the quality of the product, particularly in relation to its overall presentation; increased safety for the personnel involved in the complete operation; and reduced operator fatigue.

To band and wrap coils at the rate of 40 coils/hour without the aid of a packaging line would in all probability require 5 men working at full pace. It is doubtful that such a sustained effort could be maintained throughout a full day and as a result productivity would fall off drastically as the shift progressed.

In general, three operators are all that are required to operate a coil banding and packaging line and these men are capable of maintaining the output from the line for prolonged periods. The deployment of labor is such that one man operates the entry end, one man is responsible for the central position where the banding, wrapping and stacking units are installed, while the third supervises discharge from the line. With the employment of machinery in place of human muscle power, quality of the finished product can be ensured. Thus coils can be wrapped with a consistent uniformity and stacked so that the deviation of alignment from one to another is within 1/8 in. Such consistency forms a "shop window" for the finished product as it is presented to the end user, and this can only work to the benefit of the supplier. *Sheet Metal Industries, January 1979.*



Auto manufacturers use a number of ways to slow down the rusting process. Today, a typical car body contains materials such as galvanized steel, Zincrometal, and Zn-Fe alloys. The base metal then receives phosphate treatments, zinc-rich primers, and aluminum-rich wax coatings to ward off rust.

UNDERSTANDING ANTI-RUST CHEMISTRY

The corrosion process can be stopped by eliminating the anode and cathode, as well as removing the electrolyte. Probably the easiest way to prevent rusting is to coat the metal surface to exclude air, water, and harmful chemicals. These compounds have a petroleum or solvent base with a low specific gravity that displaces water and forms a protective film. The film also penetrates the pores of the metal to provide some lubrication.

Rust inhibitors, unlike petroleum and solvent-based preventives, produce a chemical reaction which protects the surface of a metal. In effect, when added in small amounts to an environment, these effectively decrease the corrosion rate of a metal. As additives, inhibitors are used in primers, paints, the oil-based and solvent-based preventives, and in antifreeze and other circulating fluids.

Inhibitors can be broadly classified as one of three types: passivators; organic inhibitors that function by forming an adsorbed layer on the metal surface; and vapor-phase inhibitors, which are similar to organic adsorption-type inhibitors except that they vaporize at ambient temperatures to form a thin, ionic film on exposed metal surfaces. *Machine Design, July 1979.*

REPLACING HYDRAULIC HOSES

It is basic to assume that the hydraulic components of plant equipment will fail at some point. The real question involves a decision on replacement materials. Depending on the circumstances, the choice of permanent or reusable couplings for the replacement assemblies can have considerable impact on the cost of doing business.

When considering the two basic types of hydraulic couplings, plant engineers should avoid basing comparisons on pressure capacity and impulse life. In most cases, it is safe to assume that manufacturers have done an excellent job of designing compatible hoses and couplings capable of performing to published specifications. A quality coupling, whether reusable or permanent, should maximize the pressure rating, impulse life, and overall durability of its hydraulic hose. Therefore, a comparison of reusable and permanent couplings should be based on cost and convenience. When these factors are considered, the decision will have maximum impact on the cost of hydraulic hose maintenance, the cost of plant maintenance, the safety of equipment operators, and the percentage of time the equipment will be in service.

Maintenance men have debated for years about the economics and overall efficiency of permanent versus reusable couplings. Permanent couplings are permanently attached to the hose and can be used for new assemblies with a new hose as long as the coupling components are in good condition. *Plant Engineering, May 1979.*

COMBINED ADDITION OF VANADIUM AND TITANIUM ON CAST IRON

The topic deals particularly on the influence of vanadium and titanium upon lamellar grey cast iron. Research trials recently conducted led to the conclusion that V/Ti and Vantit alloys help to promote dense castings, whether inoculated or non-inoculated. Other benefits include: a) very good strength for a given high carbon content; b) excellent wear resistance; c) good fluidity of hypereutectic compositions; d) moderate shrinkage; e) good resistance to creep up to 600°C; f) the alloying counteracts porosity and confers uniform strength throughout; g) excellent ability to assist in the carburisation of steel scrap during cupola melting; and h) improved machinability.

To some extent on account of its titanium, Vantit has an opposite effect on inculation. It decreases the number of eutectic cells, refines the size of type A graphite, and tends to convert type A further into types D and E. Inoculation increases the number of eutectic cells, and causes coarsening of the type A graphite. When making small castings, it is definitely better to start without Vantit and inoculate instead.

For very heavy castings, where the effect of "fading" of inoculation is significant, this tendency may be avoided and an even tensile strength can be secured in varying sections throughout the castings as a result of using Vantit. Thus, the addition of V-Ti in this alloy pig-iron is successfully being adopted in heavy diesel castings, paper-cylinders, and machine tool beds. *Foundry Trade Journal, April 1979.*

LONGER LIFE PROTECTIVE COATING

A new protective coating which will give steel roofing and wall cladding twice the life of traditional galvanized coating of the same thickness has just been marketed in Singapore. Called Zincalume, the new 45 percent zinc and 55 percent aluminum protective coating is expected to make a major contribution to the long-term economics of steel clad buildings. This is manufactured by John Lysaght (Australia) Ltd.

The zinc-aluminum alloy was not only found to be superior to galvanized in all tests, but the advantage increased as the period extended. The rate of corrosion slows down with time, especially in industrial and rural atmospheres.

Besides having twice the life at no extra cost, Zincalume also has the following advantages: a smooth silvery matt surface; and the same steel base is used with all the inherent characteristics of high strength, light weight, impact resistance, wide spans, and ease of transport and handling. *SEAISI Newsletter, July 1979.*

ELECTROPLATING ON IRON AND STEEL

To develop a plating procedure for steel, the following guidelines should be observed: a) identify the steel by AISI number; b) obtain the chemical composition and observe the carbon content and alloying elements; c) ask what heat treatment was used and make a note of it (it could have been carburized or nitrided, which requires special procedures); d) ask for the strength level or hardness of the steel to determine if there is a potential hydrogen embrittlement problem; e) read ASTM, Metal Finishing Guidebook and Electroplating Engineering Handbook recommendations for plating procedures; f) try the simplest method that is recommended and add steps one by one if necessary; g) make a permanent record of the AISI designation, the properties of the steel, and the process used; and h) finally, it is useful to know the function of the part — include it in the record if it is known.

As may be gleaned from above, plateability is established by trial and experimentation. The likelihood that a steel can be plated is indicated from experience with similar steels. The plater cannot predict the plateability of a steel any better from the composition and properties than can a metallurgist from the forming, heat treating and hardening practices. However, similar steels often respond well to the same plating procedures. Many of the steels that are difficult to plate can be plated successfully with the Wood's nickel strike. Other steels that are easy to plate can be plated by a simple cleaning, activating and plating procedure. *Metal Finishing, June 1979.*

DOLOMITE IN MODERN METALLURGY

Raw dolomite is used for slag conditioning in sintering and blast furnaces. The desulphurizing of iron takes place more and more between the blast furnace and the steel works. The changeover for iron ladles through ramming, slingering or lining with dolomite from acid to basic was very slow. However, the rapid performance decline of torpedo ladle linings made of fire-clay and high-grade alumina bricks, which was due to the attacks of desulphurizing slag from the soda or immersion-tube calcium-carbide treatment, led to the changeover to dolomite linings 7 years ago. This resulted in cutting costs by half. The dolomite share in the iron mixer will increase because during the current large-scale tests the throughput has already exceeded 2 million tons.

Because the chromium oxide in the slag is reduced in the AOD converter during the reduction period, other existing chromium oxides — for example in bricks with chromium oxide content — will also be reduced. Take-out results of more than 100% are therefore normal for AOD converters with magnesite chrome bricks. It is therefore no wonder that dolomite bricks, which are free of chromium oxide, behave very well in AOD converters. In addition to this, under reduction conditions, partial oxygen pressures prevail during the AOD process, which permit a reduction of the MgO. This also explains the failure of pure magnesite linings. With dolomite the periclase lies within a CaO matrix. CaO cannot be reduced by the prevailing partial oxygen pressures. Because dolomite accepts a faster heating time than a vessel with a magnesite lining, it is no wonder that today almost all European AOD steel works, and progressively more in the U.S., line with dolomite.

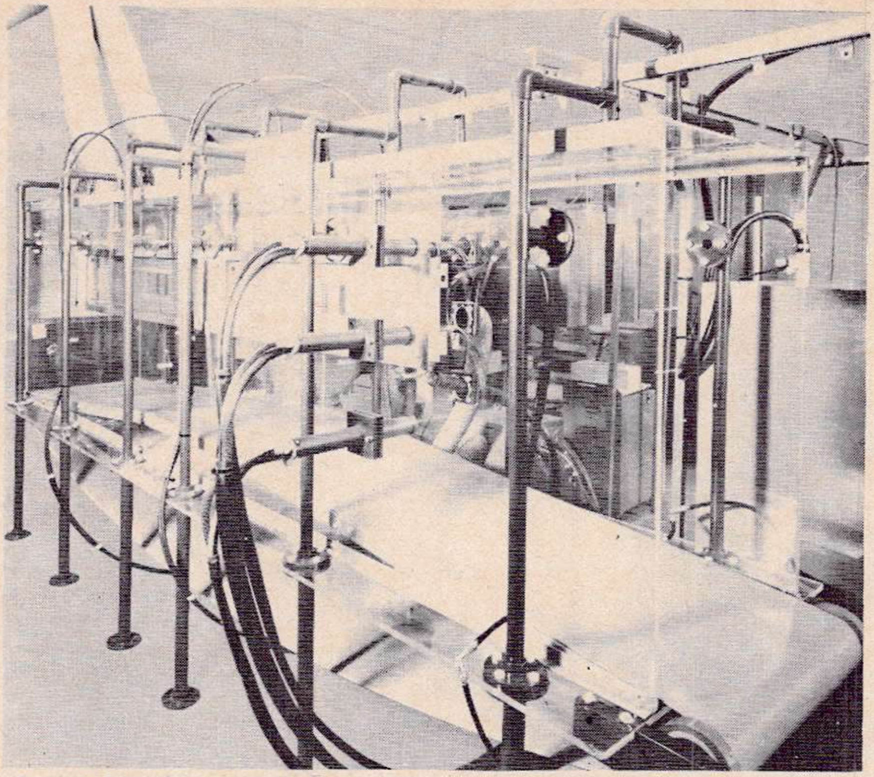
For ladles and AOD converters, direct bonded dolomite bricks are therefore of particular importance. Apart from the close dimensional tolerances, tunnel kilns of the new design present the possibility of producing bricks, with the aid of the higher burning temperature, with improved characteristics in the impact zone, and in the main wear zone above the tuyeres in AOD converters. *Metallurgical Plant and Technology, March 1978.*

A NEW SYSTEM FOR POWDER COATING

Color change and deposition efficiency are the two basic aims of the Volstatic Supercoater. The system applies a secondary charge to the oversprayed powder that is normally extracted, and while it is still inside the booth this powder acquires a second lease of life and is then deposited onto the workpiece. The spray booth is constructed of a dielectric plastic and whereas a booth of metal construction would certainly attract powder to its internal surfaces, the insulating booth will acquire an electrostatic charge on its inner faces. Since this charge will be the same polarity as that of the powder it will tend to repel particles and be self-cleaning to a very large extent.

The great majority of powder sprayed from the guns is deposited onto the production, thus necessitating very little work for the recovery system. In most cases it has been found that the amount of powder actually extracted from the Supercoater is so minimal that it does not present a need for recycling.

An important benefit gained by the Supercoater system is the tremendous increase in safety factor over conventional systems. Since the whole aim of this unit is the total usage of powder within the booth, it is necessary only to emit that quantity of powder required for the production in hand. By using the Supercoater, excess powder inside the booth is eliminated and the recovery system is also handling very little powder with a consequential vast reduction in powder cloud densities contained within that system. *Metals Australasia, September 1978.*



Volstatic high-efficiency self-cleaning super coater for continuous automatic powder coating.

WATER COOLING SYSTEMS IN ELECTRIC ARC FURNACES

Water cooling systems on furnaces have been known for a long time, particularly in the area of blast furnaces. Application of water cooled panels in electric arc furnaces has been advanced during the last several years, especially in Japan. This report deals with the Korf-Fuchs water cooling systems designed by the Korf Group in Germany. At the start, different designs and arrangements were tested. Cooling systems were then introduced to the extent that about 75% of the removable shell area and about 86% of the roof area are water cooled.

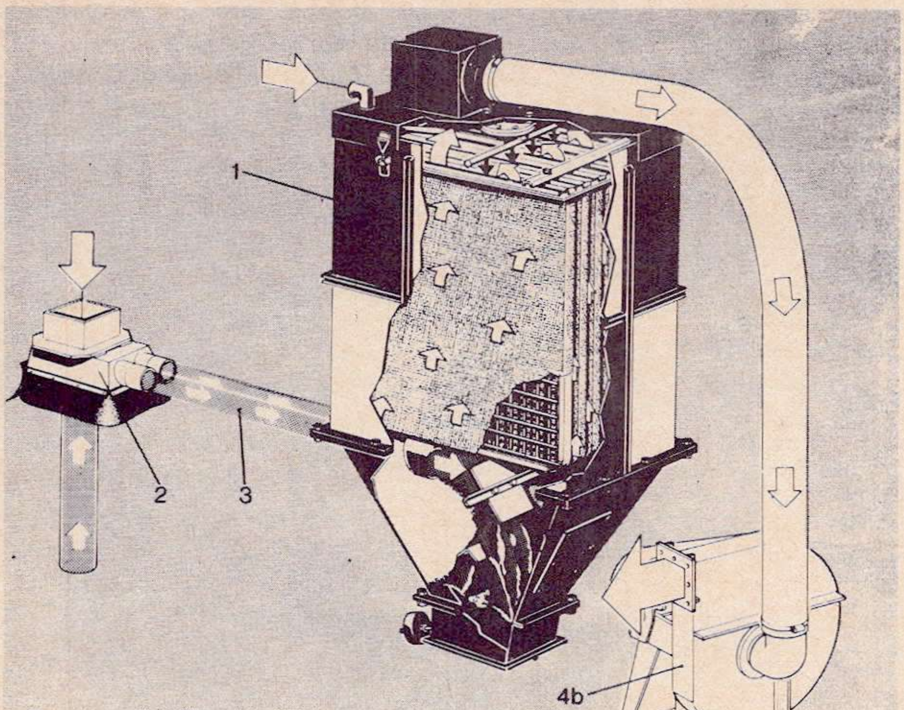
The remaining brick portions in the furnace wall are necessary to avoid direct contact between liquid steel and water cooled boxes, especially when the furnace is tilted for tapping. In the water cooled roof, only the delta is still bricked because of electrical insulation problems. The water cooled boxes are welded. Each individual application will require a specific size and shape of the boxes as well as a specific forced water flow within the boxes. The surface of the water cooled box facing the arc heat is protected by specially shaped studs and a refractory coating. The special studs improve adhesion of the refractory coating to the box wall and facilitate a uniform cooling of this coating.

All existing electric arc furnaces, be they of the split shell or conventional shell type, can accommodate the Korf-Fuchs water cooling systems for walls and roofs. Carefully controlled manufacturing and testing procedures insure the safety of the systems. The special design of the water cooling system for walls requires cooling water rates from 100 to 150 $l/m^2 \times$ min. The additional electric power consumption depends on the particular furnace design, furnace operation practice and heat time. *Metallurgical Plant and Technology, March 1978.*

$600 MILLION EXPANSION TO STOP ALUMINUM SHEET SHORTAGE

Aluminum sheet and plate mills all over the U.S. are reported to be undergoing expansions worth a total of over $600 million in new investments. That's a lot, considering the fact that nearly all expansion moves are additions to existing mills. Only one is a wholly new production mill. This is Reynolds Metals' continuous casting facility in Arkansas. A few of the units reported have been brought on stream within the past half year or so. Most of them will come into production this year or early 1980. A few are slated for 1981.

Results of a survey indicate a healthy addition to flat rolled products capacity that should not only take care of anticipated needs for the next few years, but may even encourage the industry to



One type of DCT unit includes the separator (1), the suction hood (2), the suction hose (3), the drive ejector, fan (4b), and brake ejector.

start beating the bushes for new applications.

What all this expansion will mean in terms of additional flat rolled products capacity is hard to gauge accurately. It can be conservatively estimated at something over 10% of existing capacity, or an additional 40,000 tons of new capacity. That should satisfy all anticipated new demand. *Modern Metals, May 1979.*

INDUSTRIAL NOISE CONTROL

Unless there are major redesigns of current production equipment and/or basic process changes, resultant noise levels in many areas of the foundry will remain excessive. It is therefore important that the foundryman recognize and identify the critical areas and take the necessary alternative steps to assure proper protection of employees' hearing.

Severa conclusions regarding noise reduction were drawn during a recent seminar sponsored by the Society of Manufacturing Engineers. These are:

1. Significant noise reduction is obtained in manufacturing, assembly, and production areas by adding absorbing materials.

2. Little significant reduction usually is achieved within 10 ft. of the source, which often includes the operator.

3. In many factory areas, noise sources or machines are distributed over the whole floor area. Moving 10 ft. from a machine merely puts one into the near field of another, with little or no noise reduction.

Reverberation control or adding absorbing baffles in any heavily crowded machine environment can be an effective noise reduction measure when existing levels are marginally high with respect to the criteria. In areas remote to the source – say 20 ft. or more – the addition of absorption can reduce the reverberant noise buildup by 10 decibels or more and thus provide highly effective noise control. Often these remote areas contain a cluster of personnel, and noise level criteria can be met without the use of personnel protection. *Foundry Management & Technology, December 1978.*

DUST CONTROL EQUIPMENT

Legislation that rock drills should be equipped with dust removal equipment meant that both machinery manufacturers and users intensified their work to develop methods for effective dust evacuation in dry drilling. Initially, it was deemed sufficient to have relatively simple devices primarily intended to keep the dust away from the worker's immediate surroundings. With a fan or ejector, the dust was sucked off from the mouth of the drill hole in a hose and was released where it was judged to do no damage.

In addition to the pure dust suction method, a method was also developed for binding the dust with a foaming liquid (water plus a foaming additive). Using a metering device, this was added to the flushing air, so that the foam with the bound dust was forced up to the surface of the rock with the flushing air. This equipment is inexpensive, but requires special drill steels. This method exhibited exceptionally good dust-binding characteristics, but there are disadvantages which make it less attractive to use. The method is extremely sensitive to incorrect metering – too small an amount leads to dust, and too much leads to jammed steels.

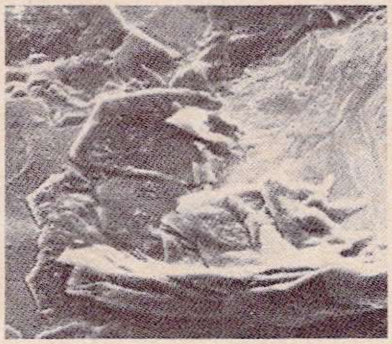
Atlas Copco has conducted an extensive program to discover the most suitable method for removing dust in dry rock drilling. This resulted in the DCT (Dust Collection Technique) method, which creates a better working environment for both men and machines. While dust evacuation is primarily intended to protect the worker against injurious stone dust, at the same time a dust-free working environment also reduces wear on machinery, such as compressors and rock drills. *Mining Equipment International, September 1978.*

CHARACTERIZING IRON CASTING DEFECTS

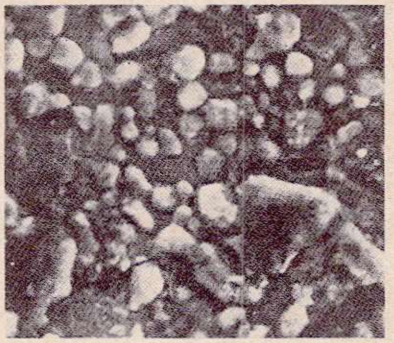
The optical microscope has long been used to produce most of the available information on the identification and characterization of casting defects. However, the scanning electron microscope (SEM) in combination with the energy dispersive X-ray analyzer (EDAX) allows for a closer examination of these defects (due to the larger depth of field) and at the same time aids in the identification of the elemental composition at the defect site. Such information at defect sites can be extremely helpful in leading to the identification of the cause and, hence, allow for suitable remedial action.

Among the various types of defects, those caused by gas probably are the most common that occur in the iron casting industry. Gases in castings may result from the entrapment of air during pouring, precipitation during solidification, or evolution on contact between liquid metal and molding material. The most common type of gas defect is the rounded surface gashole, which can be found either prior to or after shotblasting. Examination of one of these defects in the SEM (see photos) shows the presence of a characteristic thin film of graphite on the surface that may be due to the hydrogen released during solidification of the casting. In addition, tiny spherical nodules were seen in the cavity of this defect. An EDAX analysis of a single nodule revealed the presence of both manganese and sulfur. This suggests that in this instance, gas defects are accompanied by the segregation of manganese sulfide, thereby providing valuable information for further corrective action.

Combination defects can be among the most troublesome that occur in any casting. One combination often present in gray and ductile iron castings is gas and shrinkage defects. These are usually subsurface in nature and occur in thin sections that are the last to solidify. SEM examination reveals the presence of rounded, smooth dendrites surrounded by a thin, black film. EDAX analysis of these dendrites indicate the presence of iron, manganese and sulfur. Such information at a defect site actually provide some insight into the problems associated with the identification of defects. *Foundry Management & Technology, December 1978.*

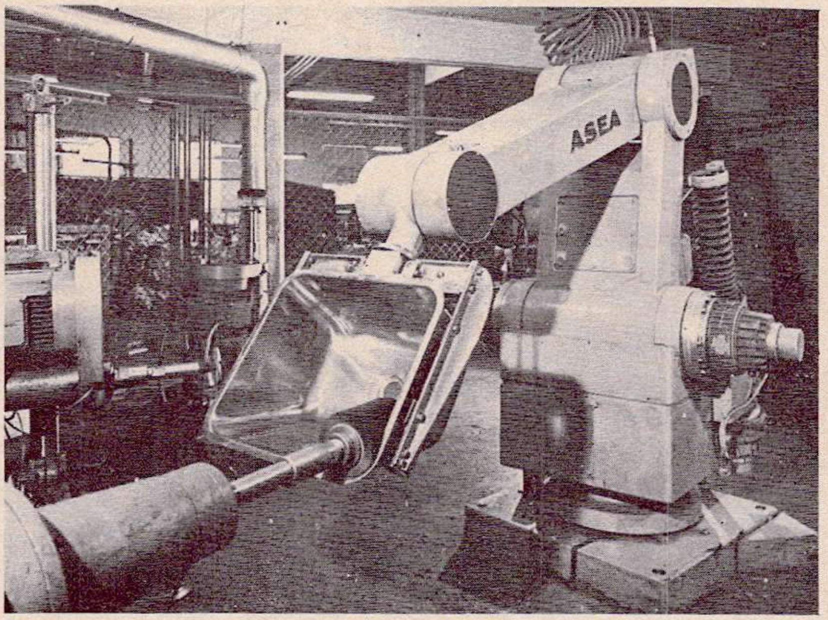


Graphite film on surface of gashole at 450 x.



Spherical nodules on surface of gas defect at 1,000 x.

USING ROBOTS FOR SURFACE FINISHING



General view of robot used to surface-finish stainless steel sinks.

Modern industrial robots are now being used to polish stainless steel sinks at the works of Bulten-Kanthal AB, Sweden. Only one operator supervises the installation, within which there are ten sinks being processed at any one time. The installation comprises one ASEA 60 kg robot as well as accessories with two conveyor belts. The conveyor belt supplying the units is sloped, and this is where units are orientated.

The units then undergo spraying with polishing agent, and proceed to polishing machines composed of an AC motor set up in a stand, providing a choice of contact angles. A suitable polishing mop is fitted on to the motor shaft. After being polished, the sink unit is passed on to the second conveyor belt, while the robot returns to the collecting conveyor to get the next unit.

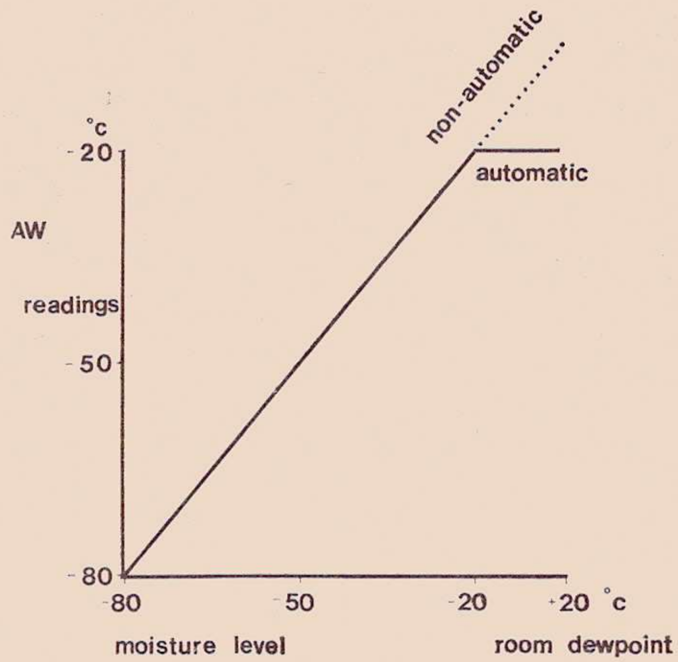
Feeding of the conveyor belt, checking that the delivery position is free, checking that the unit has been really gripped by the robot, start and stop of polishing machines and polish sprays, as well as connection and disconnection of soft servo are performed with the aid of inputs and outputs. The robot is not used in the normal manner for polishing, i.e. positioning to specified positions, but instead an attempt is made to maintain a specific polishing pressure irrespective of brush wear. This means that positioning accuracy is of no interest. *Sheet Metal Industries, January 1979.*

RAPID CALIBRATION FOR ELECTRONIC HYGROMETERS

Electronic hygrometers produced by Shaw Moisture Meters now use sensors employing a simple, rapid method of automatic calibration, which enables the instrument to be matched with the sensor at any time. Unskilled assistants can recalibrate the system in less than a minute to provide a regular check on its continued accuracy. As a result, accuracy can be guaranteed to within ± 3 °C dewpoint or ± 1 part per million of moisture over nearly all the range.

The principle of the Shaw calibration method is that the sensor output is given a completely flat cut-off at the maximum humidity that the sensor is designed to measure. Any further increase in humidity produces no change in output. Therefore, to calibrate the instrument, the sensor need only be exposed to any atmosphere with humidity known to exceed the maximum design value. For most of the sensors, designed to measure the humidity of dry gases, ordinary room air can be used for this purpose. The single adjustment on the instrument is then used to set the pointer exactly to its full scale reading. At the other end of the scale, each sensor gives zero output for the lowest moisture content it is designed to measure, so no adjustment is needed or provided.

All the sensors are based on the established Shaw principle of measuring the capacitance-changes caused by water entering or leaving a microscopically thin layer (about 10 microns) of a dielectric material. The thinness of the dielectric ensures very rapid response when the outside humidity changes, and so allows a continuous output reading. It also gives the sensor a capacitance many times higher than most capacitive sensors, permitting runs of up to 300 m of coaxial cable between sensor and instrument without amplification. Any sensor may be plugged into any instrument with rapid recalibration as described. Contamination of the dielectric over long periods of use is prevented by a porous film of metallic gold which acts as a selective filter, permeable to water vapor but not to larger molecules or to dust. The gold film also acts as one electrode of the capacitor. *EIBIS.*



Graph reading of moisture level using Shaw moisture meters.

ALL ABOUT VORTEX FLOWMETERS

Vortex flowmeters make use of a natural phenomenon (vortex shedding) that occurs when a liquid or gas flows around a bluff (nonstreamlined) object, like water flowing past rocks. As the flow rate increases, the fluid no longer divides, but begins to tumble upon itself, creating interacting currents that form vortexes or whirlpools that subsequently shed and move downstream. When the velocity of the stream increases further, the rate at which vortexes form and shed also increases. The number of vortexes formed during a specific time period is a measure of the fluid flow rate.

The three major components of a vortex flowmeter are: a bluff body strut mounted across the flowmeter bore to obstruct the path of the process fluid and cause vortexes to form; a sensor to detect the presence of the vortex and generate an electrical impulse; and a signal amplification and conditioning transmitter whose output is a signal that is proportional to the flow rate.

Vortex flowmeters can be used with a wide variety of liquids and gases. Normal construction is of type 316 stainless steel, making the instrument suitable for use with corrosive liquids, contaminated water, steam condensate, light hydrocarbons, and various aqueous solutions. Gases such as air, nitrogen, oxygen, and natural gas can also be measured. Liquefied gases such as anhydrous ammonia, propane and butane can be metered without fear of damaging the instrument, even during process startups when such materials tend to flash. *Plant Engineering, May 1979.*

HIGH-SPEED ALUMINUM ANODIZING PROCESS

A sophisticated high-speed aluminum anodizing process developed by the Tomita Electrical Institute features the following characteristics:

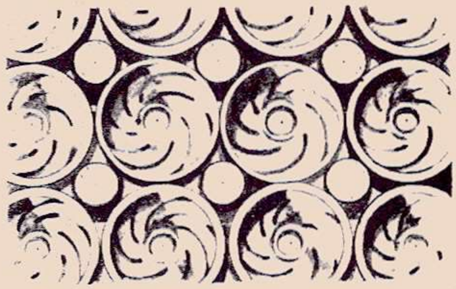
a) Sulfuric acid of 30% concentration, or double the usual density, is used in order to improve the electrical conductivity.

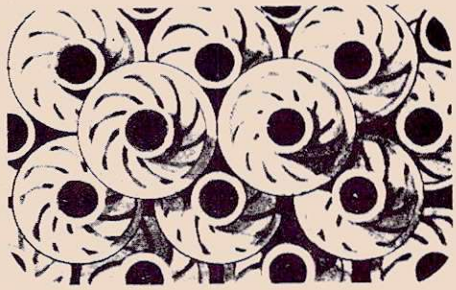
b) The single electrode per tank treatment method is used.

c) The racking jig is made entirely of titanium material.

d) The jet circulation method is used for agitation and cooling.

The racking jig was made of titanium instead of copper or aluminum because, although titanium has poorer electrical conductivity, higher electrical specific resistance and is more expensive, it is highly resistant to chemicals and its use eliminates the need to remove oxidized film. *JETRO, February 1979.*





MIRDC

SEMINAR PROGRAM
January – March, 1980

DATE	TITLE	SPEAKER/S
Jan. 28 – 31	Time Element in the Production Processes and their Incidence on Profitability	Reimer Behrens
Feb. 14 – 15	Technology in the Operation of Galvanizing plants	Jerry H. McAuliffe
Feb. 18 – 22	Training Courses on Welding	Richard Schwaiger Alfred Staetter Feliciano Dungca
Feb. 22 – 23	Technology of Gear Manufacturing in Small and Medium-Scale Industries	Heinz Dieter Winkler
Mar. 10 – 14	Plastic Injection Mold Design and Manufacture	Alfonso Azurin Elias Libutaque Dante Garvida Ernesto dela cruz

For more information contact:
Metals Industry Research And Development Center, 5th Flr; Ortigas Bldg., Ortigas Ave., Pasig, M.M.
and ask for:
Seminar Coordination Section
Tel. nos.: 693-3661
693-3664 thru 69

domestic prices

TABLE 1

DOMESTIC RETAIL METAL PRICES
(In Philippine Pesos)
October-December, 1979

ITEMS	UNIT	PRICE
G.I. Sheets (Roofing)		
Corrugated, Gauge #26 x 32"	linear ft.	₱ 6.00 – 6.10
Corrugated, Gauge #31 x 32"	"	3.60 – 3.80
Plain, Gauge #26 x 36"	"	6.00 – 6.10
Aluminum Sheets (1100 Alloy)		
0.016 x 36" x 8'	Sheet	65.40
0.019 x 36" x 8'	"	76.30
0.024 x 36" x 8'	"	98.50
0.027 x 36" x 8'	"	110.80
0.032 x 36" x 8'	"	131.05
Square Bars, 20'		
3/8" x 3/8"	Each	14.50 – 15.00
1/2" x 1/2"	"	20.00 – 22.00
5/8" x 5/8"	"	37.00 – 38.00
Round Bars, 20'		
1/4" (5 mm)	each	6.50 – 7.50
3/4" (Std.)	"	42.00 – 43.00
3/8" (9 mm)	"	13.00 – 13.50
1/2" (11 mm)	"	21.00 – 22.00
5/8" (14 mm)	"	30.00 – 32.00

TABLE I
DOMESTIC RETAIL METAL PRICES
(In Philippine Pesos)
October-December, 1979

ITEMS	UNIT	PRICE
Angle Bars, 20′		
1/8″ x 3/4″	each	22.00 – 23.00
1/8″ x 1″	″	28.00 – 30.00
3/16″ x 1″	″	40.00 – 42.00
1/4″ x 1″	″	53.00 – 55.00
3/8″ x 3″	″	Unquoted
Flat Bars mm size 20′		
1/8″ x 3/8″	each	10.00 – 12.00
1/8″ x 1/2″	″	11.00 – 12.00
3/16″ x 1″	″	25.00 – 26.00
1/4″ x 1/2″	″	19.00 – 25.00
1/2″ x 1-1/4″	″	Unquoted
G.I. Pipes (Ordinary) 20′		
1/2″	each	40.00 – 42.00
3/4″	″	56.00 – 58.00
1″	″	80.00 – 82.00
1-1/2″	″	135.00 – 140.00
2″	″	170.00 – 175.00
Black Iron Pipes, 20′:		
1/4″	each	41.00 – 42.00
1/2″	″	35.50 – 36.00
1″	″	60.00 – 65.00
1-1/2″	″	115.00 – 120.00
2″	″	7.00 – 7.50

Source: *Bureau of Domestic Trade*
Ministry of Trade
Quezon City, Philippines

TABLE II
JAPAN MONTHLY AVERAGE PRICE
(In U.S.$ per M.T. unless otherwise indicated)
October-December, 1979

IRON & STEEL	OCTOBER	NOVEMBER	DECEMBER
Round Bar, 9 mm	306.32	285.98	299.37
16-25 mm	316.48	294.95	304.45
Flat Bar, 6 x 50 mm	333.04	310.69	319.31
Equal Angle, 6 x 50 mm	295.93	276.81	298.16
10 x 90 mm	303.18	286.98	310.81
Channel, 6 x 65 x 125 mm	311.54	291.33	307.39
H-shape, 9/14 x 250 x 250 mm	376.03	350.09	353.77
Hot-Rolled Sheet (3 x 6), 1.6 mm	381.94	354.57	356.75
Cold-Rolled Sheet (3 x 6), 1.2 mm	434.99	405.37	410.26
Medium Plate, 3.2 x 3 x 6	370.46	343.86	346.25
Plate 6 x 4 x 8	364.90	314.47	343.11
9 x 4 x 8	360.45	310.69	338.91
Gas Pipe (black), 15A (1/2 inch) (per kg)	0.4311	0.401	0.4039
Water Pipe (white), 15A (1/2 inch) (per kg)	0.615	0.573	0.5796
Galvanized Sheet			
(plain), 0.30 mm	528.22	494.32	502.72
(corrugated), 0.25 (per sheet)	1.73	1.64	1.69
Wire Rod, 5.5 mm	88.44	82.42	83.42
Round Nail, 100 mm (4 inches)	484.69	449.26	451.18
Iron Wire No. 8	418.30	389.82	394.52
Annealed Iron Wire, No. 8	442.02	410.22	416.18
Barbed Wire, No. 14	615.21	573.32	580.24
Tinplate, 90 L (0.23 mm)	532.67	496.39	501.75
Wire Rope — JIS (per 200 m)			
1st Grade, zinc coated (24 x 6)			
10 mm	188.59	175.57	177.83
20 mm	485.05	452.02	457.47
NON-FERROUS METALS (per kg)			
Electro-Copper	2,166.79	1,016.48	2,190.83
Electro-Zinc	821.38	786.19	828.53
Electro-lead	1,426.23	1,337.74	1,352.11
Tin	16,628.18	16,335.74	17,861.72
Antimony	3,530.32	3,400.54	3,567.45
Nickel	7,921.00	7,409.36	7,806.42
Selenium	51,175.00	47,690.50	48,265.50
Bismuth	9,345.00	8,708.70	8,813.70
Cadmium	8,455.00	7,879.30	7,974.30
Mercury	364,900.00	355,273.49	397,288.02
Aluminum	1,790.77	1,726.52	1,884.45

index to advertisers

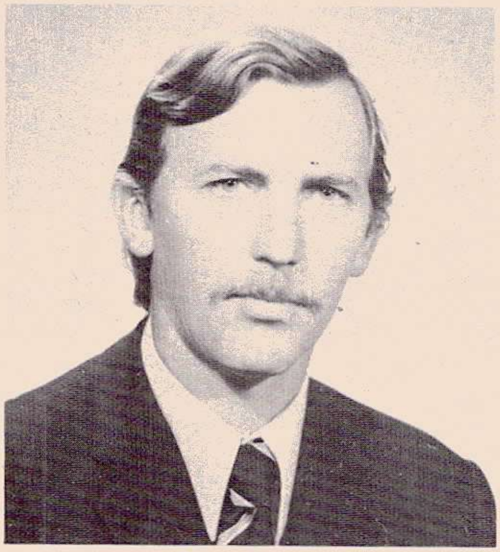
MIRDC, PATMAP INK AGREEMENT

The Metals Industry Research and Development Center (MIRDC) and the Pipes and Tubes Manufacturers' Association of the Philippines (PATMAP) signed a memorandum of agreement last September 8, 1979, covering the testing and inspection of black and/or hot-dipped zinc-coated (galvanized) longitudinally welded steel pipes and tubes intended for ordinary use in steam, water, gas and air lines, manufactured by member companies of PATMAP.

Dr. Antonio V. Arizabal, MIRDC Executive Director, signed the agreement for the Center, with Maj. Amado D. Dumlao, Jr., PATMAP President, and the association members countersigning.

With this agreement, PATMAP members are bound to undertake an inventory of their products on or before January 1, 1980, and products found to be substandard shall be disposed of in accordance with existing rules and regulations provided by approriate government agencies. The agreement, which shall take effect on January 1, 1980, runs for a period of one year and shall be renewed upon the discretion of both parties.

The agreement also states that all pipe products deliveries from manufacturers of steel pipes and tubes should conform to the standard specifications set by the Philippines Bureau of Product Standards as embodied in PTS 681-13.03, series of 1973.



Reimer Behrens

BEHRENS JOINS MIRDC – GERMAN PROJECT

Reimer Behrens, a Paraguay-born and raised German, recently joined the MIRDC-German Project as promotion and technology adviser. He is a practicing design engineer and is likewise a graduate of business administration (Industriekaufman).

Behrens has undergone special upgrading in the Federal Republic of Germany (1974) and was assigned as an expert for technical and micro-economic advisory service. From 1974 to 1978 he was involved in the conceptualization, organisation and initiation of a national advisory in Quito, Ecuador. This was aimed at the improvement of technical and economic output of small and medium industries through entrepreneurial training and management consultation. He also served as lecturer for time studies at Universidad Central Quito, Faculty for Administrative Sciences. At the same time he gave advisory service to SECAP concerning central administration, particularly provisions for material and store keeping, servicing and maintenance of machinery, system of distribution of students, and room and equipment requirements.

In 1964 to 1974 he was designated technical manager in a German cooperation project in Santiago, Chile, working with a counterpart in the establishment, equipment and management of workshops and laboratories for vocational training of skilled workers and technicians. In line with this project, he was advisor to the Chilean Ministry of Education on matters concerning vocational training in the productive sector.

Prior to his Chile assignment, Behrens worked for one year as business assistant and designer in the manufacture of airconditioning apparatus in Ludwigshafen, Germany, securing two patents for technical innovations he introduced in that field.

He speaks German, Spanish and English, plus enough French to get by.

FIRST PROVINCIAL SEMINARS HELD

The Metals Industry Research and Development Center (MIRDC) teed off on its first round of provincial seminars in Iloilo, Cebu and Davao last October 15-23. Eighty-nine participants from the three venues made up the total of those actively interested in "Metals Technology and Applications to Industry," which was the theme of the seminars.

The Cebu dialoque during the seminar on "Metals Technology and Applications to Industry."

Highlighting the lectures on each particular venue was the dialogue on the last day. This gave the participants a chance to air their views on the industry, as well as request for continuing seminars with corresponding shop work on specific areas. These included promotion of skilled manpower, time element study in machine shop production, metrology, materials selection and testing, heat treatment, and foundry technology.

The MIRDC resource speakers included Dr. Paavo Asanti, Marcelo B. Villanueva, Eduardo Lacbay, Horst Witt, Toribio Jamolin, Antonio Lazo, and Reimer Behrens. The panel on the dialogue was composed of Atty. Jose G. Bautista, Jr., Dr. Paavo Asanti, Horst Witt, Jose S. Sason, and Mrs. Rosa G. Tejada.

These technical seminars were conducted in cooperation with the Small Business Advisory Center, Ministry of Industry.

SEAISI OFFICIAL ON BRIEF VISIT

Takashi Itaoka, executive consultant of the South East Asia Iron and Steel Institute (SEAISI), toured the country last November 12-18 primarily to gauge developments in the iron and steel sector, as well as current technology being utilized in local industries.

Extensive plant visits to twelve leading member firms of the Philippine Iron and Steel Institute (PISI) were coordinated by the Philippine National Committee to SEAISI, which is maintained by the PISI and the MIRDC.

In Metro Manila, Itaoka visited the plant facilities of Philippine Blooming Mills, International Pipe Industries, Inc., Super Industrial Corp., Philippine Appliance Corp., Atlantic, Gulf & Pacific Co., Delta Motor Corp., Armco Marsteel Alloy Corp., Engineering Equipment, Inc., and the MIRDC complex in Bicutan.

He likewise toured the Iligan plants of National Steel Corp., Ma. Cristina Chemical Industries, and Refractories Corp. of the Phils., as well as the Philippine Sinter Corp. in Cagayan de Oro.

Itaoka's trip to the Philippines was part of an extensive tour of all SEAISI member countries to gain insights into the South East Asian region's capability in iron and steel.

MIRDC TECHNICAL GROUP TO SINGAPORE

Dr. Antonio V. Arizabal, MIRDC Executive Director, headed the technical delegation to the symposium on "Modern Technology on Non-Destructive Testing" held in Singapore last November 27 to 19. The other members of the group were composed of Atty. Jose G. Bautista, Jr., Mrs. Beatriz D. Orinion, Marcelo B. Villanueva, Priscilla A. Mantaring, and Wilfredo L. Balmores.

This affair was sponsored by the Federal Ministry of Economic Cooperation, Federal Republic of Germany, and a joint venture of Carl Duisberg Gesselschaft and the Singapore Institute of Standards and Industrial Research (SISIR).

The symposium was intended to offer a platform on which experts from ASEAN countries and Germany could exchange eperiences in the aim of finding new solutions for the future. The major topics included development of NDT technology in ASEAN countries, NDT economics, and ultrasonic, X-ray, electrical and magnetic test methods.

JOINT ASSOCIATIONS CONDUCT SYMPOSIUM

The Philippine Foundry Society (PFS), Society of Manufacturing Engineers (SME), and the Metalworking Industries Association of the Philippines (MIAP), in copperation with the Metals Industry Research and Development Center, held a joint symposium on "Metal Manufacturing Processes: A System" last October 18 to 24 at the Pamantasan ng Lungsod ng Maynila.

The symposium was designed to orient engineering instructors to the appreciation of engineering materials and processes, provide insights on applied technology for the integration of engineering curricula, and establish effective cooperation between educational institutions and the industry.

The topics included metalcasting, welding, metal forming, metal cutting, and metal treatment and finishing. To supplement the lectures, plant visits were made at Delta Motor Corporation in Parañaque and Philparts Mfg. Co., Inc., in Valenzuela.

The speakers, picked out from the officers of the various associations, were composed of Benjamin G. Cabàllero, Jose S. Sason, Leonardo B. Santiago, Jovito M. Luis, Romarico J. Platon, Ernesto C. Ignacio, Albino F. Maglalang, Jose Miguel Paez, Narciso P. Buenaventura, Candido Miguel, Jr., Bro. Ignatius Alex Gardin, Jose O. Ocariza, Mario Garrolini, Ruben Pinaroc, and Pacificador C. Directo.

Coordinators were: J. Hermes D. Bautista, President, Philippine Foundry Society; Wilfredo M. Azarcon, Chairman, Society of Manufacturing Engineers – Manila Chapter 165; and Raul M. Consunji, President, Metalworking Industries Association of the Phils.

SASON OFF FOR STUDY MISSION

Jose S. Sason, manager of the Metal Casting and Treatment Dept., MIRDC, left last December 9 for Thailand and Pakistan to join a 14-day Multi-Country Study Mission on Foundry, Casting and Steel Re-rolling Industry, sponsored by the Asian Productivity Organization (APO). This was organized in cooperation with the Productivity and Development Center (PDC), Japan.

The study mission aims to provide the participants with an opportunity to study the foundry, casting and steel re-rolling industry in Pakistan and Thailand. This is with the view of upgrading technological and managerial levels of the industry, and also to increasing productivity. Implementing organizations in both countries were the Pakistan Industrial Technical Assistance Center (PITAC), and the Thailand Management Development & Productivity Center (TMDPC).

The programme for the study mission included: orientation, lectures and discussions on general aspects of the subject including national policies; observational studies at the appropriate institutions, and foundry, casting and steel re-rolling mills; and final report presentation, evaluation and recommendations.

SEMINARS

A seminar on "Modern Welding Processes: the TIG and MAG" was held last December 7-8 at the MIRDC Pilot Plant III, NSDB Science Complex in Bicutan, Taguig. The course dealt with theories and practices involved in welding. This gave an insight into the processes used to join metals by application of heat, with emphasis in the two modern welding processes, tungsten inert gas arc welding (TIG) and metal arc gas welding (MAG).

The MIRDC resource speakers were Alfred Staetter, welding technology expert of the MIRDC-Austrian Technical Assistance Project, and Feliciano Dungca, officer-in-charge of the Welding Section. Practical demonstrations were carried out by Aristeo Mercado and Salvador de Paz.

"The Vortex Process – For Inoculation, Desulphurisation & Nodular Iron Production" was the subject of another seminar last December 7, conducted by the MIRDC in cooperation with the Technical Foundry Center, TNO, Netherlands, and the Metallurgical Institute, Ljubljana, Yugoslavia.

Resource persons were B.J.J. van der Holst and A. van der Ent, both of TNO, and Ciril Gorisek of TOZD, Yugoslavia.

As covered in the course, the Vortex Process is a simple and cheap method by which additives could be added to a melt. Developed by TNO's Technical Foundry Center, the process is suitable for the production of nodular cast iron, especially for treatment of melt batches ranging from 50 to 1000 kg.

DEPARTURES/ARRIVALS

Tagumpay Cruz, supervising mechanical metallurgist, left for Tokyo, Japan last October 15 to attend the 10-day "1979 Application Seminar," sponsored by the Japan Iron and Steel Exporters' Association (JISEA).

Meanwhile, Elias Libutaque, asst. design engineer, left for training on "Tool Engineering" in New Delhi, Hyderabad and Madras, India from October 21 to November 17. This was under the sponsorship of the Asian Productivity Organization (APO).

Edgardo B. Lopez, Jr., asst. engineer, arrived on the first week of December from Texas, U.S.A. after 9 months training in "Mechanical Maintenance for Engineers."

Rodolfo I. Panganiban, machinist, also arrived on the same period after 23 months training on "Gearmaking and Pedagogy" in West Germany, under the MIRDC-FRG Technical Assistance Program.

After 18 months of training as "Theory Instructors" in West Germany under the MIRDC-FRG Technical Assistance Program, Dominadoe Cabatic, Jr. engineer, Federico Fernando, Jr. engineer, and George Maravilla, planning and scheduling officer, were scheduled to arrive on the last week of December. PM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