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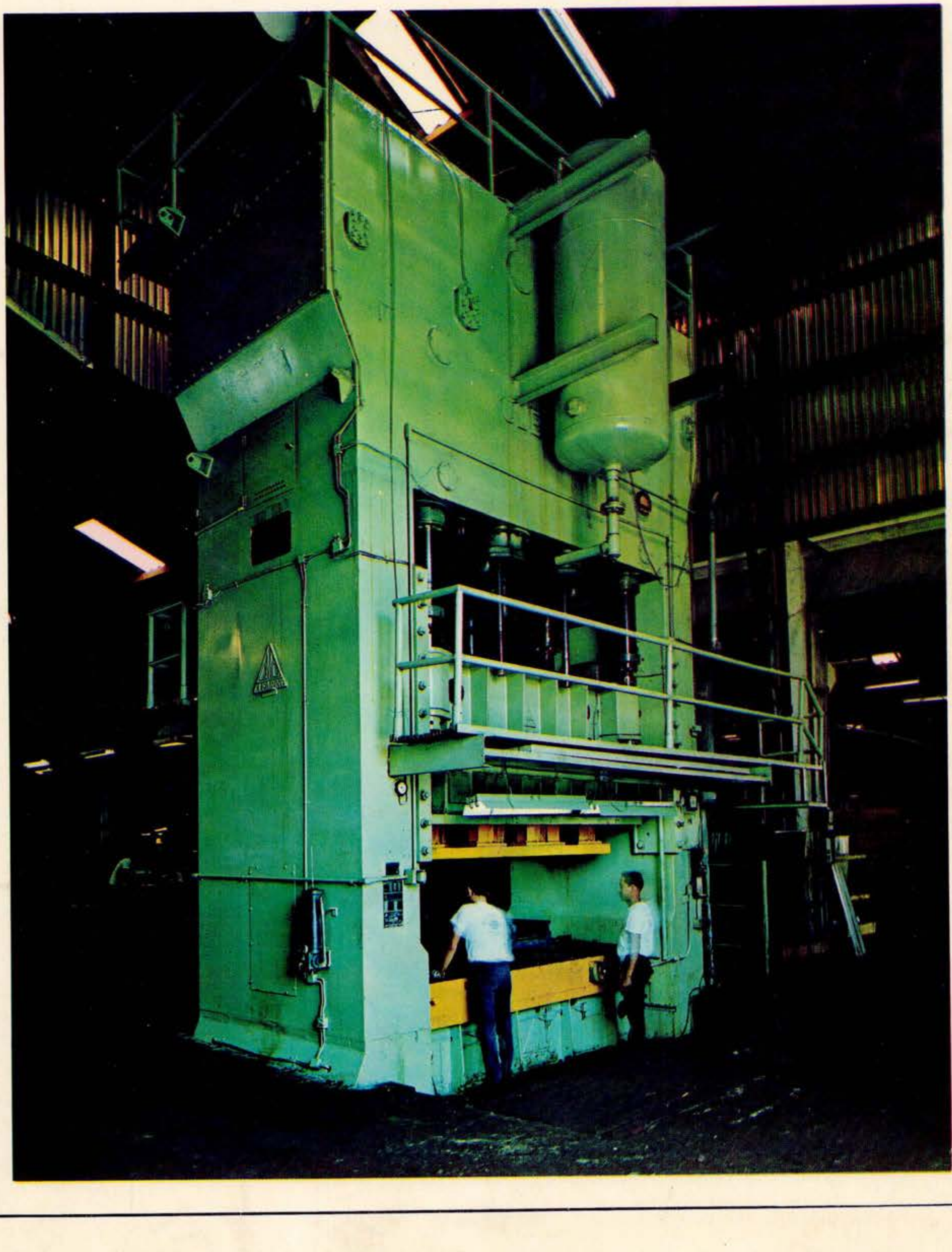

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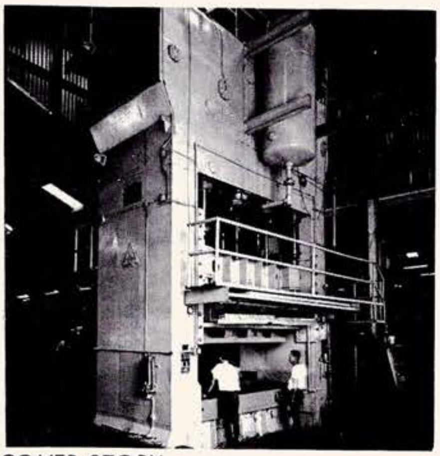

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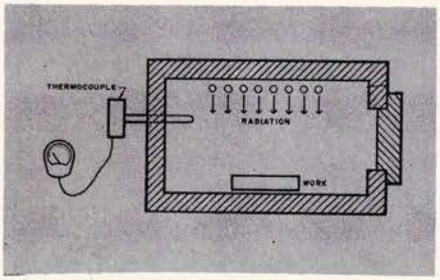

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editorial

MIDC Looks Forward to Congress for an Extension of Life

The Metals Industry Development Center was created by virtue of R.A. 4724 enacted on June, 1966 and given by operation of law seven years of existence. Counting from the year of its birth, the Center's lease on life will expire by June 1973.

Despite the fact that the Center was created in 1966, it had been provided funds only towards the third quarter of 1969. In short, if it expires by 1973, it would have had an effective life of four years.

Can four years be sufficient time to judge the value or worth of a complex technological service in an era of massive and complex technological advances?

By these considerations, MIDC stands to be judged, and to judge!

Come 1973, must another government creation go down the drain instead of being given an extension of life to prove its worth?

The original concept of the law was to make MIDC a seven year experiment in private sector-government cooperation in the realm of technological services and manpower skills upgrading. The idea was to use government funds and support to give technological and training assistance to the metals industry which is almost exclusively, with the exception of NASSCO, in private hands.

MIDC is now jointly managed by the government and the private sector to enable it to be more responsive to the needs of private industry. This scheme was supposed to gain the best of "two worlds": government financial support and the dynamism of a privately-managed organization.

Unfortunately, MIDC has not yet been able to go into operation in view of the delayed releases of government funds.

It is therefore vital that Congress agree to extend the life of the Center as a government-supported institution even after the completion of its seven years of legal existence which was originally stipulated in R.A. 4724. Only then will it be proven that a government-subsidized project subjected to joint management could be effective and be able to meet the many requirements of the private sector in the field of technology.

The plan to turn MIDC into a purely government agency after its legal life of seven years will have expired would not be a solution to the problem. MIDC must retain some of the more important management features of a private agency to maintain operational efficiency.

Considering the complex technological service that it offers, the Center must operate in a businesslike way. Furthermore, it needs a brand of management equivalent at least to that of private organizations. On these two counts, MIDC as a purely government agency is not practical.

It may be true that some government agencies are not responsive to the needs of the private sector and the private sector has no need for them. But it is not definitely true, as some sectors of private industry vociferous proclaim, that any government agency is a flop, service-wise and efficiency-wise. One can look at the most capitalistic of capitalist countries, namely the United States, and find a lot of government-subsidized agencies performing their proper roles for industry.

What MIDC therefore asks is for Congress to extend its life until it is given enough time to prove its worth. By then, it can be seen whether the Center should be purely governmental, purely private, or joint.

LOW SHAFT FURNACE SMELTING OF FERRUGINOUS MATERIALS

PART III

by ESTEFANIO M. GACAD

7. THE GERLAFINGEN LOW-SHAFT FURNACE (1,6)

This low shaft furnace was constructed from a cupola at Gerlafingen, Switzerland, for experimental meltings conducted in 1954 using local ore and coal containing high volatile matter (49%) with oxygen enriched blast. The furnace was 3.76 m from hearth to top with a working height of 2.74 m, hearth diameter of 1.47 m, and equipped with four tuyeres of 38 mm inside diameter each. A typical result obtained is shown below.

Iron Ore

Analysis:

Fe	44%	Al_2O_3	2%
Mn	2.7%	CaO	9%
P	0.04%	MgO	5.4%
S	0.05%	Igniting loss	6.5%
SiO_2	9%	Moisture	3.7%

Consumption = 2,050 Kg. per ton pig iron

Coal

Analysis:

Moisture	16%	Ash	6%
Volatile Matter	49%	S	0.25%

Consumption = 2,900 Kg. per ton of pig iron

Pig Iron

Analysis:

C	4.0-4.3%	Mn	3%
Si	1.5%	S	0.020-0.12%

Production = 8 tons per day

Top Gas

Analysis:

CO	51%
CO_2	7%
H_2	8%

Calorific Value 1,870-1,960 Kcal/m^3

8. EXPERIMENTAL BLAST FURNACE OF THE SCIENTIFIC RESEARCH DEPARTMENT, PAO-T'OU METALLURGICAL COMBINE, PEOPLE'S REPUBLIC OF CHINA (3)

This experimental blast furnace was constructed in 1955 principally to investigate the smelting characteristics of Pao-T'ou ores, which has an iron content varying from 20 to 45% with flourspar as principal impurity and to study the effects of flourine during smelting on the erosion of the refractories, wear of metallic parts plus other problems.

The original furnace had a working volume of 0.76 m^3. Two preliminary smeltings in this furnace were carried out toward the end of November, 1955 after which some improvements were made and the furnace was blown in again on April 23, 1956. The modified furnace had a working volume of 0.96 m^3 and a maximum working height of 2.68 m. It had a circular cross section with throat, barrel and hearth diameters of 0.550 m, 0.750 m and 0.640 m, respectively. The heights of the throat, stack, barrel, bosh and hearth are 0.540 m, 1.155 m, 0.305 m, 0.686 m and 0.376 m, respectively. The slag notch is 0.226 m above the furnace floor. The furnace has four tuyeres set at a slope of 15 degrees with nozzle internal diameter of 30 mm provided with ceramic refractory rings for reducing the inside diameter to 23 mm. Figure 5 shows a vertical cross section of the furnace in 1956.

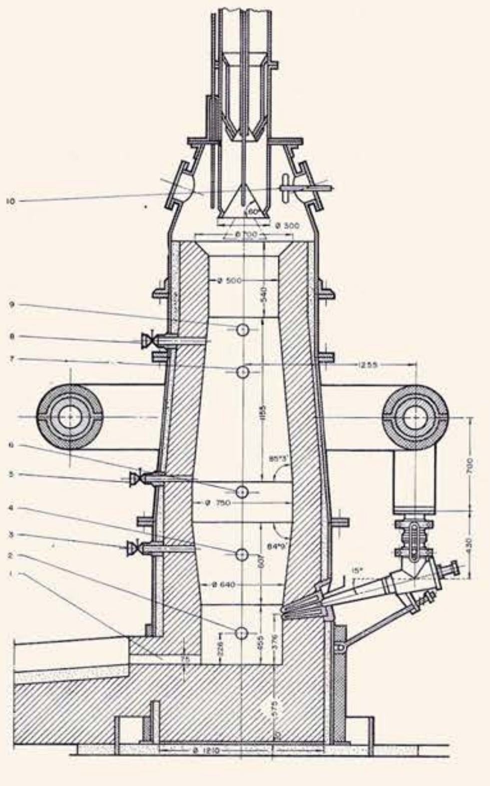

Fig. 5 - A vertical cross section through the Pao T'ou experimental blast furnace. 1) pig-iron tap hole ; 2) slag notch ; 3), 5), 8) gas sampling points ; 4), 6), 7), 8), 9), 10) sampling points for charge materials.

The blast is supplied by a rotary air blower, with another as spare, each having a maximum capacity of 720 m^3/hr at a maximum pressure of 3000 mm H_2O. A high silicon cast iron tube recuperator is used for preheating the blast to 600°C. Combustion of clean furnace top gas or diesel oil is used for heating the recuperator.

The furnace charging equipment consists of two bells without a revolving distributor. The hoist for charging raw materials into the furnace is manually operated.

The gas cleaning plant consists of a dust catcher, a cyclone, a scrubber without wood packing, a scrubber with wood packing and an electrostatic precipitator.

Results of Operation

The size of raw materials used are: ore, 7-11 mm; limestone, 7-15 mm; and coke 10-20 mm. The first experimental smeltings conducted from November to December, 1955 were unsuccessful. The results of the smelting tests conducted from January to May, 1956 are shown in Table VII.

9. LOW-SHAFT FURNACE PROJECT, NATIONAL METALLURGICAL LABORATORY JAMSHEDPUR (5,11,12)

The Low-Shaft Project of the National Metallurgical Laboratory in Jamshedpur was initially of the single stage Demag-Humboldt Niederschachtofen type. The furnace is of circular cross section having both a hearth and a throat diameter of 1.300 m and a barrel diameter of 1.600 m. The heights of the hearth, bosh, barrel and stack are 0.900 m, 0.800 m, 0.400 m and 2.400 m, respectively. The maximum charging level is 2.6 m, above the level of the tuyeres with a maximum working volume of 6.08 m^3. The volume of the hearth is 1.19 m^3, giving a total volume of 7.27 m^3, while its cross sectional area is 1.32 m^2. A hopper and two revolving drums, each having a small segment open and distributor comprise the charging mechanism. The furnace bottom, hearth and bosh are lined with carbon blocks. It is lined with high alumina bricks (40-42% Al_2O_3) around the tuyeres, and the shaft is lined with fireclay bricks (36-39% Al_2O_3) around the tuyeres. The air blast is supplied by a single-stage turbo blower having an intake capacity of 5,000 m^3/hr with an output pressure of 0.28-0.35 kg/cm^2. The blast is preheated to 600°C in a metallic tube type recuperator heated by the combustion of cleaned low-shaft furnace top gas. The hot blast goes to the Bustle pipe then through four water cooked tuyeres, each of 100 mm diameter, into the furnace with a velocity of 95-100 m/s and at a pressure of 3,000 mm H_2O. The tuyere diameter can be decreased by the insertion of reducers. The furnace shell is externally water cooled. The tap hole and slag holes are at an angle of 180°, the slag hole being located 450 mm above the tap hole. Figure 6-A shows a section through the shaft and hearth of this furnace and Figure 6-B is a picture of the general view of the plant.

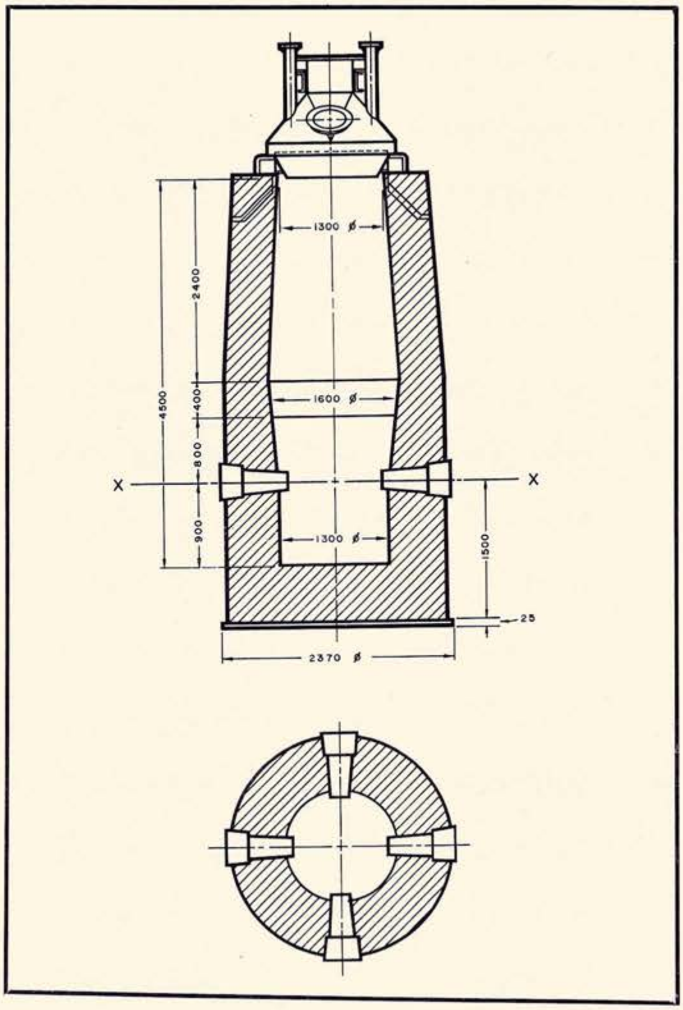

Fig. 6 - A section through shaft & hearth of the Jamshedpur low-shaft furnace.

Results of Operation

The operation of the furnace is by a series of campaigns in which a particular test is performed during each campaign. The program of research and development work adopted was divided into the following phases:

PHASE I

Smelting tests were performed using the following raw material combinations:

1. Iron ore from Orissa and Bihar with non-coking coals from Raniganj and Dishergarh coal fields either in bedded charge or by briquetting iron ore, limestone and non-coking coal.
2. Iron ores from Chanda district and non-coking coals from Ballarpur, Kamptee and Wardha Valley, Maharashtra State.
3. Iron ores from Chapra, Antribeharipur in Mahindergarh, Punjab, with nutcoke or non-coking coals.
4. Iron ores from Anantpur, Warangal, etc. with non-coking coals (and low-temperature carbonized coke made thereof) from Kothagudem Yellandu, etc. in Andhra Pradesh.
5. Iron ore from Katni in Madhya Pradesh with non-coking coals from adjacent coalfields (Kanhan and Pench Valleys).
6. Iron ores from Nathare-ki-Pal near Udaipur and Morinja (Chomu-Samond) near Jaipur, Rajasthan, initially with nutcoke and then with high temperature carbonized Palana lignite.

PHASE II

Smelting of self-fluxing briquettes made from iron ores, fines limestone and non-coking slack coals.

PHASE III

1. Utilization of lignites after its high temperature carbonization for iron smelting.
2. Utilization of Salem magnetite after its benefication and agglomeration by pelletizing or briquetting in conjunction with carbonized lignite briquettes.

PHASE IV

Research and development work on oxygen enrichment of air blast, direct injection of naphta and furnace oil, including low-shaft furnace clean gas through auxiliary tuyeres and study of overall economics of production of such operations.

PHASE V

Utilization of agglomerated fine-grained iron ores, blue dust in the form of sinters, self-fluxing sinter, pelletizing and briquetting and study of fuel requirements, etc.

PHASE VI

Production of ferro-alloys, such as ferro-manganese with or without oxygen injection.

As of 1966, thirty-three campaigns of extensive investigations from Phase I up to the first half of Phase IV were completed.

The first few campaigns were essentially investigations on the adaptability of the single-staged Demag-Humboldt process to low grade Indian raw materials. Tables VIII, IX, X, XI and XII show the raw material analysis and the composition of briquettes. The composite self-fluxing briquettes required 4% of sulphite lye and 4% of coal tar pitch as binders. For exclusive operation using briquettes only the specific consumption was 6.7 tons of briquettes per ton of pig iron or an equivalent fuel rate of 3.95 to 4.32 tons of coal per ton of pig iron.

The operation was characterized by heavy dust losses which amounted to 10% of the burden weight or 670 kilos/ton of pig iron, serious hangings and recurrent blockage which resulted in discontinuous smelting operations. The Demag-Humboldt process was therefore discarded because it proved unpractical and uneconomical under India's conditions. Table XIII shows the result of the low-shaft furnace operation using one component briquettes.

TABLE VII — OPERATING CHARACTERISTICS OF THE METALLURGY AND CERAMICS INSTITUTE'S 0.96 m^3 EXPERIMENTAL BLAST FURNACE OF THE PEOPLE'S REPUBLIC OF CHINA

A. RAW MATERIAL ANALYSES

Components, %	Pao-t'ou Ore	Sinter I	Sinter II	Sinter III	Manganese Ore	Limestone
Fe (total)	55.82	50.42	50.11	54.05	17.86	—
MnO (Mn)	0.25	0.57	0.55	0.95	(38.59)	—
CaO	9.20	10.90	10.22	8.14	0.48	55.57
MgO	1.21	1.29	1.28	1.18	0.05	0.18
SiO_2	2.27	12.25	12.93	9.84	5.94	0.22
Al_2O_3	0.28	2.00	2.42	1.68	1.66	0.22
P_2O_5	0.53	0.64	0.49	0.53	0.07	—
S	0.14	0.18	0.18	0.17	0.01	—
Na_2O	0.14	0.20	—	—	—	—
K_2O	0.12	0.14	—	—	—	—
F	3.98	1.18	1.07	1.08	—	—
Ignition loss	3.07	—	—	—	10.92	43.74
Moisture	0.08	0.01	—	—	—	—

COMPONENTS, %	COKE I	COKE II
Moisture	2.32	0.37
Volatile Matter	3.08	2.34
Fixed Carbon	81.22	83.88
Fe_2O_3	0.90	0.75
CaO	0.96	0.90
MgO	0.21	0.18
SiO_2	5.93	5.52
Al_2O_3	4.57	1.45
P_2O_5	0.07	0.13
S	0.62	0.62
Na_2O	0.11	0.10
K_2O	0.07	0.07

B. Raw Material Consumption:

	Operation with 100% Pao-t'ou ore	Operation with 100%, Sinter
Pao-t'ou ore, kg/t pig iron	1679	—
Sinter I, kg/t pig iron	—	349
Sinter II, kg/t pig iron	—	522
Sinter III, kg/t pig iron	—	1003
Manganese Ore, kg/t pig iron	47	73
Limestone, kg/t pig iron	212	383
Coke I, kg/ pig iron	—	940
Coke II, kg/t pig iron	1112	1074

C. Operational Data:

Blast temperature, °C	550	610
Production, t.p.i./day	2.205	1.482
Slag yield, kg/t pig iron	562	908
Top gas temperature, °C	330	380
Dust loss, kg/t pig iron	34.5	45.4

D. Product Analyses:

Pig Iron, Weight %		
Si	0.06-0.43	0.73-1.65
Mn	1.24-1.89	1.69-2.69
S	0.018-0.044	0.016-0.044

TABLE VIII – CHARACTERISTICS OF INDIAN IRON ORES

Location	Fe, %	SiO_2, %	Al_2O_3, %	S, %	P, %	Fusion point, °C	Particle size mm
1. Barjamba (Orissa)	59.92—	3.20—	4.10—	0.01—	0.02	1580	52% —12+3
	64.50	6.34	5.20	0.29			45% —3
2. Barbil (Orissa)	57.70	2.20	9.50—	0.31	0.04	1475	43% —12+6
	61.10	4.11	12.10				20% —6
3. Barbil (Orissa)	64.14	3.28	4.57	0.01	0.02	1450	43% —12+6
							53% —6
4. Noamundi (Bihar)	63.00	3.50	6.00	0.04	0.13	1450	64% —25+12
							24% —12
5. Andhra Pradesh	63.64	3.80–	2.00—	0.03	0.06—	1424	60% —25+12
		4.60	5.90		0.12	1500	40% —12
6. Chanda (Maharashtra)	64.30	3.10	2.50	Trace	0.03	1530	—30+5
7. Mohindergarh (Punjab)	62.60	6.65	2.00	0.03	0.40—	14 24	75% —12+3
8. Chomu-Samod Morija	61.60	9.90	1.20		1.20		15% —3
(Rajasthan)				0.20	0.05	14 75	—30+5
9. Bolani (Orissa)	57.00	5.00	6.50	0.03	0.05		96% —3
10. Deulgaon (Maharashtra)	64.40	54.44	2.00	0.089	Trace	—	60% —25+12
							20% —12
11. Khursipar (Maharashtra)		1.04	5.12	0.096	0.027	—	57% —25+12
							23% —12
12. Phul Choki Godvari (Nepal)	60.00	9.00	2.80	0.038	0.01	—	72% —25+12
							12% —12+6

TABLE IX — ANALYSES OF INDIAN LIMESTONE AND DOLOMITE

Source	CaO, %	SiO_2, %	Al_2O_3, %	MgO, %	Particle size, mm	
1. Birmitrapur (Orissa)	44.80	6.96	1.60	3.57	35%	—25+12
2. Warrangal (A. Pradesh)	32.20	0.30	0.56	25.00	62%	—25+12
3. Salem (Madras)	54.31	0.88	1.23	1.01		—75+12
4. Rajur (Maharastra)	47.28	6.68	0.85	3.45	75%	—25+12
5. Birmitrapur (Orissa)	32.60	3.90	1.60	20.40	36%	—25+12
6. Assam/W. Bengal	31.30	0.63	0.40	20.70	87%	—25+12

TABLE X — PROXIMATE ANALYSES OF INDIAN NON-COKING COALS

Source	Moisture, %	V.M., %	F.C., %	Ash, %	S, %
1. Jambad (Raniganj)	3.50	39.94	41.10	20.50	0.40
2. Samla (Raniganj)	4.50	34.00	47.50	14.00	1.01
3. Ghusick-Muslia (Raniganj)	4.50	31.10	38.80	25.60	—
4. Jaipuria (Raniganj)	3.20	35.00	41.00	20.50	0.39
5. Sirka (Bokaro)	3.50	30.80	49.52	19.70	0.63
6. Saunda (Bokaro)	3.70	31.00	51.50	9.80	0.54
7. Khaskenda (Bokaro)	6.60	35.90	45.20	12.30	0.48
8. Real Jambad (Bokaro)	4.70	33.60	43.90	17.80	0.31
9. Bankola (Raniganj)	4.00	32.00	44.56	19.40	—
10. Central Satgram (Raniganj)	3.40	36.00	43.00	17.60	0.44
11. Saltore (Raniganj)	2.50	36.40	48.80	12.30	0.53
12. Ghughus (Maharashtra)	9.70	34.40	42.80	13.10	—
13. Kamptee (Maharashtra)	5.00	34.00	37.80	23.40	1.30
14. Hindusthan (Maharashtra)	5.30	32.70	45.80	16.20	—
15. Singareni (Andhra)	7.10	26.10	49.50	17.50	0.21
Washed Coking Coals:					
16. Kargali (Bokaro)	1.20	30.00	56.60	12.20	—
17. New Sitalpur (Disergarh)	1.50	36.30	49.30	12.90	—

TABLE XI — ANALYSES OF COAL ASH

Source	SiO_2, %	Al_2O_3, %	CaO, %	MgO, %	Fe, %	P, %
1. Jambad	57.85	22.28	—	2.90	6.94	0.59
2. Samla	62.96	22.82	4.56	1.63	5.09	0.60
3. Ghusick-Muslia	63.73	21.93	1.09	2.40	5.43	0.15
4. Jaipuria	53.28	23.00	5.43	1.63	9.18	0.51
5. Sirka	54.26	27.26	2.74	1.05	6.57	0.50
6. Saunda	61.20	31.90	2.70	3.10	2.70	0.46
7. Khaskenda	49.04	24.93	2.44	1.33	4.37	0.59
8. Real Jambad	61.50	27.80	2.10	2.20	4.40	0.33
9. Bankola	56.30	24.46	10.42	0.39	4.59	0.377
10. Central Satgram	58.12	25.74	3.07	1.27	6.44	0.61
11. Saltore	50.00	30.52	6.60	3.12	3.47	0.29
12. Ghughus	57.80	35.00	3.70	2.80	0.59	—
13. Kamptee	55.00	34.90	2.90	3.20	2.90	0.11
14. Hindusthan	42.80	47.00	3.80	2.30	1.80	—
15. Singareni	65.60	22.80	1.30	1.40	6.30	0.058
16. Kargali	46.30	29.70	3.92	3.35	5.88	0.33
17. New Sitalpur	54.40	25.30	6.60	2.50	4.10	0.90

TABLE XII — COMPOSITION OF BRIQUETTES

Type	Washed Coking Coal		Non -Coking Coal		Total Coal, %	Iron Ore Fines, %	Lime-stone Fines, %
	Source	%	Source	%			
I	Kargali	27.7	Central Satgram	36.1	63.8	18.2	18.2
II	Kargali	30.0	Saltore	34.4	64.4	23.6	12.3
III	—	—	Saltore	64.5	64.5	23.2	12.3
IV	Kargali	41.5	Bankola	20.5	62.0	25.0	13.0
V	New Sitalpur	40.0	Sirka	19.0	59.0	25.0	19.0

The succeeding campaigns were investigations on the direct use of non-coking coals having poor coking index in a bedded form of charge. Tables X and XI show the characteristics of the coals used. The operation of the furnace was characterized by descent of the charge stock in irregular slips, heavy dust losses amounting to 10-12% of burden weight, poor permeability of the charge stock and wide variation in the composition of pig-iron and slag. Based on the results obtained it was concluded that direct utilization of non-coking coals was impractical because of 1) heavy dust losses, 2) development of abnormally high pressure inside the furnace, due to formation of fluidized hanging bed of friable coal charged, 3) chilling of the hearth following hanging and slips, and 4) production of unacceptable grades of foundry iron and high fuel and flux rates.

Extensive campaigns were next conducted using two kinds of low temperature carbonized coke made exclusively from non-coking coal by the Regional Research Laboratory of the Council of Scientific & Industrial Research at Hyderabad and the Central Fuel Research Institute of the CSIR. Their characteristics are shown in Tables XIV and XV. The smelting operations were characterized by very regular burden descent, absence of bridging or hanging in the furnace stock and the incidence of chilling of the hearth.

The result of smelting operation using Kolsit made at the RRL is shown in Table XIII. Two types of burden were used, one consisted of iron ore, limestone and dolomite, having a particle size of $-100+75$ mm and the other type consisted of iron ore and dolomitic limestone. In the smelting operations using CFRI low temperature-coke (LTC), iron ores of two different particle sizes and a blended flux were employed. The fuel rate of 2.03 tons/ton of pig iron decreased to 1.81 tons/ton with the fineness of size of the iron ore yielding slag rates of 1.65 and 1.52 tons/ton pig iron, respectively. The high ash content of 28% in the LTC led to high slag volumes while its large particle size contributed to higher top gas temperature and increased CO/CO_2 ratio.

10. THE J. PANGANIBAN LOW-SHAFT FURNACE OF NASSCO

The J. Panganiban low-shaft furnace which has a rated capacity of 40 tons of pig iron per day was constructed in 1962 at Jose Panganiban, Camarines Norte by NASSCO to utilize raw materials indigenous in the region. Abundant iron ore deposits are found in the region and there are coal deposits in the neighboring islands of Polilio and Catanduanes. Limestone deposits are also found in the region.

This low-shaft furnace is the circular version of the previous oval low-shaft furnace at Ougrée. Both furnaces were designed by the firm "Stein et Roubaix" of Belgium. The Panganiban furnace has a slightly bigger working volume but it can operate under normal pressure only with a maximum hot blast temperature of 600°C.

The maximum working height is 6.000 m and the corresponding working volume is 30 m^3. There are six air tuyeres set 60° apart around the tuyere belt, two slag tuyeres and a taphole. The taphole and slag tuyeres are set 120° apart. The distance from the air tuyeres' level to slag tuyere no. 1, slag tuyere no. 2 and hearth floor are 0.300 m, 0.430 m and 1.400 m respectively. All the tuyeres which are made of forged electrolytic copper are internally water-cooled. The inside diameter of the air and slag tuyeres are 80 mm and 60 mm, respectively. The mounting and assembly of the tuyeres' system is similar to that of a blast furnace.

The refractory linings are of standard blast furnace alumina-silica grades but of smaller sizes. The alumina content varies from 32 to 48% from the top of the stack to the hearth. The spaces between the refractory bricks and steel shell is filled with carbon paste. The shell is externally cooled by water sprays.

The furnace top charging system is of the standard McKee type with a revolving hopper, a small bell and big bell. Raw materials are brought to the top by a skip hoist.

The air blast is supplied by three centrifugal fan blowers connected in series, two of which are used, with the third on reserve. Each blower is capable of delivering 8000 SCM/hr. of blast at a pressure of 2000 mm H_2O. The blast is heated in the metallic tube type recuperator of the air preheater where it flows countercurrent to the hot flue gas supplied by the combustion of clean recycled top gas in the combustion chamber under the recuperator.

The top gas is cleaned in either of the two lines of the gas cleaning plant. Each line has a water seal valve, a primary gas scrubber, a secondary scrubber, disintegrator and a droplet separator.

Results of Operation

Eight campaigns have already been undertaken in the Panganiban Low-Shaft Furnace with an aggregate production of 4,745 tons of pig iron. The summary of these campaigns are as follows:

Campaign No. 1 – January 22-25, 1966
Pig iron production: 31 tons
Cause of stoppage: Inability to tap the furnace due to partial blockage of the hearth.

Campaign No. 2 – July 15-16 and 19-20, 1966
Pig iron production: Negligible
Causes of stoppage: For the first part of the campaign barely 10 hours after the furnace was fired, there was a partial blockage of the hearth as a result of an emergency shutdown because of a busted water cooling hose of an air tuyere. After restarting the furnace, the condition gradually became worse until the hearth became totally blocked so that the operation was temporarily stopped to partially clear the hearth. Then the furnace was fired again but despite all the remedial measures, the blockage of the hearth persisted so that 16 hours later, the operation was stopped completely to totally clear the hearth.

Campaign No. 3 – August 6-8, 1966
Pig iron production: Negligible
Cause of stoppage: Total hearth blockage as a result of uneven descent of the burden due to a scaffold formed on one side of the bosh. The campaign was stopped 39 hours after the furnace was fired.

Campaign No. 4 – September 12-19, 1966
Pig iron production: 87 tons
Cause of stoppage: Collapse of the refractory wall lining of the combustion chamber for the air preheater.

Campaign No. 5 – October 17 to December 31, 1966
Pig iron production: 1,454 tons
Causes of stoppage: Explosion of slag tuyere No. 1. This was melted by pig iron that flowed with the slag during slag-off. The presence of pig iron in the slag was brought about by a partially blocked hearth as a result of successive emergency shutdowns prior to the explosion.

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TABLE XIII — OPERATIONAL CHARACTERISTICS OF THE NATIONAL METALLURGICAL LABORATORY LOW-SHAFT FURNACE OF INDIA

Ore (Table, No.) — Fuel (Table, No.) Limestone (Table, No.)	Briquettes	X-15 VIII-5 IX-1	XIV-3 VIII-5 IX-2	XIV-4 VIII-5 IX-2, 3	XIV-6 VIII-10 IX-4	XIV-5 VIII-10 IX-4	XIV-1 VIII-10 IX-4	XIV-2 VIII-10 IX-4
Fixed Carbon rate, kg/t.p.i.		2000	1900	2200	1750	1900	1200	1500
Slag yield, kg/t.p.i.		1800	1350	1600	1600	1470	860	930
Blast flow, SCM/Hr		2700—2900	2600—2800	1950—2300	—	—	2350	1950
Blast pressure, mm H_2O			1800—2000	1500—1900	—	—	2000	1700
Blast temperature, °C		580	595	500	480	530	500	500
Top gas temperature, °C		530	385	400	450	460	475	420
Dust loss, %		5.00	3.0	9.0	4.20	4.50	2.00	3.0
Average Product Analyses:								
Pig iron, Weight %								
C	2.8 —3.75	3.25	3.5	2.75	2.54	2.70	2.60	2.80
Si	2.5 —4.0	—	3.75	3.60	3.70	3.50	3.50	3.20
S	0.01—0.1	0.12	0.06	0.13	0.09	0.08	0.06	0.07
Slag, Weight %								
CaO	34—41	38.6	35.00	32.50	36.80	34.10	36.50	38.30
MgO	—	—	18.00	6.40	8.00	7.40	6.70	4.30
SiO_2	30—36	35.3	35.00	37.50	35.13	35.50	30.30	35.30
Al_2O_3	22—24	—	17.00	19.80	24.00	26.20	18.70	20.70
FeO	0.5 —0.9	0.6	0.80	3.60	0.80	0.70	0.90	0.60
Top gas, Volume %								
CO	24.0	23.0	25.00	25.20	25.47	24.50	25.20	25.60
CO_2	4.5	4.2	5.00	3.80	3.65	3.70	4.20	4.50
CH_4	5.5	8.1	7.00	5.80	3.72	4.20	3.60	3.50

TABLE XIV — PROXIMATE ANALYSES OF CARBONIZED FUELS

Nature of Fuel	Moisture, %	V.M., %	F.C., %	Ash %	S, %	Particle size, mm
1. Nut Coke	3.00	1.80	75.10	20.10	0.51	64% —24+12 27% —12
2. Pearl Coke	1.10	4.35	71.35	23.20	0.35	40% —25+12 60% —12
3. Kolsit L.T.C.* (R.R.L.)	2.30	8.90	65.67	21.20	0.26	34% —50+25 58% —25+12
4. L.T.C. (C.F.R.I.) (Raniganj Area)	5.80	4.60	61.60	28.00	0.27	50% —50+25 5% —25
5. L.T.C. (C.F.R.I.) (Wardha Valley Coals)	8.5	4.1	61.5	25.9	0.23	48% —50+25 38% —25
6. L.T.C. (R.R.L.) (Wardha Valley Coals)	0.75	13.09	54.42	31.74	0.36	48% —50+25 32% —25

TABLE XV — ASH ANALYSES OF CARBONIZED FUELS

	SiO_2, %	Al_2O_3, %	CaO, %	MgO, %	Fe, %	P, %
1. Nut Coke	52.10	33.00	3.80	2.10	6.00	0.43
2. Pearl Coke	55.28	25.10	4.85	2.50	7.80	0.35
3. Kolsit L.T.C. (R.R.L.)	62.07	22.72	1.59	2.18	7.60	0.11
4. L.T.C. (C.F.R.I.) (Raniganj Area)	56.31	22.00	3.45	2.20	7.61	0.50
5. L.T.C. (C.F.R.I.) (Wardha Valley Coals)	53.80	28.00	5.68	1.88	4.60	—
6. L.T.C. (R.R.L.) (Wardha Valley Coals)	50.1	31.02	9.47	Trace	6.20	0.36

* Low Temperature Carbonized Coke

TABLE XVI — OPERATING CHARACTERISTICS OF THE J. PANGANIBAN LOW-SHAFT FURNACE DURING CAMPAIGN NO. 7

A. RAW MATERIAL CHARACTERISTICS.

Components (dry basis), %	Manganese Ore	Iron Ore	Limestone	Coke
Fe (total)	9.99	56.95	—	—
FeO	—	7.28	0.52	0.97
Fe_2O_3	—	73.45	—	—
MnO	31.29	0.13	0.01	0.01
CaO	0.91	0.19	52.87	0.30
MgO	—	0.12	0.52	0.14
SiO_2	25.14	7.97	1.98	4.23
Al_2O_3	—	2.11	1.17	3.59
P_2O_5	—	0.19	0.04	0.10
S (total)	0.02	0.30	0.01	0.54
Ignition loss	—	—	41.62	—
Volatile Matter	—	—	—	3.13
Ash	—	—	—	10.03
Fixed Carbon	—	—	—	86.84
Moisture		4.16	2.15	23.73

Screen Analyses Weight %

Size, mm	Iron Ore	Limestone	Coke
+30	6.56	26.03	0.78
+25 —30	28.01	20.47	9.22
+20 —25	28.96	19.98	38.20
+15 —20	28.33	21.45	37.57
+10 —15	3.54	3.59	3.93
+ 5 —10	3.40	5.64	6.45
—5	1.20	2.84	3.85

B. RAW MATERIAL CONSUMPTION (DRY BASIS):

		Cost/t pig
Iron Ore kg/t pig iron	1782	₱72.60
Manganese ore, kg/t pig iron	23	1.60
Limestone, kg/t pig iron	335	10.60
Coke, kg/t pig iron	1140	139.00
Blast (calculated), SCM/t pig iron	3135	—

C. OPERATIONAL DATA:

Blast flow (calculated)	3970 SCM/hr
Blast pressure	140— 220 — mm Hg
Blast temperature	600°C
Stock height	5.2—5.6 m
Production	30.4 t pig iron/day
Slag yield	450 kg/t pig iron
Top gas flow (calculated)	5365 SCM/hr
Top gas pressure	300 mm H_2O
Top gas temperature	180—320°C

D. PRODUCT ANALYSES:

1. Pig iron	Weight %
C	3.39
Mn	0.63
Si	2.46
P	0.10
S	0.10
Range of S	0.02—0.24

2. Slag (tapping sample)	
CaO	38.24%
SiO_2	32.08%
Al_2O_3	19.46%
FeO	3.17%
MnO	0.51%
S	1.46%

3. Gas	Volume %
CO	30.0
CO_2	7.87
H_2	2.48
N_2	balance
Calorific Value (calculated)	978 kcal/SCM

Campaign No. 6. — August 9 to November 5, 1967
Pig iron production: 1,761 tons
Cause of stoppage: Chilled hearth as a result of unprepared shutdown due to total power failure brought about by a typhoon.

Campaign No. 7. — February 4 to March 24, 1968
Pig iron production: 1,333 tons
Cause of stoppage: Chilled hearth as a result of strong water leakage into the furnace from a burned air tuyere.

Campaign No. 8 — March 14-27, 1969
Pig iron production: 79 tons
Cause of stoppage: Total hearth blockage due to irregular burden descent and excessive fines in the charge.

Operational Data

The results of Campaign No. 7 are shown in Table XVI. This was the campaign with the most comprehensive data. All figures given here represent the average for the whole campaign.

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Note: To be continued — Philippine Metals Vol. II No. 2

The following treatise attempts by means of a simplified representation to explain some elementary facts in the heat treatment of steel. Its scope is limited only on the influence of temperature and change of temperature on plain carbon steels (where other alloying elements are not specifically mentioned).

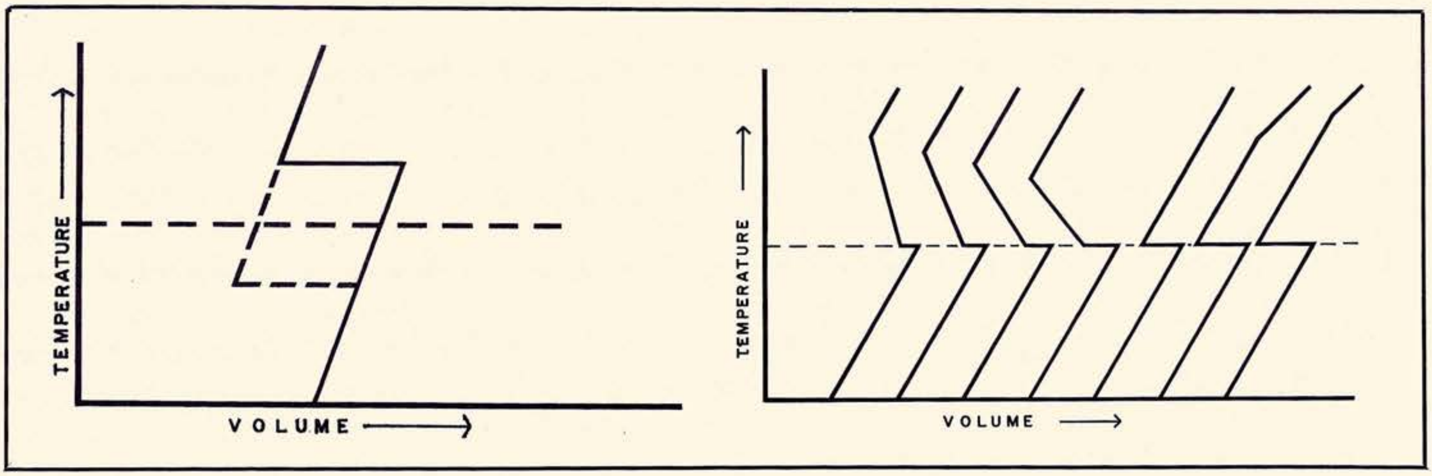
PART I

Some Elementary Problems in the Heat Treatment of Steel

by H. Wicke of Messrs. DEGUSSA, Frankfurt/M., Germany

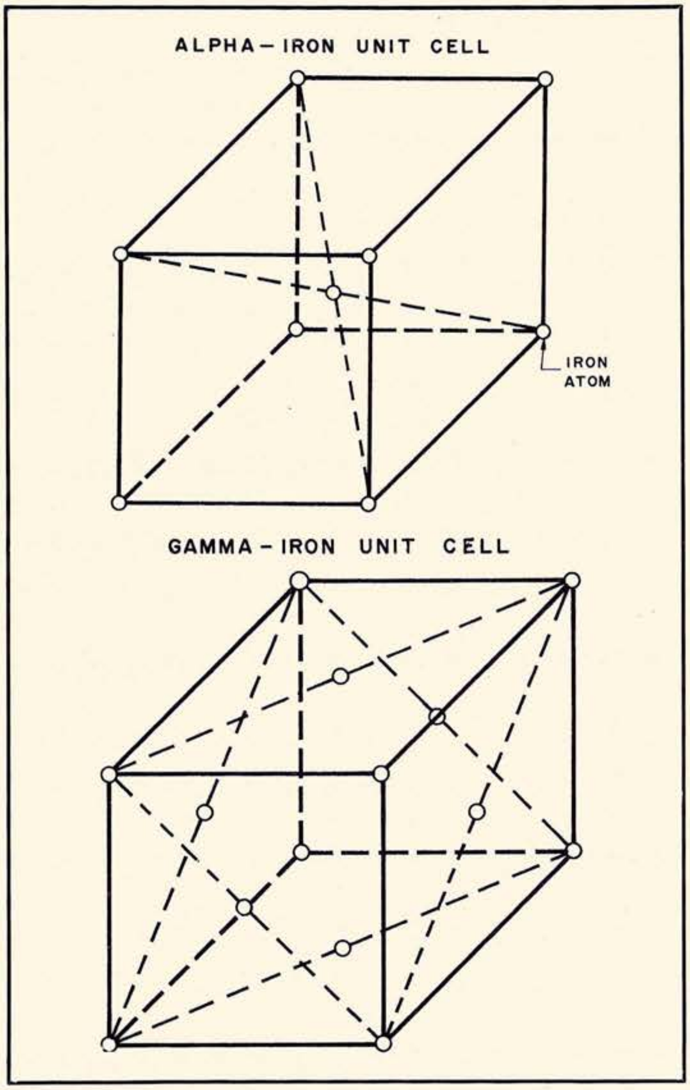
IT is a well known fact that steel exposed to heat begins to expand. The transfer of calorific energy to a piece of steel results in an increase in its volume. If one examines this expansion on a steel sample to start with simple conditions we take a sample of a eutectoid steel, i.e. a steel consisting of Fe with app. 0.87 per cent C in relation to temperature one will at first observe a direct interdependence between the transfer of calorific energy, the rise of temperature and the increase in volume. However, upon reaching a temperature of above 700 degrees centigrade suddenly an unexpected phenomenon occurs: in spite of continued heating the steel sample spontaneously contracts a bit while showing no further rise in temperature. In other words, there is a sudden decrease of volume at halted temperature in spite of continued transfer of calorific energy. After reaching a certain degree of contraction the steel sample soon restarts to increase its volume with the same dependence on heat and temperature as before. These normal conditions then prevail until the steel reaches its melting point.

On slowly cooling down the steel sample from its solidification point the same phenomena will occur in reverse order, the only difference being that the sudden alteration of volume will take place at a somewhat lower temperature. Apparently this sudden phenomenon occurs with a certain retardation. In the following graph showing the relation between temperature and volume (even and continual



heating and cooling is understood as a precondition) the diagram produced by heating is marked by "C" (Chauffage) and the diagram resulting from cooling by "R" (Refroidissement). Since the above-mentioned retardation is of no importance in the context of this treaties we may neglect these slight differences taking for convenience the theoretical mean temperature, i.e. 721 °C, at which the described sudden alteration of volume occurs.

In describing this phenomenon special emphasis must be placed on the fact that it occurs spontaneously either with absorption of calorific energy on heating up or release of heat on cooling down. Apparently some regrouping of matter, requiring a certain amount of energy, is taking place. Radiographic examinations show that below 721 °C the arrangement of the iron atoms differs from and occupies a larger volume than the arrangement of the iron atoms above the temperature. In the first instance the individual iron crystals are built up by a cubic body centered atomic lattice (called alpha-iron) whereas in the second instance above 721 °C the crystals consist of a cubic face centered atomic lattice (called gamma-iron). A unit cell of these atomic lattice can be represented as shown.



Iron crystals of alpha-structure are called "Ferrite"; Iron crystals of gamma-structure are called "Austenite." Iron crystals of alpha-structure containing in addition carbon in the form of iron-carbide (normally segregated within the Ferrite as lamellae) are called "Pearlite".

Our previous observations were directed to the behavior of eutectoid steel, i.e. a steel every crystal of which contains carbon (iron carbide) or, in other words, which consists of pure Pearlite.

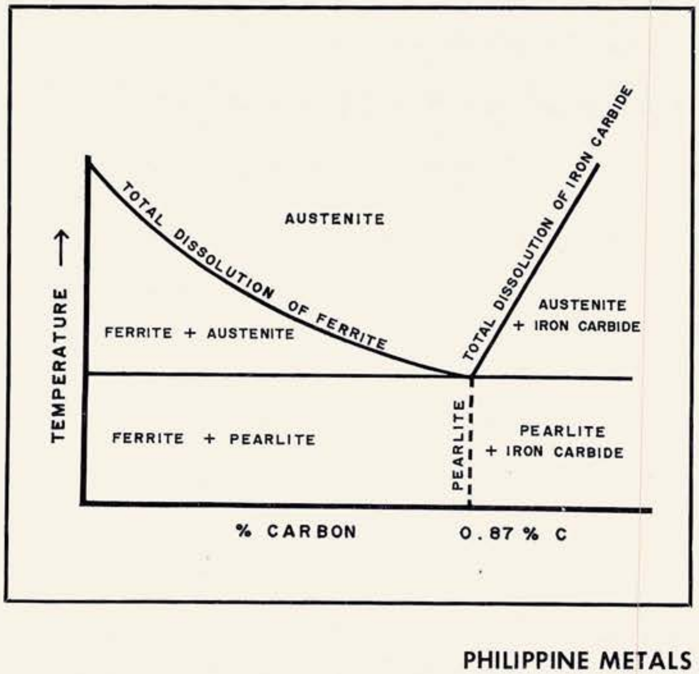
If we applied the above described test to steels with a lower or higher carbon content we would get the following diagrams (for convenience arranged in the order of their carbon content).

We find that the hyper-eutectoid steels (steels with more than 0.87 per cent C) show the same sharp contraction of their volume at 721 °C (i.e. undergo a total transformation from Pearlite to Austenite) as the eutectoid one but after this sharp contraction they start expanding at a reduced rate until reaching a certain point (the height of which depends on the carbon content) before resuming the usual rate of expansion. The hypo-eutectoid steels (steels with less than 0.87 per cent C) also show the expected sharp contraction at 721 °C but only to a lesser extent, graded according to their respective carbon content, while afterwards the contraction continues at a much slower pace with the temperature slowly rising again. After a certain interval the slow contraction stops and the steel resume their normal expansion. The total amount of the decrease of volume is practically equal for all hypo-eutectoid steels: only the transformation of their structure and with it their contraction takes place at different rates, while protracting over different intervals of temperature. These differences are correlative to the various carbon contents of the steels.

Translating the phenomena into terms of transformation we may say that only the eutectoid steel transforms at 721 °C without delay from Pearlite (alpha-structure with iron carbide) into homogeneous Austenite whereas hypo-as well as hyper-eutectoid steels execute their transformation into homogeneous Austenite with a certain retardation correlative to their respective carbon content.

For hyper-eutectoid steels this retardation is due to a high percentage of carbon. At room temperature a crystal or grain with alpha-structure can absorb only up to 0.87 per cent carbon in form of iron carbide (not as free carbon); if a steel contains more than 0.87 per cent C the additional iron carbide must segregate mainly along the grain boundaries. On reaching 721 °C the iron carbide within the eutectoid Pearlite crystals dissolves and transforms into Austenite (a so called solid solution) in which the carbon freely disperses. However, at 721 °C the solid solution can absorb no more than 0.87 per cent C as a maximum. The higher iron carbide content of the hyper-eutectoid steel can be dissolved and put into the form of solid solution only after the absorption power of the Austenite is increased by a further rise of temperature.

The retardation of the transformation of hypo-eutectoid steels is due to their being — at room temperature — a mixture of eutectoid Pearlite crystals and (iron-carbide free) Ferrite crystals. In the alpha-structure carbon does not evenly disperse but always flock together to precipitate as iron carbide within individual eutectoid Pearlite crystals. When heated to 721 °C all pearlite crystals transform into Austenite as described above, producing the sharp contraction more or less conspicuously according to the original number of Pearlite crystals, i.e. according to carbon content. The carbon atoms having been set free after dissolution of the iron-carbides during transformation are now freely dispersing not only in the Austenite but, with the further rise of temperature, also tend to penetrate into the neighboring Ferrite crystals which have still remained in their alpha-structure. As the solubility of free carbon in Ferrite is very limited, a supersaturation of the remaining Ferrite with consequent instability soon results. This instability, increasing with the rise of temperature, causes the remaining Ferrite gradually to transform into Austenite whereby a slow contraction of the steel is taking place until the whole material has attained a homogeneous austenitic structure. It is obvious from the foregoing that the lengths of the temperature interval over which the total conversion into Austenite is achieved must depend upon the respective carbon content of the steel.



The range of temperature over which all these transformations take place is commonly called "critical range". It stands to reason that the described transformation from Ferrite or Pearlite into Austenite or vice versa entails a thorough recrystallization of the steel.

These considerations and the curves developed above enable us to draw the following diagram which turns out to be the part of the iron-carbon equilibrium diagram which is most important for the heat treatment of steel.

From the previous theoretical considerations the following practical conclusion can be drawn:

1. A steel may show poor machinability causing abnormal wear of tools. This resistance may be due to the considerable hardness of the iron-carbides which, in an annealed steel, tend to segregate in lamellar form (pearlite). When machining such a steel, these hard lamella have to be cut by the edge of the tool causing a much greater wear of the latter than the cutting of the comparatively soft Ferrite.

   We found that iron carbide dissolves during the transformation of Pearlite into Austenite. This dissolution does not occur suddenly but is prepared beforehand during the pearlite's approach to 721° C by a gradual coagulation of the iron carbide lamella into a number of separate parts which in turn tend to contract into small spheroids. If enough time is given to the latter process the lamellar iron-carbides can thus be dissolved into speroidal particles. On subsequent cooling to room temperature the iron-carbides are retained in this speroidized form.

   Consequently, to save tools one can improve the machinability of a steel by heating it to a temperature just below its critical range and maintaining it on that temperature for a sufficient time followed by cooling down in still air. This process can be accelerated considerably by making the annealing temperature oscillate several times around 721°C before cooling.

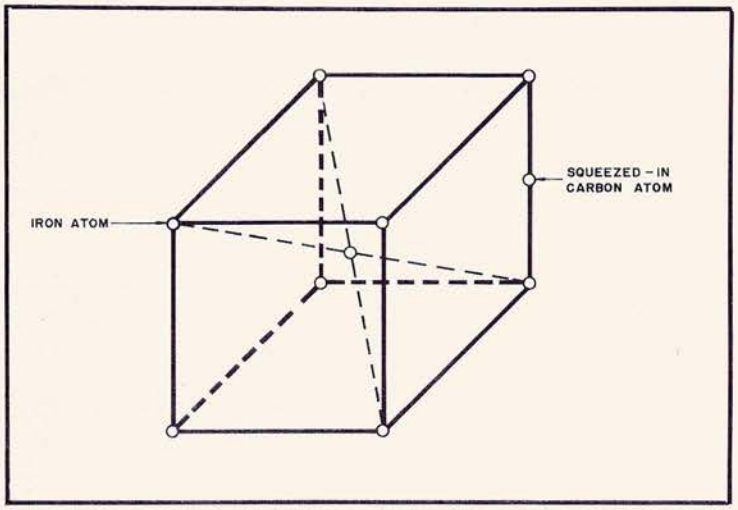
2. Coarse structure in a steel due to some previous heat treatment will entail brittleness. A mechanical reduction of the grain size by forging will be applicable in rare cases only. Fortunately, as we have seen above ferrite and Pearlite recrystallise during their transformation into Austenite. During this transformation large crystals or grains are liable to recrystallise into several smaller ones since they usually contain numerous recrystallisation nuclei. So, to diminish the grain size of a steel we have to heat it up to a temperature app. 30-50° above the critical range (to be sure that we have achieved total transformation) and then let it cool down in still air.

3. If a steel is impaired by an uneven distribution of carbon or other allyoying elements (e.g. oversaturation with carbon after carburisation of a case hardening steel) a sufficiently homogenous structure can be restored by thoroughly austenitising the steel (at app. 900-950°C) and keeping at this temperature for a sufficient time. As the austenitic structure allows atomic carbon to move freely and as the latter always tends to disperse evenly, a sufficient homogeneization can thus be achieved. Because of the considerable growth of grain size during the long stay on a comparatively high temperature a normalization must usually be carried out after this procedure.

Our previous considerations about the transformations of the atomic structure were based on tests in which steel samples were heated or cooled slowly, i.e. on the tacit precondition that the factor time was taken as a constant. Now we have to examine the influence of time upon these transformations.

Extremely slow heating or cooling as well as rapid heating would produce no essentially different phenomena. However, after a quick cooling of an austenitised steel sample (by quenching in water for instance) we will find that it has remarkably increased in volume compared with its previous size at room temperature and that it shows a better tensile strength or hardness. A metallographic examination would prove that we have actually come across a new structure called "martensite" which distinguishes itself from all other structures by its hardness. Radiographic investigation has made it clear that the iron atoms of Martensite obviously tend to regroup in the above described alpha-pattern but are impeded to do so by squeezed-in carbon atoms which, during the preceding austenitisation, had evenly dispersed in the gamma-lattice. The atomic lattice of Martensite could, therefore, be defined as a braced alpha-lattice the elementary cells of which are no longer cubic but slightly tetragonal — the latter fact explaining its remarkably increased volume.

A unit cell of this Martensite lattice can be represented as follows:

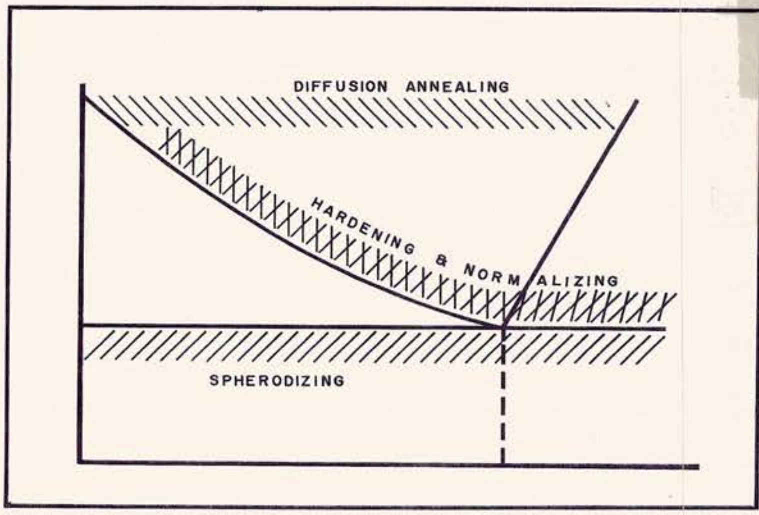


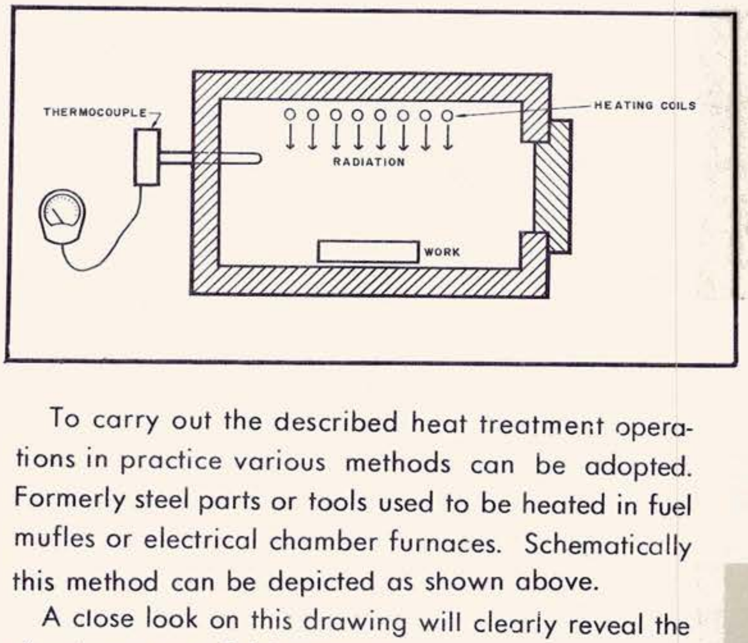
The described "bracing" of the Martensite lattice manifests itself in a substantial increase of the tensile strength or hardness of the steel. Thus, the degree of possible bracing or in other words the possible hardness of a steel will depend upon the amount of free carbon brought into solution during the preceding austenitisation. Full hardness is obtained at a carbon content of 0.7-0.9%; more carbon would "over-brace" the atomic lattice, i.e. produce undue brittleness.

Practical application of the foregoing: only steels with a sufficient (more than app. 0.3 per cent) carbon content may be called hardenable (of course there is no sharp limit to hardenability). To this end it has to be thoroughly austenitised by heating up to a temperature approaching 30 to 50°C above its critical range and then adequately quenched (e.g. in water).

It must be mentioned that normally the free iron-carbides of hyper-eutectoid steels should not be dissolved completely for two reasons: first because of the rather high temperature that would be required with its inherent danger of undue growth of grain size, and secondly because of the fact that an over-saturation with carbon would entail other detrimental effects (due to residual Austenite which is not to be discussed here) apart from the above-mentioned brittleness by "over-bracing".

For convenience the iron carbon equillibrium diagram is once more shown with indications for the approximate temperature for the most common heat treatment operations:





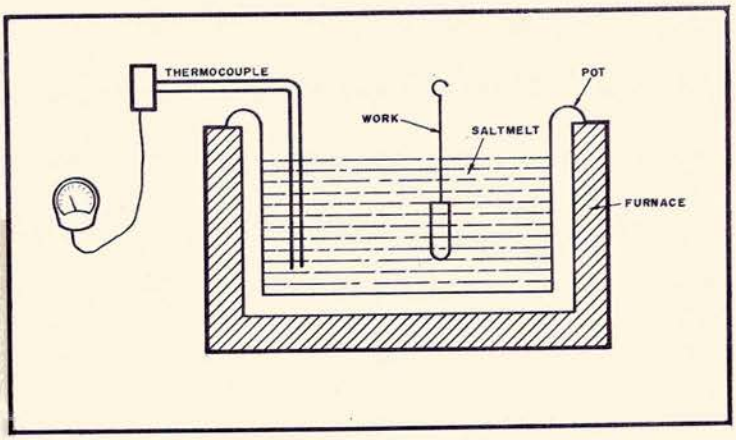
To carry out the described heat treatment operations in practice various methods can be adopted. Formerly steel parts or tools used to be heated in fuel mufles or electrical chamber furnaces. Schematically this method can be depicted as shown above.

A close look on this drawing will clearly reveal the disadvantages of this method:

1. Steel scales as it is always surrounded by oxygen-containing atmosphere.
2. Temperature control is rather inaccurate since the thermocouple is distant from the steel and thus it is not the temperature of the steel that is measured by the thermocouple but that of the atmosphere in the furnace chamber, the uniformity of which—as in all gaseous media — is insufficient.

3. Structure of steel tends to become coarse-grained, since in practice the poor control of heating in gaseous media used to be compensated, particularly above the critical range, by longer soaking at a somewhat higher temperature than strictly required.
4. Edges of steel are overheated (coarse grain) as they are open to direct radiation the temperature of which is practically uncontrolled.
5. Steel decarburises at temperatures above the critical range, and after quenching, its surface and particularly its edge will be soft—apart from their considerably increased susceptibility to crack on quenching.

For explanation of point number 5 it may be recalled that on top of the critical range in the austenitic structure the carbon atoms are able to move freely and tend to disperse evenly. This tendency of the carbon for even distribution is not restricted to the steel proper but the carbon atoms can even leave the surface of the steel if the latter is surrounded by a medium able to take up carbon (e.g. oxygen or carbon dioxide). This process uses to assume considerable proportions during the comparatively long time needed for heating a work in gaseous media. It stands to reason that a decarburised surface or edge of a work can never achieve the required hardness after quenching. The susceptibility of decarburised edges and surfaces to crack on quenching results because of their structure. Due to lack of carbon, decarburised edges and surfaces undergo a much lesser bracing, i.e. expansion, on Martensite transformation than the material underneath which has retained its high carbon content. The decarburized top layer is thus liable to burst under the stress from below.



To eliminate the described deficiencies the salt bath heat treatment has been developed during the last 30 years. Schematically this method — where the heating up to the required temperature is performed in a liquid salt melt — can be sketched as shown.

If we now compare the salt bath method with the chamber furnace in view of the five main drawbacks we will find the following conditions:

1. No scaling as steel is protected against access of oxygen by surrounding salt melt.
2. Accurate temperature control irrespective of distance of thermocouple from the steel due to uniformity of temperature in liquid media (tolerance plus or minus 1 °C).
3. No coarse-grained structure, since the heating process in liquid media is accurately controllable and soaking above the critical range can, therefore, be kept to the minimum of temperature and time required.
4. No overheating of edges as they are surrounded by the controllable and uniform temperature of salt bath.
5. No decarburisation of work because salt bath can be made absolutely inert in relation to iron or any of its alloying elements including carbon.

This comparison shows that — special cases apart — the salt bath can be considered as an ideal method for the heat treatment of steel.

(TO BE CONTINUED — PHILIPPINE METALS, VOL. II NO. 2).

THE MANTOS BLANCOS OPERATION

INTRODUCTION — Empresa Minera de Mantos Blancos S.A., operates a copper mine and treatment plant at Mantos Blancos, situated 45 kms. to the north-east of the city of Antofagasta Chile, a short distance from the Antofagasta-Calama road, and from the Antofagasta to Bolivia Railway. The company is a subsidiary of the Hochschild group, with participation of the Corporacion de Fomento de la Produccion (a government agency) and other smaller partners.

Operations were initiated at the beginning of 1961, after a period of 8 years of explorations, metallurgical investigation and engineering and construction works. From the date up to the end of July 1970 almost 15 million tons of ore have been mined and approximately 235,000 tons of fine copper produced in form of ingots and copper cement. Present production rate is 2,800 metric tons per month (2,300 tons ingots and about 500 tons cement).

Mineralogical and economic conditions were responsible for the adoption of a special chemical precipitation process for treating these ores, which made it possible to obtain metallic copper of high purity without electrowinning or refining, this being the first time that such process had been practiced on a commercial scale.

MINE — The deposit consists of several ore bodies, which have reserves of from 2 to 6 million tons each. The total presently known reserves of oxidized ores are in the neighbourhood of 20 million tons, with approximately 1.65% of soluble Cu. Although a certain quantity of sulphide ore exists, its tonnage is of minor importance so far.

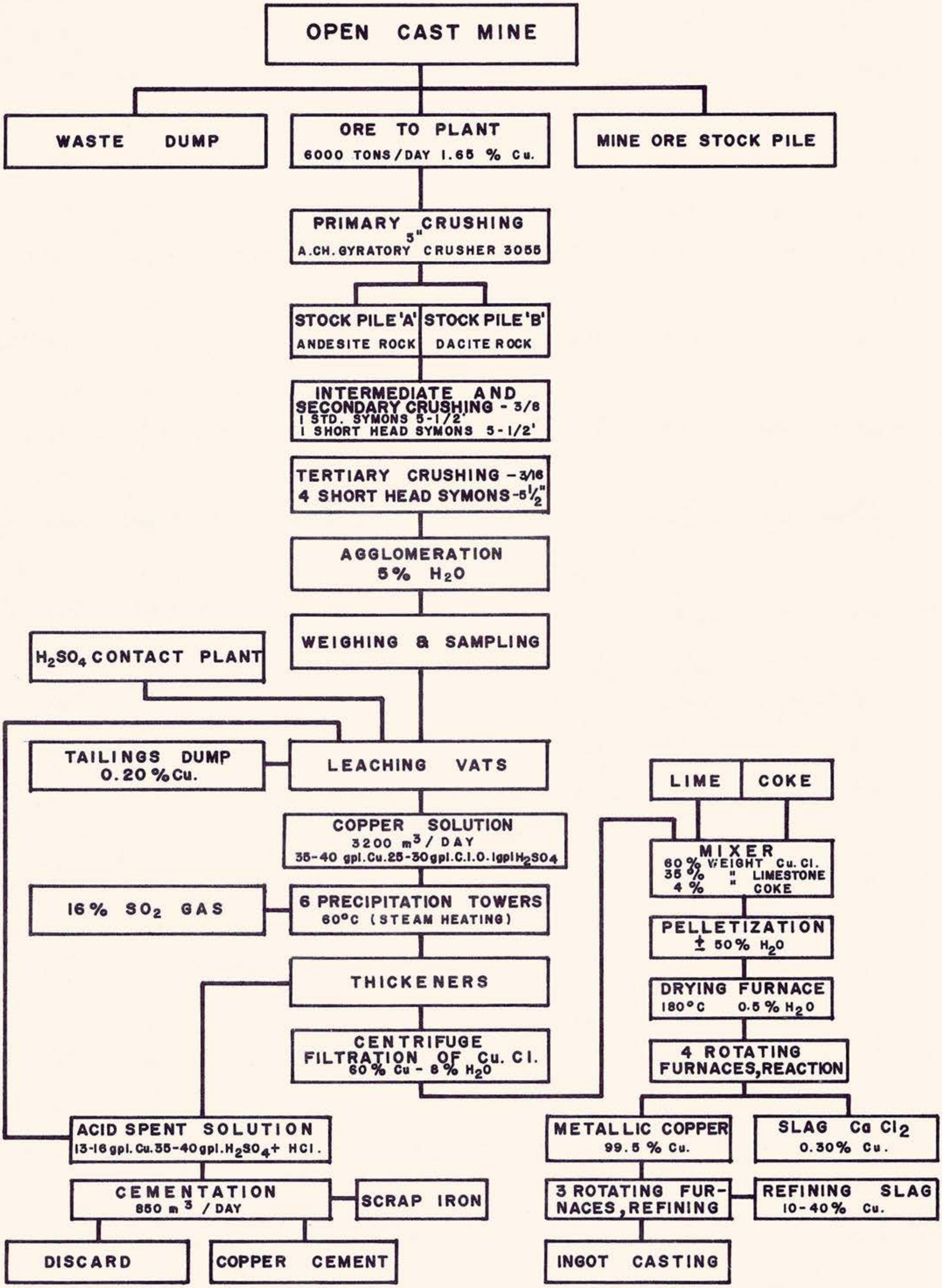
Predominant mineralogical species are atacamite (oxychloride of copper, $Cu_2(OH)_3Cl$) and chrysocolla* (silicate of copper, $CuSiO_3 \, 2H_2O$), which are accompanied as gangue by: rock salt (NaCl), gypsum and calcite. The host rock is principally made up of dacite and andesite. The copper minerals occur in fractures and cracks and also in the form of small disseminations in the rock; requiring, therefore, fine crushing in order to ensure satisfactory leaching extraction. Its hardness and abrasive nature make the drilling and crushing operations difficult and expensive.

Ore is extracted in an open cut, using 12-meter high benches and a final pit slope of 40°. Drilling is carried out with Reichdrill "down-the-hole" hammer drills and with Bucyrus-Erie Chrun-drills. Ammonium Nitrate mixed with petroleum ("Anfo") is used in blasting. The broken ore is loaded on to 25, 30 and 45 ton capacity Dart lorries by P&H 2 1/2 and 4 1/2 cubic yd. shovels. Under normal operating conditions, about 700,000 tons of rock are moved per month, of which 190,000 tons correspond to ore for treatment in the plant and the rest to submarginal ore and waste.

WINNING PLANT — (see Flow Sheet). The treatment of the ore up to the point of obtaining metallic copper comprises the following stages:

CRUSHING — In the primary gyratory crusher ore is reduced from run-of-mine size to approximately 10 to 12 cms. The crushed ore passes to a stockpile from which it is taken by an underground belt conveyor to the fine crushing section. The latter; consists of one 5 1/2 ft Symons Standard Secondary

*In the Philippines, copper is usually found in oxide or sulfide form. Small deposits of chrysocolla could be found here although as an accessory mineral.



OPEN CAST MINE
WASTE DUMP
ORE TO PLANT
6000 TONS/DAY 1.65 % Cu.
MINE ORE STOCK PILE
PRIMARY CRUSHING
5"
A.CH. GYRATORY CRUSHER 3055
STOCK PILE 'A'
ANDESITE ROCK
STOCK PILE 'B'
DACITE ROCK
INTERMEDIATE AND
SECONDARY CRUSHING - 3/8
1 STD. SYMONS 5-1/2'
1 SHORT HEAD SYMONS 5-1/2'
TERTIARY CRUSHING - 3/16
4 SHORT HEAD SYMONS - 5 1/2"
AGGLOMERATION
5% H2O
WEIGHING & SAMPLING
H2SO4 CONTACT PLANT
TAILINGS DUMP
0.20 % Cu.
LEACHING VATS
COPPER SOLUTION
3200 m3 / DAY
35-40 gpl.Cu.25-30 gpl.C.I.O. 1gpl H2SO4
16 % SO2 GAS
6 PRECIPITATION TOWERS
60°C (STEAM HEATING)
THICKENERS
CENTRIFUGE
FILTRATION OF Cu. Cl.
60 % Cu - 8 % H2O
ACID SPENT SOLUTION
13-16 gpl. Cu. 35-40 gpl. H2SO4 + HCl.
CEMENTATION
850 m3 / DAY
SCRAP IRON
DISCARD
COPPER CEMENT
LIME
COKE
MIXER
60 % WEIGHT Cu. Cl.
35 % " LIMESTONE
4 % " COKE
PELLETIZATION
± 50 % H2O
DRYING FURNACE
180°C 0.5 % H2O
4 ROTATING
FURNACES, REACTION
METALLIC COPPER
99.5 % Cu.
SLAG CaCl2
0.30 % Cu.
3 ROTATING FUR-
NACES, REFINING
REFINING SLAG
10-40 % Cu.
INGOT CASTING

crusher, one Symons Shorthead 5 1/2 ft. tertiary crusher and four quarternary crushers, of the same type, in closed circuit with Nordberg 6′ × 10′ (two per crusher) vibrating screens with apertures of 3/16″. The capacity of this crushing section is about 340 tons per hour.

The screen undersize normally carries 9% over 1/14″ and 6-8% under 200 mesh. To avoid segregation of coarse and fine material, and in this way ensure a perfectly uniform and porous load for the percolation vats, the ore is "agglomerated" with 5% water on its way to the leaching section.

LEACHING — This section consists of 10 percolation vats, each with a capacity for 4,000 metric tons of ore. The vats are built of reinforced concrete with mastic lining; they have a double bottom of Douglas firwood and sisal matting and a system of piping and pumps which permits leaching by downward as well as upward percolation.

Pipes and fittings are of steel covered with hard rubber or neoprene. Circulation pumps in the vats are of the vertical centrifugal type, with internal and external rubber lining; while the pumps for advancing solutions are centrifugal, made of a moulded phenolic plastic. Also forming part of the leaching section are: two DEMAG unloading bridges with 5-ton clam-shell, for excavation of leach residue and loading of same on to lorries; a MIAG loading bridge; and 16 solution tanks of mastic lined concrete with capacities between 700 and 2,000 m^3.

The ore, crushed to minus 3/16″ and agglomerated, is submitted to a leaching cycle of 140 hours made up as follows:

Loading	12-14 hours
First overflow	4-6 hours
Acid treatment	80 hours
Washing and draining	25 hours
Unloading	12 hours
Vat maintenance	4 hours

Return solution from precipitation, which contains sulphuric and hydrochloric acid regenerated in this process, is used as a solvent. Some 180 tons of concentrated sulphuric acid must be added daily to compensate the lost acid from reaction with soluble gangue minerals. The total acid consumption averages 3.0 kilos H_2SO_4 per kilo of Cu extracted, and the extraction, on the basis of soluble copper, is about 87%.

Although the leaching process by percolation follows generally conventional lines, it was found necessary to develop different methods owing to the characteristics of the mineral itself and the final process of precipitation.

a) Loading is effected carefully to guarantee uniform distribution of ore bed, which is extended in horizontal layers through several passes of the loading bridge over the vat. Simultaneously, the ore is "covered" by upward percolation in such a way that the level of the solution is slightly below the level of the solid, by which is achieved uniform settling of the ore-bed and greater facility for the liberation of CO_2 gases formed by the acid attack on the calcite contained in the ore.

b) The "first" overflow of the vat, after covering the ore, i.e. a volume of some 200 to 250 m^3, generally contains little acid and little Cu (since this is principally displaced agglomeration water) but, on the other hand, a considerable amount of slimes carried over by the effect of the gases mentioned in the previous paragraph. To avoid that during their recirculation these slimes clog the filter bottom and the voids in the ore bed, causing channeling, this pulp is pumped to a prior vat in the washing state, where the fine solids are filtered over the ore without causing any damage. When the calcite content of the ore is high (2 to 3% $CaCO_3$), it is necessary to deviate an additional volume to a settling tank from which the clarified solution is returned to the circuit, with the thickened slimes having been rejected. In order to improve clarification some H_2SO_4 is added as well as approximately 1 gr/m^3 of "Superfloc" Flocculant.

c) The porosity of the bed is improved by reversing the direction of percolation, with downward percolation maintained during the advances of the strong and washing solutions, and upward percolation for recirculation and the advances of treatment solutions between vats.

d) Part of the Mantos Blancos ore, in andesite rock, is sensitive to acid attack on the gangue causing high acid consumption, formation of secondary slimes and low copper extraction This effect is accentuated with high acid concentration in the solvent, and high temperatures (particularly during the summer). For this reason, the ores are mixed in such a way that the andesite rock content in the leaching is less than 20% and acidity is closely controlled at maximum 35 gpl H_2SO_4 during the initial stage of treatment to be dropped later to 20 to 25 gpl towards the end of the cycle. To decrease the temperature of the precipitation return solutions, there are three air-cooled spray towers connected in series.

e) The strong solutions are clarified before being pumped to precipitation, by adding "Superfloc" and settling from 6 to 8 hours. In order to improve the precipitation efficiency, these solutions shall be neutral and must have a predetermined chloride ion concentration which is controlled by rock salt addition to the ore during crushing.

PRECIPITATION — This phase of the process constitutes its truly new and unique aspect, since instead of conventional methods for cementing or electrolysis, etc., the copper here is separated from the leach solutions by selective chemical precipitation in the state of cuprous chloride using sulfur dioxide gas. The reactions involved are as follows:

$$2CuCl_2 + SO_2 + 2H_2O = 2CuCl + 2HCl + H_2SO_4$$
$$2CuSO_4 + 2NaCl + SO_2 + 2H_2O = 2H_2SO_4 + Na_2SO_4 + 2CuCl$$

The process is carried out in 6 towers of 4 meters in diameter by 17 meters high, made of steel sheet lined with "Repanol" plastic and a protective sheating of anti-acid bricks, and one smaller lead and brick-lined gas cooling tower. The towers are empty with the exception of the lower part formed by a reservoir of solution with a volume in accordance with the residence time required by the liquid to react with the SO_2 absorbed in every successive exposure to the gas phase. The empty part of the towers is connected to the SO_2 gas tubing and the gas/liquid contact is effected by dispersion of the liquid through nozzles sited in the upper part (pointing downward) and above the solution reservoir (pointing upward). The solution in each tower is recirculated by means of pumps and a portion is advanced to the next tower at the rate of 140 m^3/hour.

As heat favours speed and efficiency of reaction, live steam is injected into the towers to increase temperature up to 60°C This steam is generated in waste heat boilers, from the hot sulphur combustion gases of the sulfuric acid and precipitation plants.

The precipitation is effected countercurrent-wise, i.e. the most concentrated gas is in contact with the weakest solution and vice versa.

The gas enters with a concentration of 16% SO_2 and leaves the last tower at 1.5% SO_2 or less which yields an absorption efficiency of over 90%. The solution reaches the tower with an average of 38 to 40 gpl Cu and Cl/Cu ratio of 0.90 leaving with 14 to 16 gpl Cu and about 40 gpl regenerated H_2SO_4 and HCl. The precipitated copper amounts to 24-26 gpl. i.e. some 40 gpl CuCl in the form of small white crystals. This is decanted in a Door-Oliver thickener and is washed and dried by 2 automatic horizontal-drum batch centrifuges.

The thickener overflow and filtrate from the centrifuges are cooled by contact with air in empty towers, of construction similar to the precipitation towers and return as solvent to the leaching section.

TYPICAL ANALYSIS OF SOLUTIONS

	Stronger pregnant solution entering precipitation	Spent, solution leaving precipitation
Cu, gpl	39.5	14.5
H_2SO_4 & HCl, gpl	0.2	40.2
Cl, gpl	35.0	20.0
Fe, gpl	15.0	14.5
Al_2O_3, gpl	20.5	20.0
SO_4, gpl	225.0	236.0
Density	1.310	1.280
Temperature, °C	25.	38.

PELLETIZING AND SMELTING: The centrifuged CuCl precipitate is transformed to metallic copper by a pyrometallurgical process. Finely ground limestone and coke are used, respectively, as flux and reducing agent, and are added with sufficient excess to avert volatilization of CuCl and Cu losses in the slag. The stoichiometrical relation is based on the following reactions, which take place at high temperature:

$$4CuCl + 2CaCO_3 + C = 4Cu + 2CaCl_2 + 3CO_2, \text{ or:}$$
$$4CuCl + 2CaCO_3 + 2C = 4Cu + 2CaCl_2 + 2CO_2 + 2CO$$

In practice, the mixture contains approximately 59% CuCl, 36.5% $CaCO_3$ and 4.5% C. After leaving the mixer, the material is pelletized on an inclined disc and the "green" pellets are dried in a "travelling grate" tunnel furnace with hot air, at a maximum temperature of 180°C. No binder is added, since the oxychloride formation during drying is sufficient to produce fairly hard and abrasion resistant pellets.

The pelletizing step is essential for the subsequent smelting process, as it eliminates dust losses in the rotary furnaces and, furthermore, improves reaction kinetics by forming an intimate, uniform mixture of the 3 ingredients in close contact, which react and smelt quickly.

380 mie

Dry pellets are loaded into the reaction furnaces by a special "weighing bin" loading machine. There are four reaction furnaces, each of the "Short Drum" (Kohlmeyer) design, 3.5 meters in diameter by 4 meters length. Each furnace smelts 5 charges of 13 MT pellets per day, producing per charge approximately 4.5 MT of liquid crude Cu and 5 MT of $CaCl_2$ slag. Part of the latter is used for road stabilization after granulation with compressed air, or crushing the rest is discarded.

The short-drum furnaces have rotating speeds of 0.1 and 1 rpm. They are heated by low sulfur, heavy Diesel oil burners, and have a refractory brick lining of special "Super-Duty" schamotte with 44/45% Al_2O_3 which has a life of 500 to 550 charges.

220 MT pellets with 35.5% Cu are treated daily. Smelter recovery (including refining) is of the order of 97%, the main losses being in fumes and slag.

Crude copper is transferred by a crane-moved ladle to the refining section. This section has one holding and two refining furnaces, of similar construction as the short-drum reaction furnaces, from which they differ, however, in their conical shaped covers, magnesite refractory linings and light oil burners.

A refining cycle lasts approximately 10 hours, distributed as follows:

Loading	3 hours
Oxidizing and slagging	3 hours
Poling (reduction)	2.5 hours
Casting	1.5 hour

Owing to the selective character of the chemical precipitation reaction, the impurities of the crude copper are only sulphur (0.01 to 0.1%) and iron (0.003 to 0.01%), which is why the refining process is rather a "finishing" step not very different from that utilized for electrolytic cathodes. The oxidation is effected with compressed air and the reduction or "poling" with eucalyptus poles, until an oxygen content of 0.030 % is achieved, which corresponds to a "tough pitch" copper.

The refined copper is moulded in a casting wheel of 10 moulds with 6 forms in each, into ingots of 24.5 kilos. Its purity is characterized by total absence of Se, Te and Bi, and trace contents of Sb and Pb, which, apart from high electrical conductivity, also gives it outstanding mechanical properties of softness and malleability.

In order that these qualities should be used to a greater extent, a LOMA semi-continuous moulding machine for billets and rolling cakes was installed and is at present under experimental operation. This installation includes a 42" circular saw whch allows to cut billets and slabs to customer's specifications.

75 to 80 tons of copper in ingot form are pròduced daily, and typical list of properties and analysis is shown below:

Electrical Conductivity	101%
"Spring Elongation"	427 mm.
Recrystallization temperature	175°C
Cu	99.96%
O	0.03%
S	0.0006%
As	0.0006%
Sb	0.0001%
Se, Te	0.
Bi	0.
Pb	0.0002%
Ni	0.0011%
Fe	0.0070%

CEMENT — PRODUCTION: In order to purge the solution circuit of impurities dissolved from the ore, as well as compensate for the volume of water additions to the circuit for washing and agglomeration, etc., it is necessary to discard, some 900 to 1,000 cubic meters of spent solution per day. The copper content in this solution is recovered by cementation with scrap iron, in inclined drums of HUMBOLT construction. There are four drums with capacity for

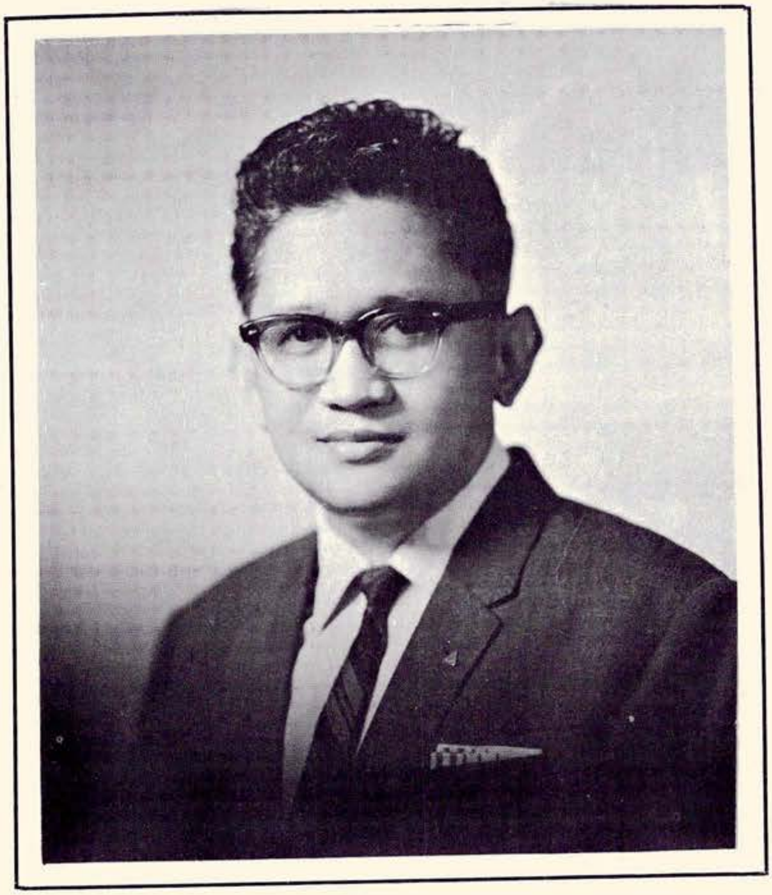
25 cubic meters of solution each, every precipitation cycle lasting approximately 2 hours including loading and unloading. Normally, spent solutions previously cooled are sent to cementation, but at times when greater discarding is required or when some drums are being repaired, hot solutions (at 55°C,) are used whereby a treatment time reduction of up to 20% is achieved. Under the latter conditions the product will be finely grained and more difficult to filter and wash.

The production of copper in cement amounts to 12-15 tons per day. A recovery of 97.5% is obtained in cementation with scrap consumption of 1.8 kg/kg Cu. The cement is bagged in 75-Kg. plastic sacks at the plant, and is exported with the following typical analysis: 88% Cu, 0.5% H_2O, 0.25% Cl. This purity is achieved by washing and drying the cement in a vertical drum centrifuge.

SULPHUR COMBUSTION AND SULPHURIC ACID PRODUCTION: Sulphur is an important raw material for the Mantos Blancos production process, where it is used in precipitation as well as in the manufacture of sulphuric acid The monthly consumption is about 2,800 metric tons. It is employed in the form of refined sulphur of 99.5% purity and comes mostly from a company controlled benefication plant at Aucanquilcha, near the Bolivian border, at a distance of 400 km by rail. This operation is noteworthy because it produces brimstone by autoclave treatment of volcanic sulphur ores from a mine located at an altitude of 6,000 mts. above sea level.

The sulphur is crushed, molten and filtered in porous graphite pressure filters, after which it is injected in liquid state into the various sulfur combustion furnaces. Sulfuric acid production facilities are of the vanadium pentoxide catalyst type and are rated at 210 MT/day monohydrate.

**Empresa Minera de Mantos Blancos S.A., is part of the South American Consolidated Enterprise S.A. (also known as the Hochschild group) with affiliated companies all over the world. The local subsidiary is Hochmetals Philippines, Inc. which can be reached at M.C.C. P.O. Box 1168.*



THE ACHIEVER — DJ DE JESUS

Dominador de Jesus, DJ, as he is known for short by friends and even in professional circles will celebrate his 53rd birthday a few months from now. He will then mark a good and useful life dedicated to the upliftment of the iron and steel industry.

DJ, a registered chemist and chemical engineer, is an alumnus of the Mapua Institute of Technology, where he also took a graduate course in industrial management. During his college days, he was editor of The Builder for four consecutive years. After graduation he became associate editor of the Philippine Engineering Record, official organ of the Philippine Society of Civil Engineers. He was editor of MIT's NAMA Alumni Directory *and was business manager of Cardinal and Gold Yearbook.*

From a practicing chemical engineer (1942-1947), he went up the ropes to become Chief, Construction Materials Chemist of the Bureau of Public Highways' Materials Testing Laboratory. In 1954, he became materials and testing engineer of the Materials Testing and Physical Research Division, Bureau of Public Highways.

From a government job he turned to the private sector. The several management positions he handled included the presidency of the firm he pioneered, DJ & Associates, Inc. — executive officer, then vice-president and general manager of Neris Philippines, Inc.- among others. From this point, he began working hard for the advancement of the industry. He scored four important "firsts" in the history of local industry.

Mr. Holzgraf of RMK-BRJ and Mr. DJ de Jesus of IPI conclude agreement for IPI to supply pontoons for Navfacent Command, Cam Ranh Bay, South Vietnam, Manila, January 15, 1971.

Mr. Holzgraf of RMK-BRJ and IPI officers are shown during the signing of the contract for the supply of IPI pontoons, January 15, 1971.

He set up the first emulsified asphalt plant in the Philippines, the first continuous asbestos cement plant and the first automatic corrugating asbestos cement sheet plant, as manager and director of the C & C Commercial Corporation Emulsified Plant which started in 1959, (later changed to C & C Commercial Corporation in 1962). As general manager and vice-president of International Pipe Industries Corporation set up the first spiral welded pipe mill, now the only pipe mill in Southeast Asia authorized to use the API (American Petroleum Institute) monogram.

DJ's present positions include: vice-president and general manager, International Pipe Industries Corporation; Chairman of the Board, Mapua Institute of Technology Testing Laboratories, Professional Lecturer, MIT's School of Engineering and School of Business Administration; and consultant for the following: Hydraulic Machineries, Inc., Sathask Driam (Thailand) Co. Ltd., Bangkok, GASCOM Engineering Corporation and Neris, Philippines, Inc.

He is a member of the American Society for Testing and Materials, American Water Works Association, Community Chest Councils of the Philippines, Inc., Philippine Institute of Chemical Engineers, Philippine Standards Association, Southeast Asian Society of Soil Engineering and National Association of Mapua Alumni Inc. (NAMA, Inc.)

His awards and certificates include — Most Outstanding MIT Alumnus in Industrial Management and Engineering Education, 1963; Certificate of Achievement — Special Seminar on Production — Faculty from Syracuse University; and Certificate of Attendance — SGV Profit Planning and Control, Conference Series on Business Management.

DJ was elected president of the Philippine Iron and Steel Institute in May 19, 1971. His task was initially to revitalize the organization formed in 1963 and had vanished in 1969. As president he was expected to advise, guide and steer the PISI (which counts on 32 member firms and 10 individual members) to development and success.

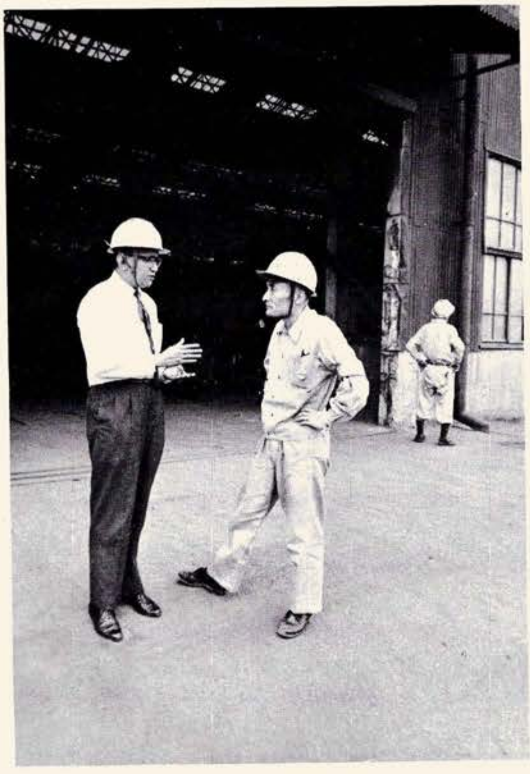
One of the first activities of the organization under DJ's leadership was the restructuring of the organization to facilitate involvement of all sectors of the iron and steel industry including rod, wire product and raw material producers; flat products, machinery and parts, and appliance manufacturers; steel product fabricators, and metal casters. Meanwhile the Institute became involved in seminars in which authorities, mostly from different government offices, were invited to address the iron and steel people on vital industry matters. This enabled PISI to establish dialogues with government bodies and lay the groundwork for a more favorable restructuring of the tariff code and for the establishment of standards for iron and steel products. PISI with the leadership of DJ took an active role during congressional hearings held last Dec. 9-10, 1971 to remedy defects in the existing Tariff and Customs Code. In January, final PISI proposals on the Tariff and Customs Code were brought up through the Tariff Commission.

DJ's crusade for the development of the local industry led him to make representations with Malacañang protesting NEC approval on reparations importation by a large number of consumers of steel products of such materials as prefab steel for school buildings, pipes for water systems, and structural steel for bridges inspite of the capacity of local steel fabricators to meet domestic requirements. As a result, President Marcos expressed desire to know more of the problems of the iron and steel sector. PISI through the assistance of its secretariat, the Metals Industry Development Center, launched an intensive survey to determine industry's problems and proposed solutions. Pertinent informations were furnished the President hoping to effect a more vigorous implementation and strengthening of government policies with respect to assistance to the local iron and steel industry.

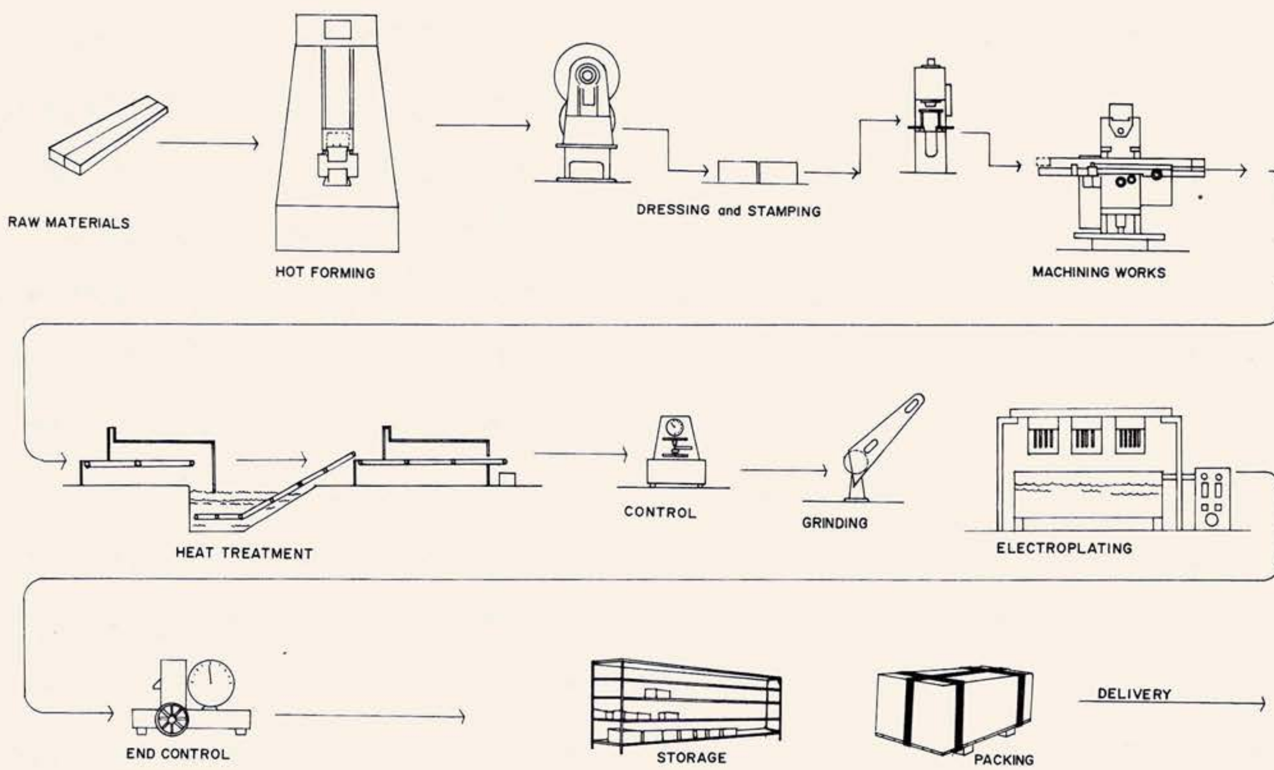
Another achievement of PISI through DJ's leadership is the use of the PISI seal on manufactured articles that could be produced according to international standards as a solution to the problem of non-uniform and inferior products finding their way to the market because of lack of quality control and testing facilities. MIDC was designated to do the testing and evaluation to determine whether manufactured articles conform to specifications. And now, because of one man's leadership and initiative, quality consciousness has become a byword in the iron and steel industry.

DJ, in one of his inspection tours of the IPI plant.

DJ exchanges opinions with a Japanese technician at Sumitomo Metals Plant. Osaka. Japan.



ELISCO TOOL MANUFACTURING CORPORATION



FLOWSHEET FOR THE MANUFACTURE OF HANDTOOLS

In developing nations like the Philippines, there is an overabundance of untrained and unskilled labor indirectly resulting in increased unemployment. This, however, is partly due to insufficient training. The lack of quality tools for the use of prospective trainees and laborers in the various fields of the industry has been a contributory factor. It is the intention, therefore of Elisco Tool Manufacturing Corporation (ELITOOL) in undertaking the project to manufacture handtools, besides opening new horizons for employment, to contribute towards the upliftment of technological skills in the country.

Elitool, one of the subsidiaries of Elizalde & Company, is managed by the Elizalde Iron & Steel Corporation, a corporation duly authorized by its corporate charter to engage in any phase of steel manufacture. It is registered with the Board of Investments as a pioneer industry with a capacity of 1,000 tons of handtools. A total work force of 300 personnel will be employed to produce this expected quantity.

The local manufacture of handtools is also intended to contribute to the economic stability of the country. Since supply will no longer be imports from countries like Germany, the United Kingdom, the United States and Japan, the supply and prices of these tools will not be affected by the demand and domestic prices in the countries of origin. A major boost to the economy will be the increase in the rate of industry growth in the country.

After one to two years of domestic production, Elitool is expected to be in a competitive position with other countries as far as the supply of handtools to the Southeast Asian export market is concerned.

Belzerk Werk of Wuppertal, Germany is providing technical assistance to Elitool in the setting up of its project. To ensure the manufacture of quality handtools, Belzerk Werk through its consultants working on this project, is providing expertise on the latest developments and trends in the manufacture of handtools. Some 15 Filipino engineers and technicians are now currently undertaking actual training on the various aspects of handtool manufacture in Germany.

Karl Muller, a mechanical engineer specialized in handtools manufacture, is the consultant for Belzer-Werk of Wuppertal, Germany. He is presently assisting Elisco engineers in putting up the Elitool plant.

The technical studies conducted by the Belzerk Werk consultants on imported handtools came to a general conclusion: the lack of quality control standards, thus leading to damage or malfunctioning of the handtools. Elitool intends to safeguard the interest of the consumers who demand for quality even at the expense of cost. Elitool's plant is designed to utilize high grade steel (chrome-vanadium) for the production of handtools.

An expansion of facilities will be made as soon as the need for mass production arises.

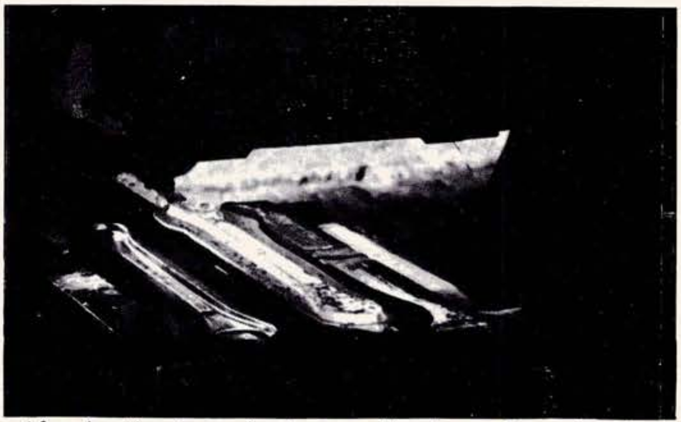
Based on the initial market studies made, the following handtools were selected. These handtools have a market demand substantial enough to justify their economical production:

1. Wrenches: 46 Different Sizes in Both the English & Metric Systems
   a) Open End Spanners
   b) Ring Spanners
2. Adjustable Wrenches: 4 Different Sizes
3. Pliers:
   a) Long Nose Pliers
   b) 2 Sizes of Slip Joint
   c) Pipe Plier
   d) 2 Sizes of Combination Plier
   e) Side Cutters
4. Screw Drivers:
   a) Flat Tip (13 Sizes)
   b) Philipps (4 Sizes)
5. Allen Key Wrenches: 20 Different Sizes in Both English & Metric Systems
6. Sugar Cane Knives

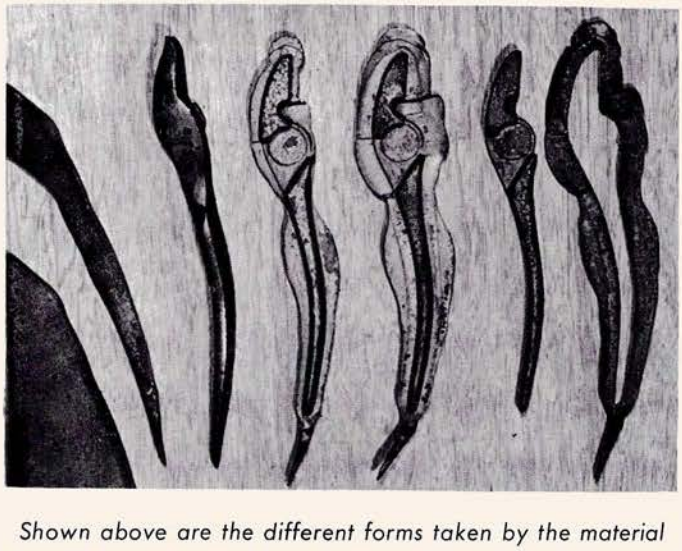
As soon as operations become normal and the market secured, plant and production may be expanded to include the product line of handtools, the manufacture of which involves from 15 steps for an open end spanner to 45 steps for an adjustable wrench. For purposes of illustrating the different operations, presented below are steps in the production of an open end spanner.

Flat bars of varied sizes, which are the raw materials for handtools of different sizes and shapes are stored in the forging shop. These flats are picked up by an overhead crane and placed on a conveyor and conducted to the eccentric presses The eccentric presses, which are of different capacities (the maximum is 200 tons) are equipped with special cutting dies. The flats are cut according to the desired shape. The form of the cut pieces are so designed to save on raw materials.

From here, the cut pieces go directly to the forging furnace where they are heated to a temperature



After heating to a plastic state, blanks are forged in drop forge hammers.



Shown above are the different forms taken by the material after blanking, forging and trimming.

ranging from 950°C—1150°C, according to the type of steel. It is important to use the correct temperature to prevent decarburization of the surface of the steel pieces. For this reason, all the forging furnaces are equipped with control panels to maintain the desired temperature.

From the furnace, the hot pieces are forged, which is done on a belt driven drop hammer in 3 or 4 steps. The first drop is for the bending of the flat side. The second is for the bending of the edge side, the third drop is to impart the preliminary shape and the fourth drop is to obtain the correct size according to the working design of the tool. The forging die itself is made from special alloy steel in the Die Shop of Elitool.

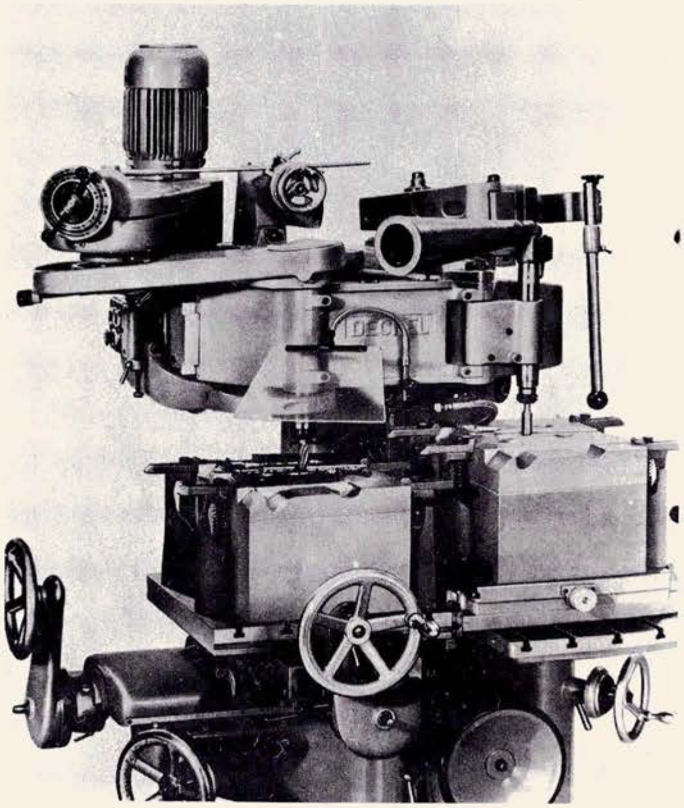
After the forged piece has cooled, the next step is to remove the "flashes" or excess material on the eccentric presses for the trimming process. These presses are fitted with special trimming dies to trim the forged pieces.

After trimming, the tools are placed in a shot blasting machine to remove the scales from the surface of the forged piece. After shot blasting the first quality control inspection is conducted. All pieces that are not clean and poorly forged are separated and scrapped. Pieces without defects are stamped and calibrated with the trademark, size, etc. and sent to the mechanical shop.

All the different kinds of tools pass the same processes as have been previously described. The number of steps may vary from 15 to 45 for different handtools.

The succeeding operations are those which are required for the production of the open end spanners. The start is at the mechanical shop.

Both openings of the spanner are broached at the same time, using hydraulic presses fitted with special equipment, jigs and fixtures. After broaching, the spanner undergoes rough grinding before hardening.



The Deckel Copy milling machine for the machining of forging, trimming and stamping dies.

The open end spanner is then placed in the hardening furnace where it is heated to the hardening temperature, dropped into a quenching tank and carried by the conveyor up and dumped into another box. The spanner then goes into the tempering furnace where it is heated and maintained at tempering temperature. The capacity of this furnace is 250 kg. /Hr. After heat treatment, the open end spanner is tested for the required hardness specification.

The tools are checked for cracks by means of a special Crack Detector. Tools with cracks are then separated and scrapped.

The spanners undergo finishing operations, using special grinding machine, to give it a good finish. The edges are finished with the use of belt grinders. This process results in smooth and rounded edges and is done in three different steps using different grades of belts.

The heads are finished with the use of a double head grinder to obtain the same thickness for each size of open end spanner.

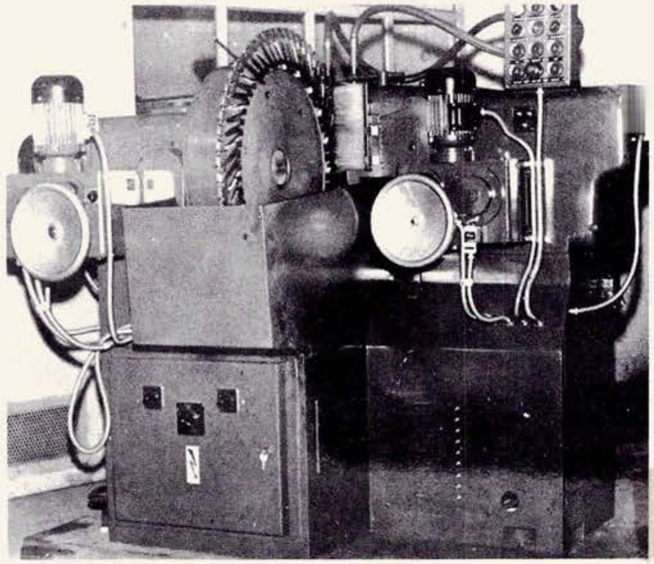
The openings of the spanners are checked with gauges and those tools requiring corrections are ground using special grinding machines to meet the desired dimensions. All parts that are desired to have bright finish undergo polishing. Before the tools undergo nickel and chrome electroplating, they are cleaned in a special cleaning machine. The electroplating process which consists of five different steps produce tools with shiny and attractive and high corrosion resistant surfaces.

To be sure that all the products are according to specifications, the spanner undergoes final quality control check. Here, it is examined for visual defects and tested for mechanical properties like tensile strength.

After the final inspection, the tools are packed and stored, ready for delivery.

Die Shop

A well-equipped die shop with high quality dies, toolings and production supplies plays a very important role in the manufacture of quality handtools. Elitool has a die shop equipped with 28 special machines for tooling, jigging, fixtures, complete with all the essential accessories for the manufacture of dies, jigs, fixtures and for maintenance work.



A double head special grinder for the rough grinding of wrenches and other tools.

The final polishing of the tool using polishing compounds.

Firm Feature
PHILACOR

PHILIPPINE APPLIANCE CORPORATION

Philippine Appliance Corporation (PHILACOR), one of the leading and largest appliance manufacturers in the country is based in Dr. A. Santos Avenue, Parañaque, Rizal. Despite an equity agreement with Westinghouse Electric Corporation and Chase Manhattan Bank, it continues to operate under Filipino management composed of Dante G. Santos, president and general manager; Joseph Kinder, vice president for finance and administration; Antonio R. Agra, vice president for manufacturing; R. R. Crisostomo, vice president for marketing; and Benjamin M. Aycardo, assistant vice president, compressor plant.

Tracing its beginnings to its incorporation in August, 1963, when a group of Filipino stockholders pooled resources and put up an authorized capital of ₱5,000,000, PHILACOR started operations with an initial organizational force of 13 employees. Today, it provides employment to 800 factory workers and directly or indirectly, to about 800 dealer service technicians and salesmen.

Its early products were limited to refrigerators (8 and 10 cubic ft. models) and room air conditioners (6,000 BTU/hr., 10,000 BTU/hr., and 12,000 BTU/hr. models). Since then, PHILACOR's product line has expanded to include nine refrigerator models, three freezer models, including a chest type model, three room air conditioners, two television models and one gas range model.

In 1969, PHILACOR expanded its test facilities for room air conditioners, doubled its power supply, and increased the manufacture and assembly of various electronic equipment. Significant in the market is the introduction of the first locally manufactured and assembled Westinghouse 16 cu. ft. "frost-free" refrigerator.

Refrigerators and freezers comprise the main products that PHILACOR manufactures. These carry four brand names: Westinghouse, which is distributed nationwide through a network of franchised dealers; Koldpoint, which PHILACOR produces for Radiowealth; Singer, for Singer Industries; and Presto for Consolidated Foods Corporation.

In terms of sales, the company has a record that matches phenomenal proportions. From 1964-65 to 1965-66, a sales growth of ₱2.8 million was realized. This meant a gain of 304 in total sales volume or a peso growth of ₱8.5 million. A steady upsurge of sales growth reached a total of 104 per cent for the period 1967-69 or an overall sales growth of 21.7 million from 1964-69. As of 1970, the total assets of the appliance firm has increased by 50 per cent from its undepreciated original value.

Of equal significance is the company's policy of increasing the local material content of its products, without any sacrifice in quality. All locally produced, these include cold rolled sheets aluminum sheets and paints. Polyurethane, enamel frits, refrigerants and copper tubing are still imported, however.

Because of this policy, the amount of local materials being used in the appliances has increased from 40 per cent to 67 per cent, generating savings in importation costs in the amount of ₱4,000,000.

Another area where the company will utilize both native ingenuity and materials, with concommitant savings, is the PHILACOR pilot plant which assembles completely knocked-down Westinghouse hermetically sealed compressors for its own consumption. The current expansion program envisions a fully integrated compressor manufacturing complex by the last quarter of 1972. This multi-million-peso compressor manufacturing plant will operate as a separate profit center of PHILACOR, with its products earmarked for

Refrigerator units undergo final inspection before crating.

Finished units undergoing rigid quality control check-up before crating.

both local consumption and for outside industrial consumers.

The expansion program now in progress, once in full operation, will undertake the following principal manufacturing processes:

— Die casting of cylinder blocks, motor housings, pistons and connecting rods from aluminum ingots, using a 20-horsepower die casting machine and a 103-kilowatt melting furnace.

— Precision machining operations, such as boring, taping, honing, grinding and turning.

— Stamping of laminates for the motor stators and rotors using an 8-ton high speed press with roll feed.

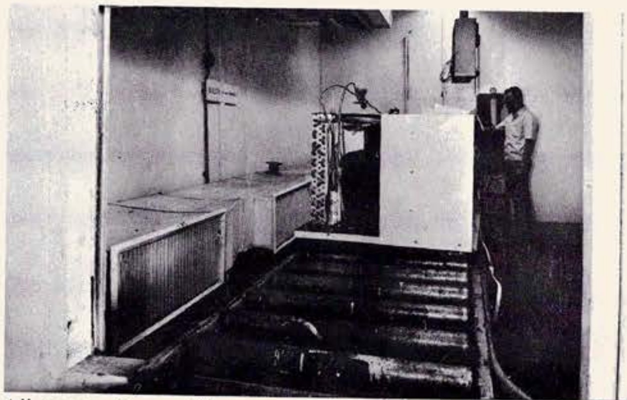
— Machining and grinding of valve plates.

All parts will be subjected to a special heat treatment process at controlled temperatures and an ultrasonic chemical cleaning operation to maintain its highly critical dimensions and properties.

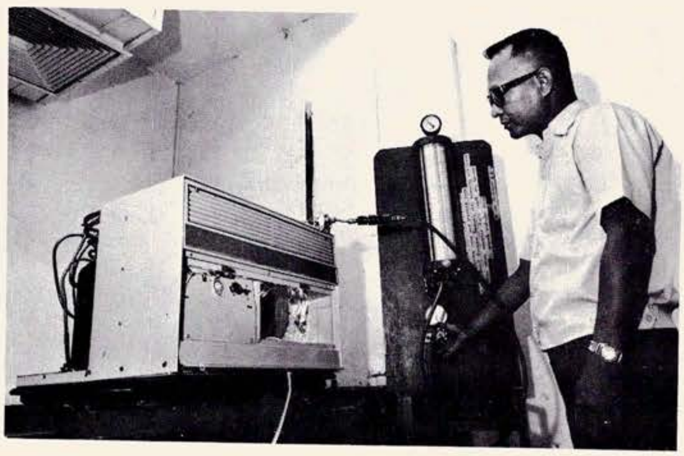
Modern facilities and instruments will also be installed in the asembly and testing operations of its manufactured components will be adopted. The completed compressor products would be made available initially in 1/8, 1/6 and 1/5 horsepowers.

PHILACOR officials relate the acceptance of its locally manufactured products to its uncompromising posture toward functional product design, style innovations and quality.

The latter is best exemplified in the quality control which PHILACOR vests in its products This begins with product design, which is programmed methodically and meticulously all the way through the complete manufacture of the prototype, and, finally, the product itself. Quality control during product design stages enables detection of even the slightest deviations.



All room air conditioners are tested for performance efficiency in the production test booth. Units which do not meet established standards are rejected and recycled for corrections.



Room air conditioner units undergo a charge calibration operation for the correct amount of refrigerant to be injected.

Strict control is maintained in the development and fabrications of tools. Dies and molds are developed and fabricated to the nearest dimensional accuracy. Operating performance of these tools are continuously tested through the production line.

Various components of the products are subject to continuous inspection during production. Upon complete assembly, the product undergoes rigorous, simulated and actual field performance tests. Here, possible weaknesses or potential breakdown areas during extremes of operating conditions are detected and corrected. It is only after a satisfactory performance rating of a product that PHILACOR delivers the appliance to the market, through its dealership network.

PHILACOR is the first in Southeast Asia that has adopted foaming-in-place for insulating refrigerators and freezers.

Briefly, the foaming process is as follows:

Two streams of chemicals, one an isocyanate and the other a combination of freon and polyalcohol; are injected into the completely enclosed space between the inner liner and outer shell of a refrigerator. The isocyanate and the polyalcohol react to form a polyurethane. The heat given off from this reaction evaporates the freon, thus forming a liquid foam which hardens into a rigid foam in 5 minutes.

The foaming mixture exerts a pressure inside the enclosed space causing the liquid foam to fill up the enclosed space completely. Since the foaming mixture exerts a pressure on the walls of the space to be insulated, a jig had to be devised to support the walls of the refrigerator. Although the foaming process seems simple, it took about a year before the process was completely debugged.

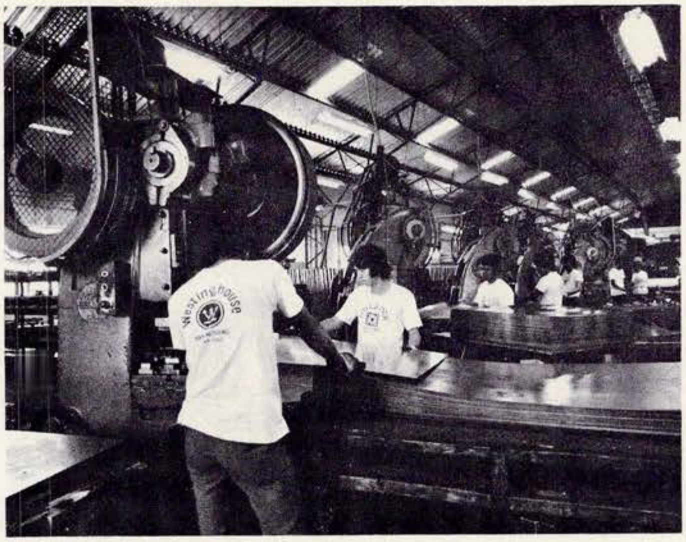
Foamed-in-place polyurethane as an insulation for refrigerators has far greater advantages over that of expanded polystyrene and fiberglass as follows:

1. Twice the insulating power of expanded polystyrene and fiberglass, allowing for thinner walls for greater storage space for the same given cabinet dimensions.
2. Greater water impermeability, providing better rust-resistance for the metal parts of the refrigerator.
3. Greater structural rigidity to the refrigerator walls, which also ensures lasting insulating utilities.

MANUFACTURING OPERATIONS

Press Working & Welding

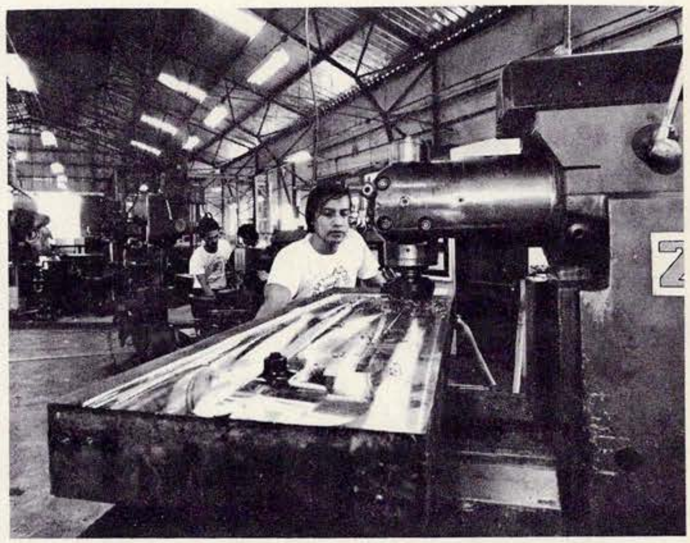
Cold rolled steel and aluminum sheets are first sheared using the mechanical guillotine shear, consisting essentially of one fixed cutting blade mounted on a bed, and one movable blade mounted on the crosshead or gate which is guided in vertical slide ways, to sizes depending upon the part of the appliance of which they are to be made. The sheared sheets are then subjected to a series of metal pressworking operations such as punching, blanking, notching, bending, embossing and deep drawing. It utilizes progressive and compound dies made of hardened tool steel mounted on press machines like the 650-ton, double action hydraulic press, power press, toggle press and press braker. The completed steel sheet parts are then assembled using spotwelding, fusewelding, electric arc welding and brazing processes. The parts, (usually refrigerator or air conditioner casing) undergo either rotary or orbital grinding where the sharp edges produced by welding are smoothened.



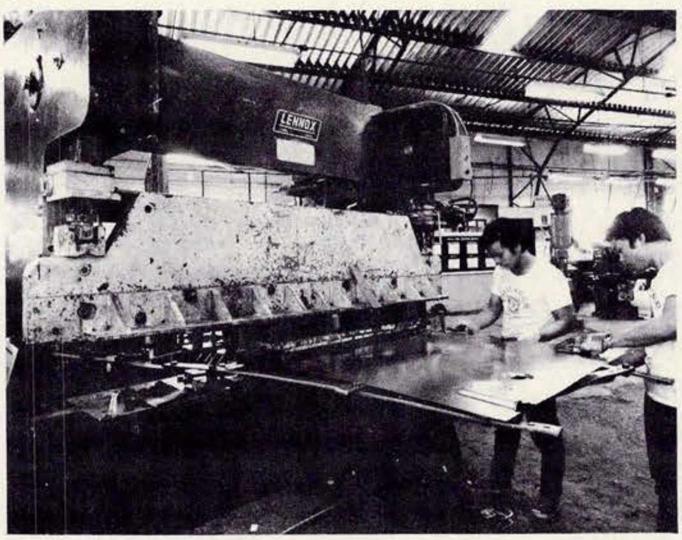
Power Presses of 50-and 30-ton capacities, used for stamping of metal sheets.

A 75-KVA spotwelder used in spot welding the rear panels to the refrigerator cabinet.

A partial view of the Weld Shop, where finished metal parts are assembled into desired structure using jigs and fixtures as guides.



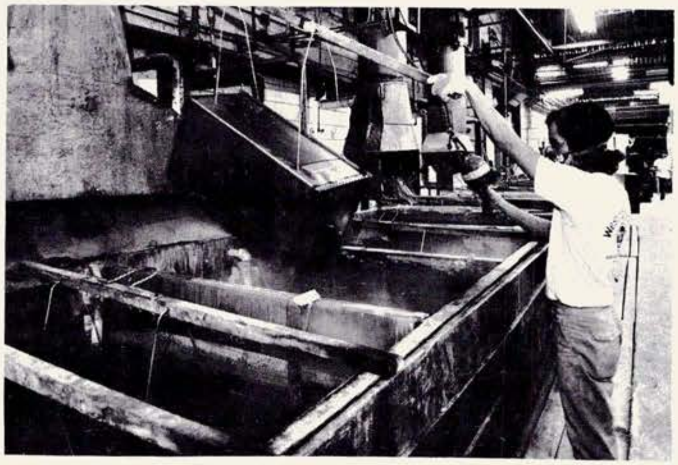
A portion of the Machine Shop where tools, jigs and fixtures dies and moulds are fabricated. Shown is a milling operation.



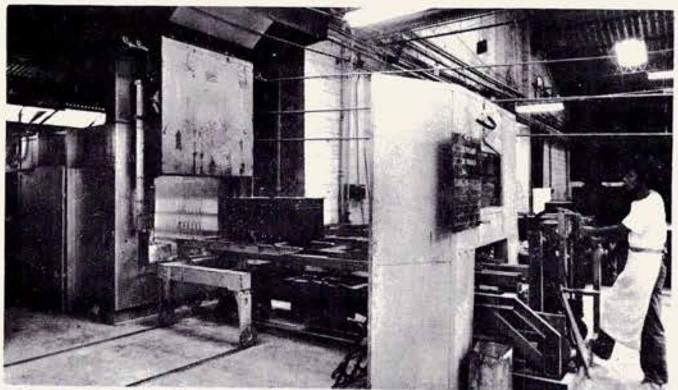
The foodliner of a refrigerator in its flat sheet form are press worked in the 40-ton press brake.

Gaps at the corner of door panels are closed by brazing.

A refrigerator cabinet being assembled by spotwelding.



Foodliner is shown undergoing pickling operation before the application of porcelain enamel slips.



After coating with enamel slips, foodliners are fired in the electric furnace at 800°C to 900°C for 3 to 5 minutes.

Bonderizing

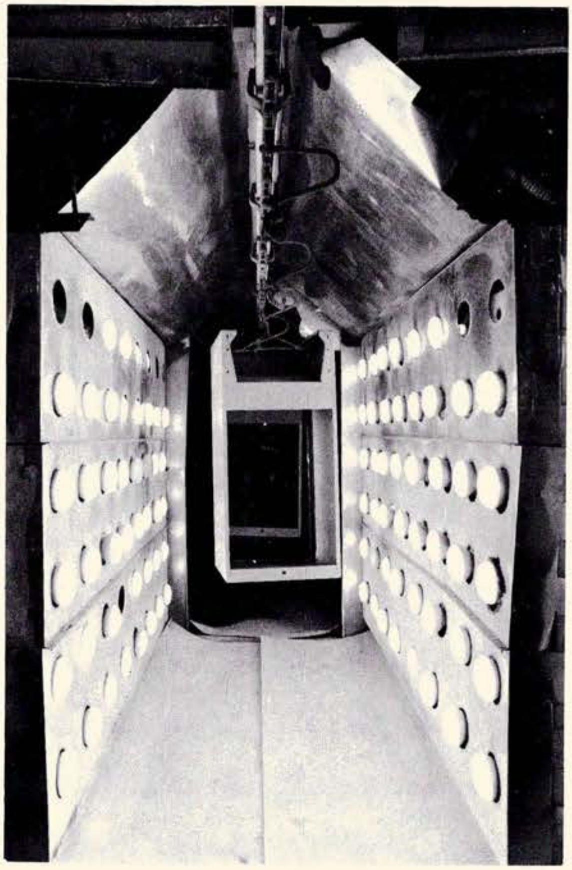
A metal preparation process for cleaning and preparing the metal surfaces prior to painting called bonderizing is then employed. This involves a series of cleaning and rinsing tanks containing various chemical solutions at specified temperatures, with or without agitation. Stages of Bonderizing Process:

1. Alkaline Cleaner — to remove soil and contamination such as grease, oils, drawing compound and other shop dirts, producing a totally clean surface necessary for good adherence of a uniform, compact coating of zinc phosphate.
2. Water Rinse — to wash off the residues and soap products from the ware, producing a clean surface necessary for good adherence of zinc phosphate.
3. Derusting Solution — to remove rusts, oxides, and scales from the metal surfaces by the action of an inhibited phosphoric acid compound which when diluted with water produces a pickle solution.
4. Water Rinse — to wash off residual acid and other impurities from the surface ot the ware.
5. Phosphating Bath — to produce a micro-crystalline corrosion-resisting, paint-bonding, zinc phosphate on the clean surface of the metal.
6. Water Rinse — to wash off adhering powders from the surfaces of the ware.
7. Final Acidulated Rinse — to improve paint adhesion; to minimize underfilm corrosion and blistering; and to neutralize hard water salts, thus leaving the surfaces of the ware which have been coated with zinc phosphate in the best condition for painting.

Pickling

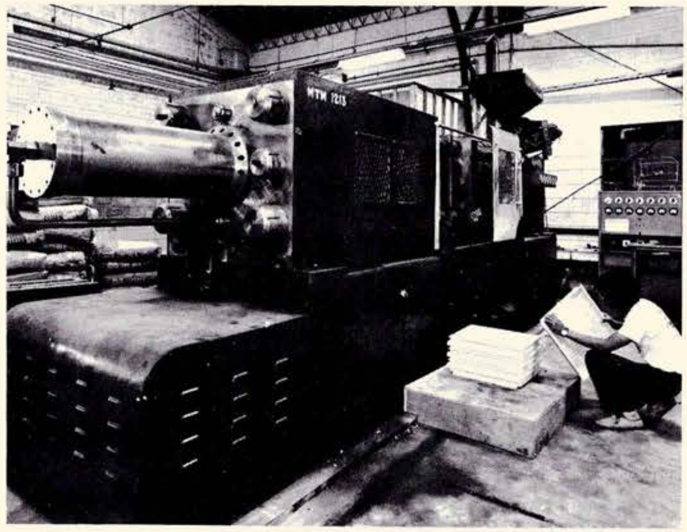
Pickling is a metal preparation process for cleaning and preparing the metal surfaces prior to porcelain enamelling. This involves a series of cleaning and etching tanks containing various chemical solutions at specified temperatures and agitation. The following are the Stages of pickling process:

1. Alkaline Cleaner (First stage)—to act as a precleaning stage by removing soils, lubricants, preservatives and drawing compounds.
2. Alkaline Cleaner (Second stage) — to remove the ware, insuring a thoroughly clean surface for uniform etching
3. Water Rinse — to wash off dirts and residue produced by the degreasing stages.
4. Water Rinse — to wash off any residual product of the degreasing operations, insuring a to-



The dry-off oven compartment of the conveyorized painting booth.

Plastic sheets from the extruder undergoing rolling and shearing processes.



A 42-oz Injection Moulding Machine for plastic parts.

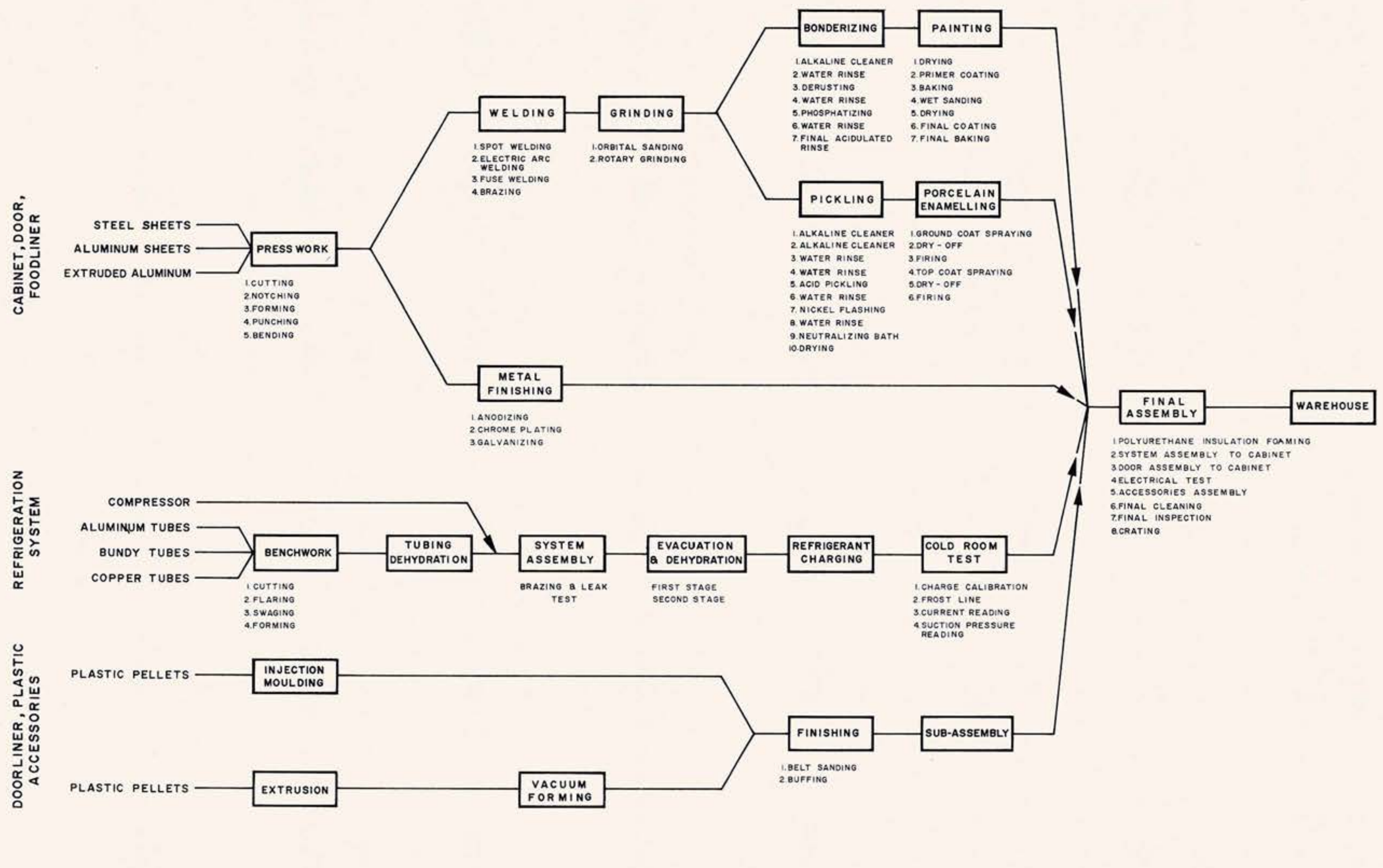
tally cleaned ware for uniform etching.

5. Acid Pickling Bath — to remove iron products and to produce a uniformly etched surface for faster nickel deposition and better porcelain enamel adherence.
6. Water Rinse — to wash off excess acid and other impurities from the ware.
7. Nickel Flash Bath — to deposit nickel on the iron surface promoting better enamel adherence.
8. Water Rinse — to wash off adhering acidic solution preventing any carry-over to the succeeding stage.
9. Neutralizing Bath — to neutralize any acidic film left on the surface of the ware, preventing any corrosion or rusting before enamelling.

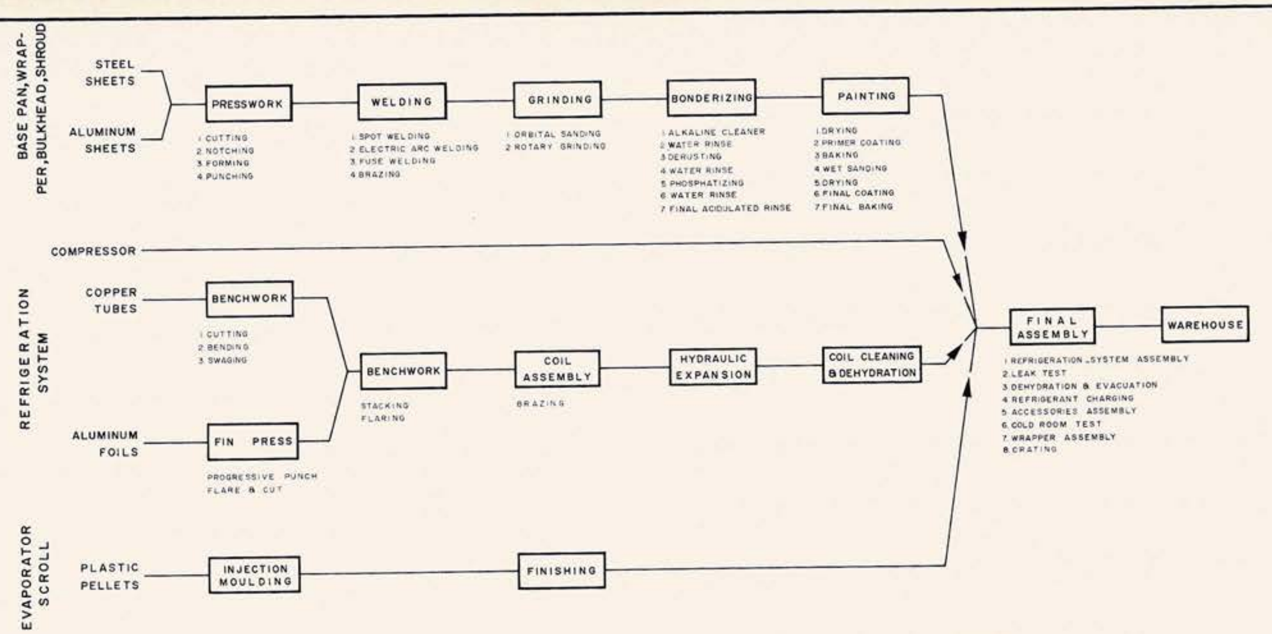
Painting

Painting process starts after the materials have undergone the bonderizing operation. The first coat of epoxy primer is applied on a completely dried surface with the use of a conventional spray gun under pressure. The paint is allowed to flash-off for approximately 10 minutes before baking at high temperatures.

After baking the primary coating, the surface has to be wet sanded. Sandpaper with fine texture is used to remove the primer gloss and any primer runs or sags. The work-piece is rinsed-off with clean water to remove sand particles. After wet sanding, the work piece is dried-off in an oven.



PROCESS CHART: MANUFACTURE OF REFRIGERATOR
(SHOWING THE FLOW OF PRINCIPAL RAW MATERIALS)



PROCESS CHART: MANUFACTURE OF ROOM AIR CONDITIONER
(SHOWING THE FLOW OF PRINCIPAL RAW MATERIALS)

The top coat is then applied using a spray gun and allowed to flash-off for 10 minutes before the ware enters a high temperature baking oven. Baking process is completed after 10 minutes at 300-360°F.

Porcelain Enamelling

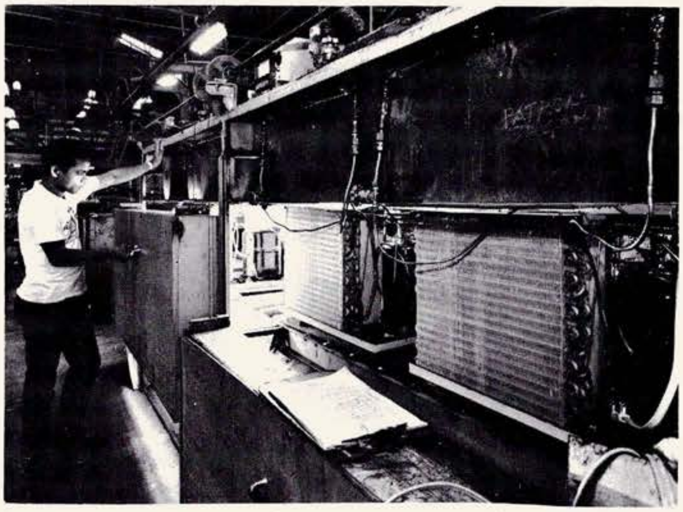
Porcelain enamelling process could be generally described as a fusing operation of a glass-like coating to a base metal. Although there are several formulations for the porcelain enamel frits, these are commonly classified as alkali-borosilicate glasses, which are chemically compounded with other inorganic materials The porcelain enamelled surface serves to both beautify and protect the base metal since it is impervious to moisture.

Application of the first coat or ground coat is done by the use of a pressure-type spray gun. The ware is then dried in an oven to evaporate the water content of the porcelain enamel slip. Firing or fusion takes place when the coated material is placed in a furnace with temperature ranging from 800°C to 900°C at a firing time from 3 to 5 minutes. The spraying, drying and firing of the top coat follow the same sequence as the ground coat application.

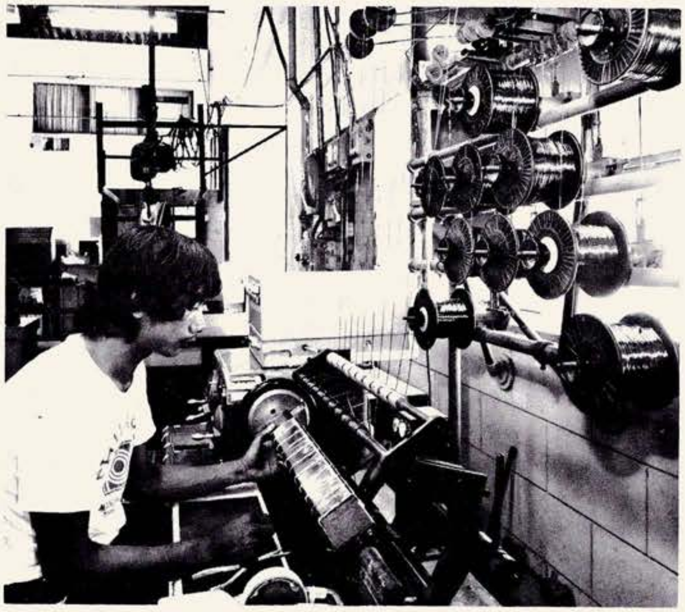
Plastics

PHILACOR uses high-impact polystyrene plastic pellets in the manufacture of the inner door panel, egg rack, breaker strips between food compartments and body, freezer tray, freezer door and meat keeper for their refrigerator products. Plastic pellets which are imported in white, aqua blue and sky blue, in order to take the form of the desired part undergo either of the following processes to give the desired configuration of the plastic:

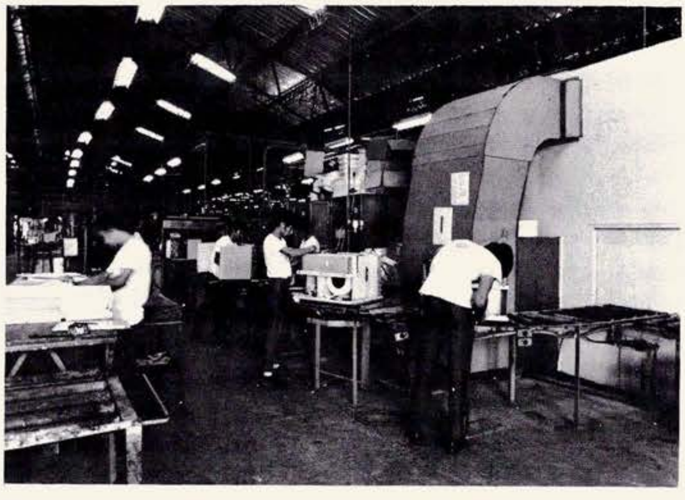
1. Injection Moulding—a type of operation which melts the raw material in a heating chamber, forcing it to flow into the cavity of the mould through the action of a plunger. The cycle stops when the cavite is filled up with plastic material, producing the required form and shape.
2. Plastic Extrusion — HIP sheets are extruded from the time the plastic pellets are dehydrated inside a chute passing thru a screw conveyor with heated cylinder. The molten plastic is then fed thru a die with an opening designed to produce the required thickness of sheet. The extruded sheet then passes a series of plated rollers adding gloss on the sheet surface, after which the sheet is passed thru a take-up roller and sheared off to the required length of sheet
3. Vacuum Forming — the plastic sheet is positioned on a frame, clamped down thru a series of plungers, and the frame with the sheet is moved into a chamber with heaters on both sides. The sheet is heated up at temperatures which will produce the necessary texture and sag. The frame with sheet is then withdrawn from the heating chamber and positioned on the top of the mould. The mould is then raised to snugly engage the frame, after which vacuum is applied. The heated plastic, then, is pushed down against the mould surface producing the right contour, shape and form desired.



Room air conditioners undergo vacuum dehydration to insure a clean and moisture free refrigeration system.



An automatic winding machine used for the manufacture of coils for transformers.



A partial view of the assembly line for room air conditioners.

REFRIGERATION & AIR CONDITIONING SYSTEM FABRICATION AND ASSEMBLY

The major components of the systems, i.e., evaporator, condenser, heat exchangers, driers and compressors are processed in the following manner:

1. Evaporator Assembly (for Refrigerators)—principally made of extruded aluminum flats and tubings. The evaporator flat is designed for mounting of the aluminum tubing, then crimping and rolling follow, allowing for positive heat transfer on all wrapper surfaces. The aluminum tube (serpentine) are formed in a tube bending machine and the evaporator flat with the tubing are formed to the correct shape in a hand bending fixture, riveted in place prior to assembly of the accumulator. Evaporator Assembly (for Room Air Conditioners) — fabrication from copper tubing hairpins, and insertion into layers of aluminum fins (usually 12 to 14 fins per inch) expanded either mechanically or hydrostatically after hairpin ends are provided with brazed end caps. Condenser assemblies for Room Air Conditioners follow the same processing scheme as the RAC evaporator.
2. Heat Exchanger — composed of two copper tubes soldered together along its length. The tube with the bigger diameter, 1/4″ or 5/16″ acts as the suction line while the other with smaller diameter serves as the capillary tube.
3. Strainer Drier — to insure that the system is moisture and dirt-free, a strainer drier is mounted. The drier is brazed with one end to the capillary tube and the other to the condenser tube end.
4. Condenser — uses a serpentine steel bundy tubing of the correct length and diameter, spotwelded by means of clips unto the condenser plate. Prior to assembly to the complete system, the condenser assembly is degreased and painted black.

5. Compressors — received by the plant with oil charge with holding pressure, ready for assembly to the system. It is imperative that the compressor supplier meets with stipulated specifications to insure reliability of the system performance.

Before starting to braze all the above components together, (with the exception of the compressor), each component assembly undergoes a series of cleaning and dehydration processes, to insure that same is moisture and dirt-free.

During the brazing process, nitrogen gas is passed thru the tubes to prevent oxidation. For purposes of preliminary leak detection, 250 psi dry air is introduced to the system before dipping in a water tank. Leaks can be detected on joints if air bubbles are present. If units are found to be leak-free, the complete system undergoes a heat-vacuum process for about 30 minutes after which the system passes thru the same process for final evacuation.

The system is then charged with refrigerant; passes thru an ambient-controlled test room where electrical, pressure and frost line tests are conducted while the unit is operating. Before the system is mounted to the cabinet, all joints are subjected to electronic leak detection.

FINAL ASSEMBLY

Component parts and assemblies originating from the Finishing Shop for painted wares, Plastics Shop for plastic wares, the Production Stores for hardwares and components not requiring intermediate operations, are fed to the various final assembly stations as required.

The food compartment and shell assemblies are put together, provided with dummy breaker strips, grommets and plugs before the foamed-in-place insulation is injected. Thermostat and other electrical accessories are put in place and the complete system is mounted at the rear of the cabinet. Simultaneously, a separate assembly line for door assemblies with magnetic gaskets is undertaken.

Final adjustments are made on all mating parts and final electrical tests are conducted before the packaging of the complete unit.

The final Assembly Line of the Room Air Conditioner follows the same assembly process, except that portion of the production test where the system and cabinetry are pre-assembled prior to final inspection.

DOMESTIC & FOREIGN EXPORT PRICES

Table I
Continental Steel Export
Monthly Price Averages Oct. 1971 to Jan. 1972
(In US $ Per Metric Ton)

	October	November	December	January
Billets	82	79	79	79+
Reinforcing rounds (a)	91.5+	90+	92.5+	91+
Merchant bars	102.5+	100+	101+	101+
Joists, channels (Brit)	—	—	—	—
Channels (US)	—	—	—	—
W.F. (Univ. beams)	—	120+	118+	118+
Wire rods	113+	108+	108+	108+
Hot rolled strip: 1 in.	114	114	112	112
Tube strip	—	—	—	—
Heavy plates: (c)	127+	122.5+	122+	122+
Medium plates (d)	117+	113.5+	113+	113+
Universal plates	—	—	—	—
Chequer plates	117+	114+	114+	114+
HR sheets: 16g. and up	122+	116+	—	—
HR coil (dry)	—	—	102+	—
CR sheets: 17-20g.	125.5+	119+	119+	119+
Galv. coils: 17-20g. (b)	164* (e)	164* (e)	164* (e)	164* (e)
Bright wire	134	—	—	—
Black annealed wire	139	—	—	—
Galv. wire: 5-16½g.	144.5	—	—	—
Barbed Wire	—	—	—	—

Source: Metal Bulletin

*+ 2½% exporter's commission incl. *less $5; corrugated extra $2; flat sheets $3.*

(a) Usual deformed bar premiums; structural $2; intermediate $3

(b) 4-ton coil

(c) over 8 mm.

(d) 3-8 mm.

(e) $ 25/$ 30 special allowance, according to spec.

MB's appraisal Continental (ECSC) mills' basis (net unless stated)

FOB export prices, ordinary Thomas Commercial quality. Markets, sizes, quantities, delivery, etc. can affect prices shown.

Table 2
Japan Monthly Average Domestic Price
(In US $ Per MT unless otherwise indicated)
October 1971-January 1972

	October	November	December	January
Iron & Steel Products				
Round Bar 9mm	79.31	73.90	74.93	87.73
16-25 mm	77.92	73.03	73.47	86.92
Flat Bar 6 × 50 mm	90.49	87.85	88.06	94.56
Equal Angle 6 × 50 mm	83.19	75.46	78.19	90.39
10 × 90 mm	86.67	78.12	81.47	94.10
Channel 6 × 65 × 125 mm	98.96	91.61	99.03	114.93
H-Shape 9/14 × 250 × 250 mm	131.46	129.34	129.65	130.56
Hot Rolled Sheet (3 × 6) 1.6 mm	90.49	88.25	96.25	107.87
Cold Rolled Sheet (3 × 6) 1.2 mm	114.72	114.70	119.03	127.89
Medium Plate 3.2 × 3 × 6	86.74	85.01	94.09	107.06
Plate 6 × 4 × 8	86.39	84.49	92.99	106.60
9 × 4 ×8	86.39	84.14	92.78	105.90
Gas Pipe (Black) 15A (1/2 inch) (per kg.)	0.13	0.13	0.13	0.13
Water Pipe (White) 15A (1/2 inch) (per kg.)	0.21	0.21	0.21	0.21
Galvanized Sheet				
(plain) 0.30 mm	160.56	159.03	159.03	159.03
(corrugated), 0.25 (per sheet)	0.52	0.52	0.52	0.52
Colored Sheet				
(lone side, plain) 0.30 mm	224.31	224.31	224.31	225.69
(one side, (corru.) 0.25 (per sheet)	0.65	0.65	0.65	0.65
Wire Rod, 5.5 mm	110.28	97.22	97.22	97.22
Round Nail, 100 mm (4 inches)	127.71	121.64	122.15	137.62
Iron Wire, No. 8	113.61	110.07	110.21	115.97
Annealed Iron Wire, No. 8	111.74	105.44	106.25	122.57
Galv. Iron Wire, No. 8	141.81	129.17	133.89	142.36
Barbed Wire, No. 14	201.25	198.61	198.75	199.31
Tinplate, 90 L (0.257) mm	276.20	276.20	276.20	276.20
Wire Netting, 20 × 15 mm (one roll)	5.21	5.21	5.21	5.21
Welded Steel Netting, (1 sq. meter)				
No. 4 (6 × 150 mm)	0.62	0.62	0.62	0.62
No. 8 (4 × 100 mm)	0.49	0.49	0.49	0.49
Special Steel				
Constructural Carbon Steel (SC)	127.78	127.78	127.78	127.78
Stainless Steel, (per kg.)				
SUS 24 (18 CR)				
Sheet (2-6 mm)	0.46	0.46	0.46	0.46
SUS 27 (18-8)				
Sheet 0.3 mm	1.08	1.07	1.07	1.07
Non Ferrous Metals				
Electric Copper	995.56	993.75	969.17	965.28
Electric Zinc	369.72	366.20	362.78	361.81
Electric Lead	279.86	270.72	266.11	262.50

Tin	3506.25	3467.50	3452.78	3423.61
Antimony	1495.83	1431.71	1388.89	1388.89
Nickel	3566.67	3535.88	3513.89	3513.89
Selenium	20902.78	20902.78	20902.78	20902.78
Bismuth	12222.22	12152.77	10590.28	9513.89
Cadmium	3888.89	3888.89	3833.33	3819.44
Mercury	9895.83	9837.96	9826.39	9826.39
Aluminum	555.56	559.03	553.82	552.08
Rolled Copper & Brass				
Copper Sheet, 2.0 mm	1321.30	1300.93	1277.78	1277.78
Copper Tube, 50 × 5 mm	1434.25	1423.61	1398.15	1398.15
Copper Rod, 25 mm	1384.30	1374.23	1342.59	1333.33
Copper Wire, 0.9 mm	1337.96	1325.62	1297.22	1291.67
Brass Sheet, 2.0 mm	1000.00	999.23	988.89	986.11
Brass Tube, 50 × 5 mm	1152.78	1152.78	1148.15	1143.52
Brass Rod, 25 mm	805.56	795.52	767.59	763.89
Brass Wire, 6 mm	1009.26	1061.73	990.74	990.74
Rolled Aluminum				
Sheet (99%), 1.0 mm (400 × 1,200)	798.61	798.61	805.56	805.56
Circle, 1.0 mm	881.94	881.94	881.94	881.94
Steel Scraps				
Special for Electric Furnace	24.40	24.69	27.03	32.64
Pig Iron Scrap	51.94	49.31	49.31	50.00
Copper Scrap				
No. 1 Copper Wire (Berry)	871.94	920.14	902.36	912.27
No. 2 Copper Wire (Birch)	820.00	847.11	821.53	831.25

Source: Japan Metal Bulletin

Table 3
Domestic Retail Prices of Selected Steel Products
Source: Bureau of Commerce
October 1971 to January 1972

	October	November	December	January
Galvanized Iron Roofing Sheet, per Sheet				
Local Gauge No. 26 Apo & River Brand				
32″ × 6′ Corrugated	10.20	10.20	10.20	10.20
32″ × 7′ "	11.90	11.90	11.90	11.90
32″ × 8′ "	13.60	13.60	13.60	13.60
32″ × 9′ "	15.30	15.30	15.30	15.30
32″ × 10′ "	17.00	17.00	17.00	17.00
36″ × 8′ Plain	13.60	13.60	13.60	13.60
Local Gauge No. 31 Apo & River Brand				
32″ × 6′ Corrugated	7.50	7.50	7.50	7.50
32″ × 7′ "	8.75	8.75	8.75	8.75
32″ × 8′ "	10.00	10.00	10.00	10.00
32″ × 9′ "	11.25	11.25	11.25	11.25

32″ × 10′ ″	12.50	12.50	12.50	12.50
36″ × 8′ Plain	10.00	10.00	10.00	10.00
Aluminum Sheet, per Sheet				
Gauge No.				
.019 × 36″ × 8′	22.00	22.00	22.00	22.00
.024 × 36″ × 8′	27.30	27.30	27.30	27.30
Square Bars				
3/8″ × 20′	4.50	4.50	4.50	4.50
1/2″ × 20′	8.40	8.40	8.40	8.40
5/8″ × 20′	13.70	13.70	13.70	13.70
1″ × 20′	40.00	40.00	40.00	40.00
Round Bars				
1/4″ × 20′	2.00	2.00	2.00	2.00
1/2″ × 20′	4.50	4.50	4.50	4.50
5/8″ × 20′	9.00	9.00	9.00	9.00
3/4″ × 20′	16.36	16.36	16.36	16.36
1″ × 20′	29.10	29.10	29.10	29.10
Flat Bars				
1/8″ × 1/2″ × 20′	3.00	3.00	3.00	3.00
3/16″ × 1″ × 20′	5.00	5.00	5.00	5.00
1 1/4″ × 1″ × 20′	7.50	7.50	7.50	7.50
Angle Bars				
1/8″ × 1″ × 20′	9.00	9.00	9.00	9.00
3/8″ × 1 1/4″ × 20′	10.00	10.00	10.00	10.00
1/4″ × 1″ × 20′	18.00	18.00	18.00	18.00
3/8″ × 3″ × 20′	80.00	80.00	80.00	80.00
Galvanized Iron Pipe				
1/2″ × 20′	12.00	12.00	12.00	12.00
3/4″ × 20′	17.00	17.00	17.00	17.00
1″ × 20′	23.00	23.00	23.00	23.00
1 1/2″ × 20′	38.00	38.00	38.00	38.00
2″ × 20′	48.00	48.00	48.00	48.00
Black Iron Pipe, a piece				
1/2″ × 20′	10.00	10.00	10.00	10.00
1″ × 20′	19.00	19.00	19.00	19.00
1 1/2″ × 20′	32.00	32.00	32.00	32.00
2″ × 20′	41.00	41.00	41.00	41.00
Barbed Wire, per roll, local				
70 lbs.	63.00	63.00	63.00	63.00
60 lbs.	60.00	60.00	60.00	60.00
35 lbs.	33.00	33.00	33.00	33.00
Machine bolts, with nuts, per kilo				
All sizes	2.50	2.50	2.50	2.50
Common Wire Nails, per kilo				
1″ — 1 1/2″	1.80	1.80	1.80	1.80
2″ — 2 1/2″	1.70	1.70	1.70	1.70
3″ — up	1.60	1.60	1.60	1.60

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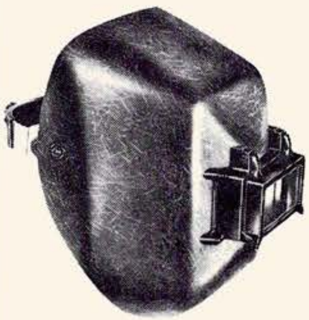

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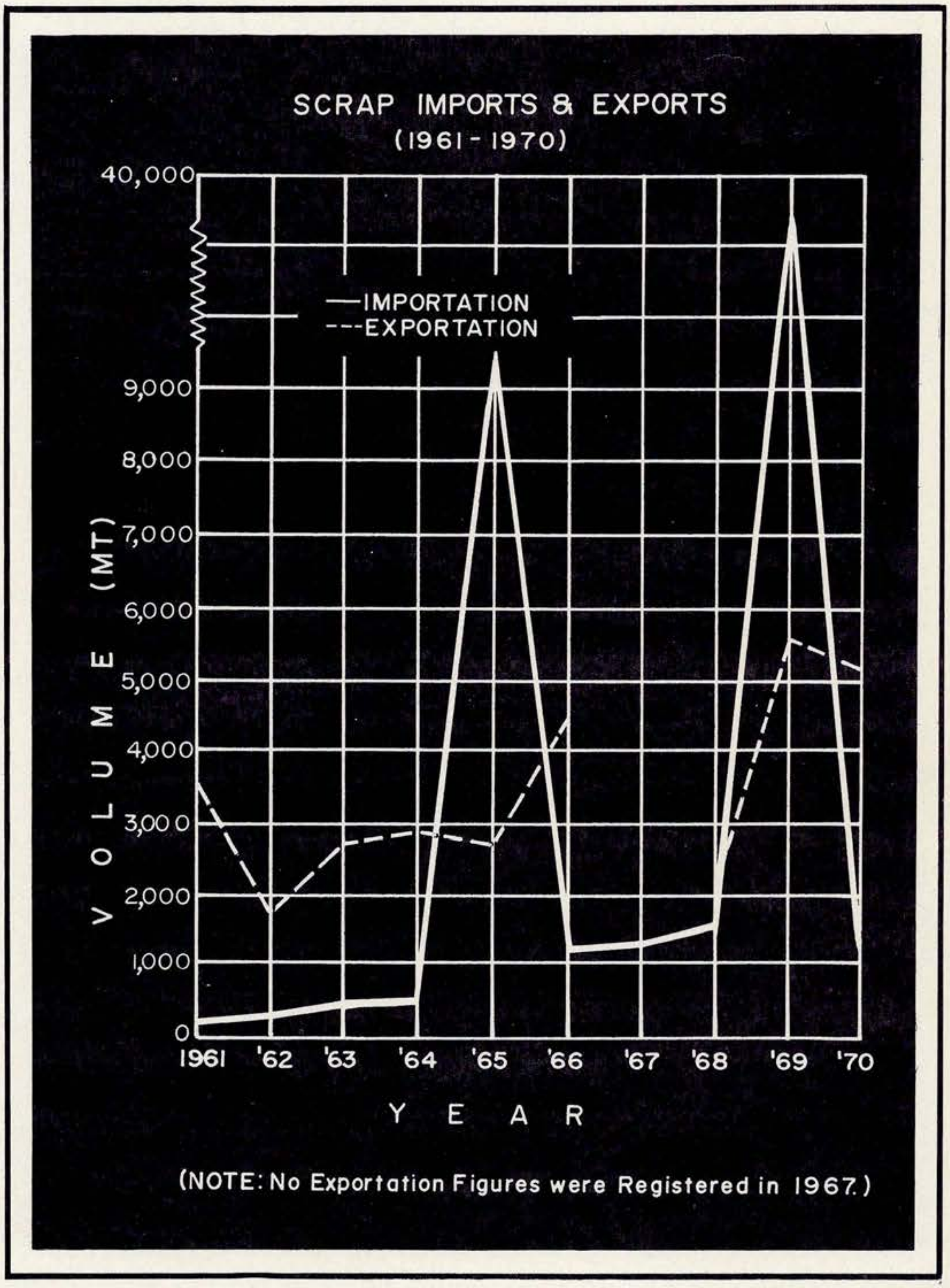


SCRAP SITUATION IN THE PHILIPPINES

No other metal industry in the Philippines today offers a more rewarding challenge than the scrap industry. This is mainly because scrap, both ferrous and nonferrous, is one of the two domestic sources of metals, the other being imports of various metal- products. Up to the present, the bulk of scrap consumption is in the form of iron and steel, although the recovery of non-ferrous scrap principally aluminum and copper, is continuously gaining importance in the metals industry.

Since the beginning of the World War II, hardly any scrap has been exported by the Philippines. On the other hand, imports from countries like Japan and the United States were fairly regular.

In 1970, an estimated 1,188 metric tons of ferrous and nonferrous scrap was imported — very low compared to that registered in 1969 which amounted to 39,056 MT. During this year, businessmen began to feel the inflationary tendencies of the economy which called for a need to stock-up inventories for available supply in the future. This and the recurrent shortages felt during that period were what primarily caused importation figures to be hiked to an unrealistic level compared to that of the previous years.

It can be noted from statistical trends that the major portion of importation throughout the decade consisted of iron and steel scrap; exactly the opposite that of the exportation figures which recorded heavy volume of nonferrous scrap. In 1970, for instance, exportation totalled 5,184 MT with iron and steel contributing a minimal amount of 35 MT. This was very close to the 1969 figures of 5,878 MT with 170 MT of iron and steel. This just proves that there is a bigger demand for iron and steel scrap in the country. It is for this reason why more attention is given to ferrous scrap in this study.

Aside from importation, we get the biggest bulk of our supplies of scrap from: Government agencies like the Philippine National Railways, the Armed Forces which include the Army, Navy and Air Force, the National Shipyards and Steel Corporation and the Bureau of Supply; metal working companies like foundries, steel plants fabricators and rolling mills; the transportation companies; industrial end users and military bases. However, no definite figures on the amount of scrap generated could be given due to unavailability of data. Nevertheless, considering the rising demand for metal products over the past years, we can estimate the substantial amount of scrap generated every year. For metalworking companies alone, an estimate of three to five per cent of scrap is generated from total production. Those firms with melting facilities process their scrap production; the others sell their scrap to scrap dealers who in turn either sell them to secondary melters or export them to foreign countries. This is an indication that there is constant availablity of scrap in the country plus the economic potential it generates.

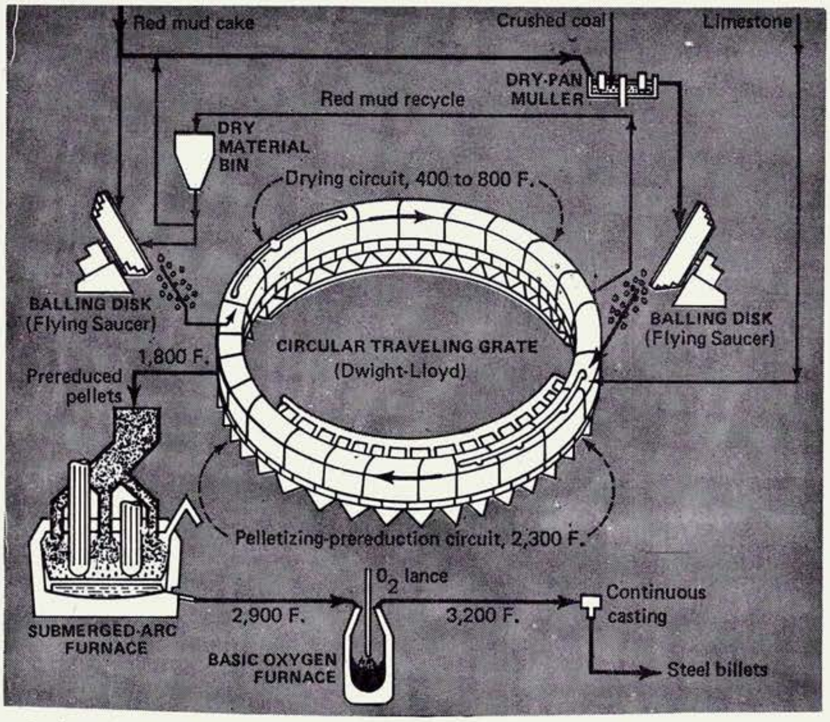
However, not all of the the available scrap can be recovered economically. Expansion of existing plants is somewhat hampered by economic limitations foremost of which are collection, transportation cost,recycling facilities and technical recycling expertise. To top it all, the price trend of scrap in the counry is continuosly increasing. In the past five *years steel scrap was quoted anywhere from ₱0.15 to ₱0.17 per kilo. Today, the maximum price given ranges from ₱0.25 to ₱0.27 per kilo.*

The planning and development of the scrap industry is somewhat handicapped due to the existence of inadequate statistics and information. There is no close communication between secondary melters and scrap dealers regarding the amount of scrap that has so far been generated. The worst part is that there is really no efficient system of collecting and of grading scrap. Up to now, collection is done haphazardly, thus the processors and manufacturers are unaware of the existence or shortage of scrap. Melting plants rely heavily on new scrap generated from existing plants with little attention given to old or abandoned scrap which up to the present has not been fully utilized adding up to the problem of storage.

The major concern today is how to get these materials back into the scrap cycle. It is imperative therefore to organize a system of collecting; reclaiming and recycling scrap which otherwise would be waste products, to supplement the increasing demand for metal products. The proposal of the different sectors of the industry affected is to form an association that will plan and implement the necessary course of action that can lead to the eventual upliftment of the industry. This association will take care of buying scrap and distributing it to its members. Pricing, grading and distribution will be determined by the association. It will also be the task of this association to record statistics on the amount of scrap generated against that recovered yearly. This study on the market condition will enable manufacturers to see the availability of supply compared to existing demand. In this manner, dependence on importation will be minimized so that foreign exchange can be conserved. The problem of processing scrap can be solved by providing technical expertise who will conduct researches on the most economical means of recovering scrap. Even if the problem of collection is reduced, if a large tonnage is wasted simply because of the lack of the necessary technical know-how and facilities, then the time, money and efforts to be exerted by such an association can prove to be futile.

The problems of the scrap situation in the country are not insurmountable, yet they present a challenge to the entire metals industry because here lies the future development of local production. Processing scrap would supplement shortages in local production rather than getting additional imported raw materials to meet local demand. Any move will affect the industry as a whole for good or bad. An efficient collecting system will mean that more scrap will be recovered and together with the modern technical method of processing, a huge tonnage of scrap can be converted into useful products. From the economic point of view, there will be no need for storage cost and the dollars spent on added raw materials importation can be used for other important products needed by the country.

Suffice it is to say that through the continuous effort of the government and the private sector, the scrap industry in the country can look forward to a future and it is hoped that the plans to improve skills and knowledge necessary for progress in the scrap metal industry, will be put to reality.



Red mud, an aluminum waste, becomes "iron ore" in the new process.

REVIEW OF THE PRINCIPLES OF FLOW OF BULK SOLIDS IN BINS

A solid flows out of a bin provided that the outlet is sufficiently large so that stable obstruction to flow do not develop. The geometry and surface finish of a bin and the construction of the feeder determine the type of flow pattern which then develops within it. The pattern, in turn, affects the uniformity and consistency of the stream, segregation, coking, degradation, live capacity and the action of level-measuring devices.

In most bins now in operation, material flows toward the feeder through a channel which forms within the stationary solid. This is referred to as funnel flow. If the hopper of the bin is sufficiently steep and smooth and the feeder capable of drawing material across the whole area of the outlet, all the solid flows whenever the feeder is in operation; this is referred to as mass flow. Mass flow bins are usually far superior to funnel-flow bins; their initial cost is also usually higher.

The paper describes the design criteria used in determining the minimum bin outlet needed for flow and the bin geometry needed for mass flow. **CIM Bulletin, June, 1970**

STEEL FROM ALUMINUM WASTE

McDowell Wellman Engineering Co. of Cleveland, Ohio has developed a process to utilize "red mud" (the aluminum wastes high in iron oxides (30-60%) that are left after aluminum has been extracted from bauxite) for iron and steel production. In this process, the red mud is pelletized and pre-reduced in a Dwight-Lloyd circular travelling grate, then fed into a submerged-arc electric furnace and converted to steel in a basic-oxygen furnace. It is estimated that a 500-600 Ton/day plant using red mud as feed could make steel at prices competitive with that from a blast furnace. Capital investment - excluding such auxiliary facilities as ship unloaders and ore yards - would range from \$20 to \$30 million. **Chemical Engineering, September, 1971**

HOT STRENGTH AND COLLAPSABILITY OF CO_2 SAND

A material for mold cavities must have good erosion resistance against onrushing metal flow, sufficient compressive strength to maintain shape under hydrostatic pressures where the metal flow changes direction, sufficient plasticity to accomodate a solidifying, shrinking casting without hot tear.

But when the casting is removed, the mold material must collapse to facilitate shakout and cleaning: high temperature behavior is at this time in the casting history is of no importance. Poor collapsability has been a chronic problem with CO_2 sands.

The purpose of this investigation was primarily the development of a sand mix and mixing procedure with an acceptable combination of low retained strength and sufficient high temperature strength without sacrificing any other advantages of the CO_2 process.

Silicate-CO_2 sands are strong at high temperature because the silica fuses with Na_2CO_3 formed in the CO_2-silicate reaction, creating a glass bond. This study tried to find an optimum mix which would retain hot strength but also collapse easily. Earlier studies showed that additions of kaolin and zircon flour to CO_2 sands of AFS grain size No. 47 were partially successful.

Our tests were run using a 4-screen subangular sand (AFS fineness 70 or 120). The finer grain size sand was stronger at high temperatures because more binder was required; it was also harder to knockout. When binder content was raised from 3.3 or 3.6%, both hot and retained strength went up greatly (see figure). Diluting the silicate sand mixture with excess water prolonged gassing time and stickiness of the sand. When invert sugar was added, however, amounts up to 2% helped retain hot strength to 1500°F caused no stickiness and eased collapsability of the sand by burning out in contact with the hot metal.

Substituting 1.7% Fe_2O_3 for 1.7% Al_2O_3 resulted in a significant reduction of retained strength over the lower temperature region. However, hot strength drops off sharply above 1750°F. An inorganic addition of 0.18% Al_2O_3, 0.3% TiO_2, and 0.82% MnO_2 proved undesirable.

Replacing Al_2O_3, by TiO_2 decreased the retained strength at all temperatures but also lowered hot strength.

Zircon additions were inferior to Al_2O_3. Considering all effects, alumina still appears the most promising inorganic additive.

Adding invert sugar, kaolin and Al_2O_3 in that sequence and finally sodium-silicate improves hot strength. When the liquid sugar is added first, hot strength does not exceed 600 lb/in.^{2} above which susceptibility to hot tearing is expected. Similarly, retained strength is below the desired maximum of 100 lb/in.^{2}.

Based on the preceding data the following mix is recommended:

3.3% Sodium-silicate, Na_2O/SiO_2 ratio 1/1.9 Baume 40°
1.7% Kaolin
1.7% 32 mesh Alumina
2% Invert Sugar (76% solids, 40° Baume)
1.4% Free Moisture

The recommended mixing sequence:

1. Mull sand + invert sugar for 1 minute
2. Add kaolin and alumina and mull for 2 minutes
3. Add sodium-silicate and mull for 1 minute

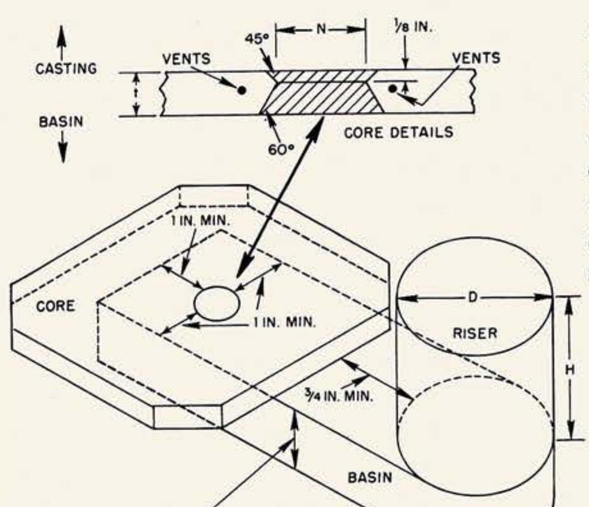
Modern Casting, June, 1971

NEW GIT-TOPPING SYSTEM FACILITATES PRODUCTION

Foseco of Cleveland, USA developed a system to promote more consistent metallurgical structure, while increasing ingot yield by minimizing "pipe". The "Seal-on" system utilizes four fibrous ceramic liner boards and a high-refractory gasket ring, which is soft enough to form a gasket under pressure, flexible enough to eliminate breakage and refractory enough to withstand the high temperatures of steel making. **Industrial Heating, July, 1971**

MINIMIZING COPE DEFECTS IN STEEL CASTINGS

Cope defects on steel castings with large cope surfaces can be minimized by a technique called "atomic" risering and gating. So-called because the molten metal flowers like the mushroom formation of an atomic bomb as it enters the neck portion of the risering core, this technique minimizes defects caused by gate erosion, slag entrained in molten metal, ladle refractories, or metal deoxidation products. **Foundry, September, 1971**



"Atomic" risering and gating techniques is similar to that used in the Washburn core technique. The neck of the core conncets the drag surface of the casting with a basin of metal that is fed by a riser-gating system, shown here.

EFFFECT OF REDUCTION RATE ON THE SWELLING AND CRACKING OF SOME COMMERCIAL HEMATITE PELLETS

Four types of oxidized pellets have been reduced to magnetite in hydrogen-steam atmospheres, and the accompanying changes in the microstructure, volume and appearance studied. In supplementary work, the rate of reduction to magnetite was investigated for two types of pellet hardness test were also carried out. The orders of merit of the different types with respect to volume expansion, surface cracking and surface hardness were in broad agreement. The extent of surface cracking appeared in general to decrease with decreasing hydrogen exerting partial pressure. Any given type of pellet should either increase in volume expansion to a maximum, followed by a decrease, or a continuous increase in volume expansion with decreasing partial pressure of hydrogen. Microexamination revealed porosity in magnetite and cracking along the macroscopic hematite/magnetite interface; transparticle reduction fronts tended to be lamellar after 900° Centigrade reduction and hemispherical on 750° reduction. Indications were obtained of inherent variation in structure between individual pellets of any one type. **Journal of the Iron and Steel Institute July, 1970**

MAKING COMPLEX SHELL CORE. . . .ONE STEP AT A TIME

The process consists of blowing the parts of the core individually and then "welding" it by a final and interlocking core. However, sometimes even shell-core experts fail at it, because even a preheated shell core expands when it is placed into a shell corebox that is at operating temperature. This the range at which silica's coefficient of expansion climbs rapidly.

If the job is not accurately engineered, the resulting assembly—after curing the added sections – sticks in the box. Box cavities for core-on-core operation must be painstakingly sized. A working knowledge of thermodynamics helps. **Modern Casting, September, 1970**

FIVE WELDING TECHNIQUES FOR SEAMLESS STEEL TUBING

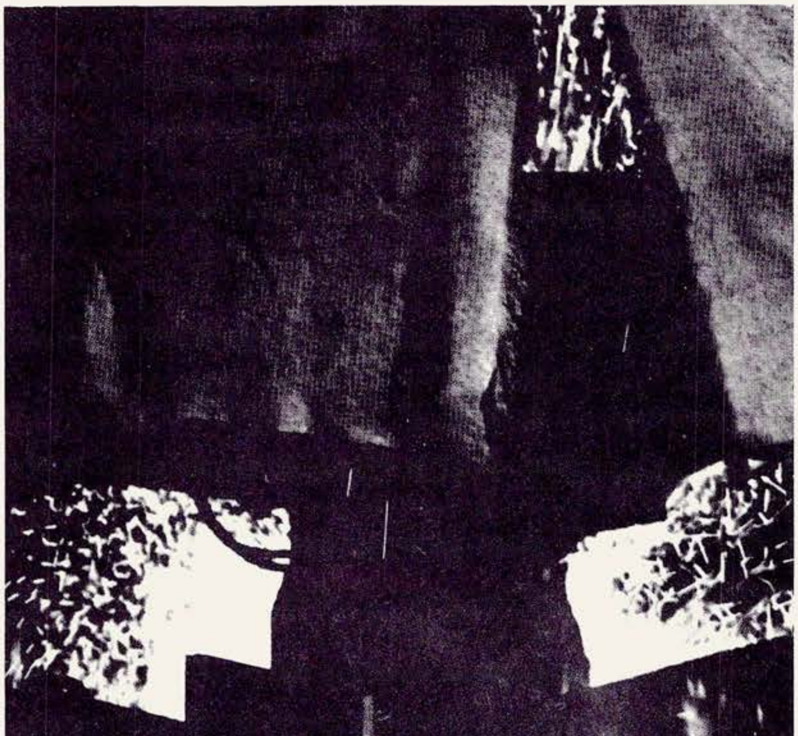
Selection of a welding process for seamless specialty tubing applications exerts a significant effect on the quality of the work and the economics of the job. The welding processes deemed practical for nearly all tube joint welds are the following: submerged arc welding, oxyacetylene welding (gas), shielded metal arc welding (TIG or heliarc welding), and gas metal arc welding (MIG or shortarc). No single process is best for all welding applications but each of them does one or more things better than any of the others. In terms of efficiency and economy, there is an optimum welding process for each tubing application. **Manufacturing Engineering and Management, April, 1971**

WATER-BASE LUBRICANT WITH GRAPHITE PARTICLES IS ADVANTAGEOUSLY EMPLOYED IN DIE-FORGING

Acheson Colloids Company has developed a non-flammable lubricant consisting of finely processed graphite particles and special additives in a water base to improve die dill and cooking life. The graphite can withstand the high temperature and pressure of the forging operation. It retains its lubrication qualities and does not produce gases that can block metal movement.

Air pollution caused by oil burning and fumes produced when used on hot dies is eliminated by the substitution of this lubricant which produces only water vapor. Cleaning time of tooling is reduced, the lubricant requiring only hosing with water to clean tooling instead of scraping sludge when oil is used. **Industrial Heating, April, 1971**

The white heat of fusion is seen cascading sparks as an alloy tube and a forging are brought together for flash welding.



AN EMPIRICAL STUDY OF COMMINUTION IN AN OPEN OPEN-CIRCUIT BALL MILL

A central composite experimental design was used to determine empirical relationships between the operating variables of a ball mill and the characteristics of the ground products. The independent variables selected for the study were the work index and size distribution of the feed material, the feed rate and the pulp density. The measured responses included product-size distribution, product-surface area, viscosity of pulp discharge, weight of dry solids in mill, mill time constant and emitted sonic vibrations. The ball mill was operated continuously in open circuit during each experimental run.

Multivariable regression techniques were used to derive linear empirical models from the experimental results. Of the four factors studied, the grindability of the feed material significantly affected every measured response. The size distribution of the ground product was affected significantly by the feed rate and size distribution of the feed, but not by the pulp density. Feed throughout capacity and pulp density were significant to the viscosity of the pulp discharge, the weight of solids in the mill and the mill time constant. Significant first- and second-order models are given for above relationship. The relationships between the characteristics of the sonic vibrations of the operating mill and the various dependent variables have not as yet been established. **CIM Bulletin, May, 1970**

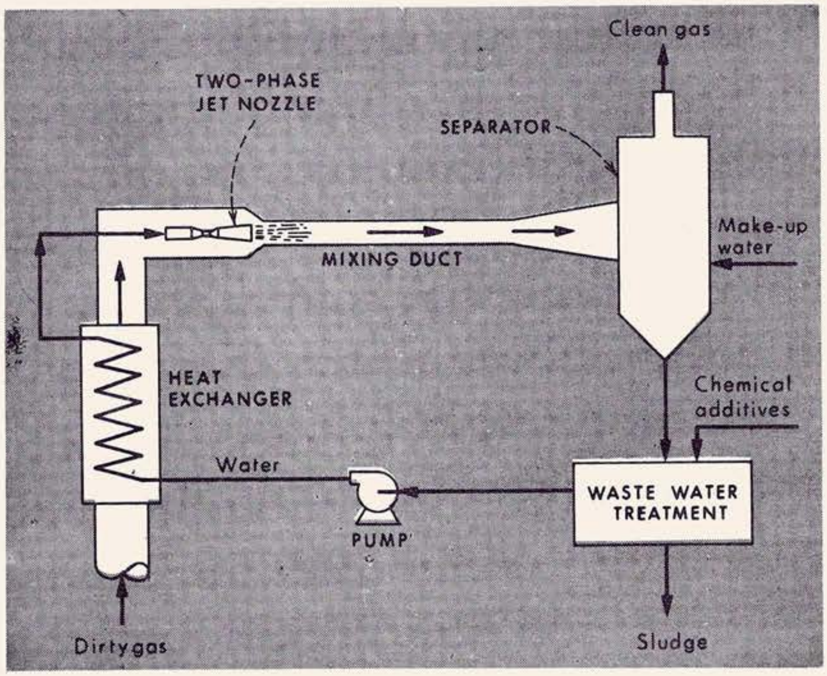
ELECTROFORMING PROVIDES NEW CAPABILITIES WITH ADVANCED PROCESS TECHNOLOGY

Electroforming is a process of fabricating new components by the electrolytic transfer of metal ions as atoms through an electrolyte from an anode to a surface. The plated metal or electroform when lifted away from the receiving surface called the mandrel, retains its as-deposited shape as a component.

Among the unusual characteristics that electroformed parts have are: 1) it can have extremely thin walls 2) high surface finish and intricate detail are easily obtained 3) dimensional tolerances can be held to high accuracy and 4) maximum size is limited only by the size of the available plating tank. **Industrial Heating, July, 1971**

HIGH-STRENGTH, HIGH-ALLOY STEELS

The demand for high-alloy (over 10%), high-strength (over 60 tsi – 930 MN/m^2 – yield stress) arises from considerations of environmental conditions where low alloy, high strength steels lack the necessary resistance to attack by highly corrosive media or suffer from high-temperature deterioration processes as excessive oxidation, loss of mechanical properties or creep. The high strength on steels depends on a microstructure which is stable only over a limited range of temperatures. Beyond this range, the cold-worked steels recrystallize and the precipitation – hardened steels overage in which case there is a catastrophic loss of strength. This restriction on the permissable service temperature is fundamental and the retention of high strength at high temperatures will be achieved only in dispersion-hardened and fibre-reinforced materials. **Journal of the Australian Institute of Metals, September, 1971**



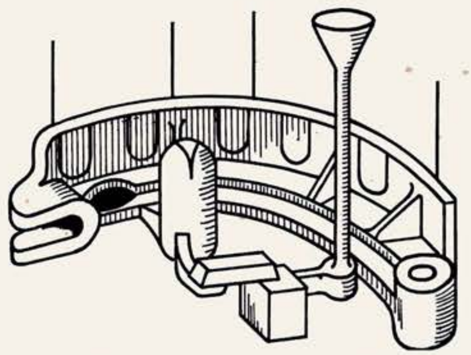
Pressure rise in the ADTEC system ranges from 10 to 30 in. water gage.

SCRUBBING SYSTEM REMOVES SUBMICRON PARTICULATES

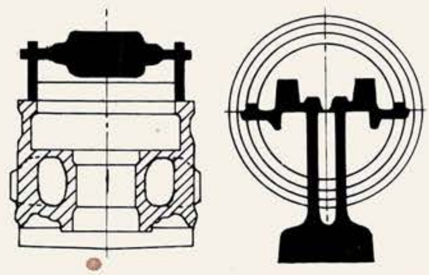
In its first full-scale installation of the new wet scrubber, ADTEC System reportedly achieved a 99.6% removal efficiency for a furnace exhaust in which about 85% of the dust particles are smaller than 0.1 micron, and is removing such water-soluble gases as sulfur dioxide and nitrogen oxides. The wet scrubber is applied in the metal industries including submerged arc furnaces, basic oxygen furnaces and foundry cupolas. The pump used in the system is essentially the only moving part so that high reliability and minimum maintenance are featured, along with operating costs said to be 50% of those for comparable systems and turnkey installations costs reportedly 80% of others. **Chemical Engineering, September, 1971**

PROCEDURE FOR EVALUATION OF PROPOSED CHANGES TO PLANT LAYOUT AND EQUIPMENT

Basically there are two reasons why consideration should be given to modification or change to plant and equipment. The first is to lower costs; the second, to put the plant in a position to meet future production demands. Either action is taken to improve profitability. Which alternative to take depends on an agreed-upon market forecast which should include product mix as well as levels of production. It would be an uneconomical action to modify or change for the specific purpose of lowering costs only to find that the change does not meet increased production demands in the near future. Once anticipated production levels are established for the present and future, work can proceed on the development of the design criteria. In this evaluation of equipment, new technology should be carefully examined to determine where it can be used effectively to improve quality and whether it is economically justified when applied. The evaluation of equipment should also provide the plant with degree of flexibility which would not accrue losses with fluctuating production demands. When completed, manning must be evaluated to determine there is a meaningful reduction in manhours per unit of product. Material cost and material flow must be weighed. Will a new facility raise or reduce the cost of raw material? While in the plant, will material handling costs be appreciably reduced? How about transportation costs, finished products and waste removal? When all this planning is completed, the acid-test will be its justification. What will be the return on investment in the final analysis? **AFS Transactions Vol. 77, 1969**



Schematic gating arrangement for a brake-shoe carrier casting. This is an example of the application of the Inmold Process.



A variation of the Inmold Process using dual nodularizing reaction chambers.

NEW NODULARIZING TECHNIQUES

New techniques in nodularizing are constantly being developed producing castings which have greatly improved strength and ductility and where the metal structure and physical properties are consistently uniform from casting to casting. In situations were no desulphurizing treatment is needed, such as with metal melted in electric arc furnaces, the "Flotret process" has already made possible to locate the nodularizing material in special chamber in the furnace pouring spout and pour iron from the furnace whenever required. In another technique called the "Inmold Process", nodularizing material is placed in a special reaction chamber in either the gating system or the runner bush. The process has been successfully used in an automatic moulding line, producing up to 400 complete moulds per hour and involving poured weights of some 220 to 440 lb. of metal per box. Variations of the technique using dual modularizing reaction chambers have been used to produce castings weighing up to one ton. **Foundry Trade Journal, September, 1971**

ADDITIVES IN IRON ORE PELLETIZING

A systematic study has been made of the effect of various additives on the compression strength of green pellets and the strength and abrasion resistance of dried pellets. A slight improvement in the compression strength of green pellets was obtained with the addition of bentonite only, whereas dry pellet quality was improved by all the additives used. The density and solubility of the additives were found to be important properties. **Institution of Mining & Metallurgy — Section C, September, 1970**

ASPECTS OF SMELTING PIG IRON IN ELECTRIC REDUCTION FURNACES

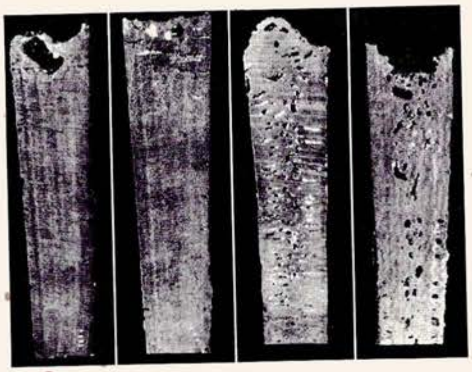
High production rate and good stability demand the optimization of all phases of electric pig iron smelting. This is important with respect to slag chemistry which to a large extent regulates the process temperature in electric smelting. Controlled basicity and slag volume, and a satisfactory screen analysis of the reduction material and sinter, are of the utmost importance for smooth furnace operation. Large variations in slag volume and in B/A and C/Fe ratio will have an influence on the furnace resistance and thus the specific energy development in the furnace, which leads to variable reduction of SiO_2. The result will be variable hot metal quality and unstable furnace operation. **The Canadian Mining and Metallurgical Bulletin August, 1970**

THE CARBON EQUIVALENT Fe-C-Si DIAGRAM AND ITS APPLICATION TO CAST IRON

The equation % C + 1/3% Si = 4.3 has long been used to express composition of the ternary Fe-C-Si eutectic. This equation has been challenged by many investigators, especially with respect to the effect of silicon on the austenite liquidus curve. Carbon equivalent actually deviates from this relation for silicon contents between one and four per cent. The multiplier for silicon in the equation should be closer to 0.25 (instead of 0.33) at higher silicon content since the true eutectic liquidus temperature actually climbs several degrees with a shift in silicon content from 0-4%. Existing information permits projection of the Fe-C-Si system sections at constant % Si into the Fe-C binary system with the limits of more than 2.0% carbon equivalent and from 2500°F (1371°C) down to the beginning of eutectic solidification. **AFS Cast Metals Research Journal, June 1971**

PARTICLE METALLURGY TURNS OUT TOP TOOL STEELS

Crucible Materials Group of Colt Industries is commercially producing high-speed tool steels by a new process, called particle metallurgy, which eliminates carbide segregation producing better tool steels. The process involes gas atomization of a molten stream of the desired alloy. When the atomized alloy is cooled, the resulting particles are extremely fine micro-ingots. The particles are then placed in containers and compacted to a 100 per cent density by an unusual hot isostatic compression method. Specific advantages claimed include: homogeneity in both macro and microstructure, superior grindability, more responsive to heat treatment, damage during grinding is minimized and improved toughness test results. **33, February, 1971**



Experimental ingots, 28 lb., showing varying degrees of porosity.

THEORETICAL AND PRACTICAL ASPECTS OF BLOWHOLE FORMATION IN CARBONSTEEL INGOTS

The paper relates the formation of blowholes in solidifying steel to the total partial pressure of gases (Ptotal) dissolved in the liquid. The treatment is based on a model of solute enrichment in the liquid within an interdendritic cell and the build-up of PCO, PH2, and PN2 in that liquid as solidification proceeds. It has been applied to silicon-killed plain-carbon steels of up to 0.5% C and to free-cutting steels of the Enla type. A large number of small experimental ingots of various compositions have been made and their blowhole structure examined. It has been found that the computed value of Ptotal (at a given stage of solidification of the interdendritic cell) for marginally porous ingots falls within a fairly narrow range of values. This can be used to predict the likelihood of subcutaneous porosity in ingots of other compositions. The laboratory work has also been applied to tonnage ladle-balanced steel production and plant trials have established the validity of the laboratory predictions. It is possible to judge the relative ease of making the various compositions in balanced ingot form. The important roles played by hydrogen and nitrogen, besides that of carbon monoxide, are highlighted. Results from the work are compared with those of other authors. An appraisal is then made of the influence processing variables may have on blowhole formation and suggestions are made for further possible spheres of work in the production of ladle-balanced steels. **Journal of The Iron and Steel Institute, September, 1971**

ECONOMIC PRODUCTION OF SHAPES AND TUBES IN GRAY AND ALLOYED IRON BY HORIZONTAL CONTINUOUS CASTING

Horizontal continuous casting of iron and alloy iron has expanded into many more geometric forms than simple round bar. About 100 continuous casting strands are now on line, producing about 30,000 tons yearly in Europe and another 6000 tons yearly in North America. These forms include square bar, channels, hollow bars, tube, even profiles for milling machine tables.

Operating experience of the authors shows that continuous casting of these shapes competes economically with centrifugal, sand and static chill casting of equal quality. They show how their own continuous casting plant prepares for continuous casting, present metallurgical aspects of the process and show the influence of rapid cooling in the graphite dies employed affects graphite form and microstructure.

Several extensive examples illustrate operating costs for a continuous casting plant with the object of amortizing these costs over 5 years on a one-shift basis. The operating costs for a continuous casting plant break down to 4.7 cents per lb., not including cost of the metal melted and poured. This is for a one-strand machine. When a

4-strand machine produces 750 lb/hr of 2-in. diameter bar, operating costs drop to 2.6 cents per lb. A complex milling table profile (see figure) runs only 2.9 cents per lb. A twin-strand machine casting bearing cap profiles costs only 3.3 cents per lb. The consistently high strength of this iron, with a low scaterband, makes the bearing cap less costly than one cast by any other technique.

In casting thin-walled tubes, the outer surface has types D and E graphite, while the inner wall is type A, 100% pearlite microstructure. Small tin additions and adjustment of withdrawal rate convert the type D and E graphite to more favorable microstructures.

The authors predict that computerized operation of the continuous casting process, as is already employed in steel mills, will virtually eliminate the need for labor, improve yield (which is already phenomenally high for continuous casting) and enable the metalcaster to offer more competitive selling prices.
Modern Casting, June, 1971

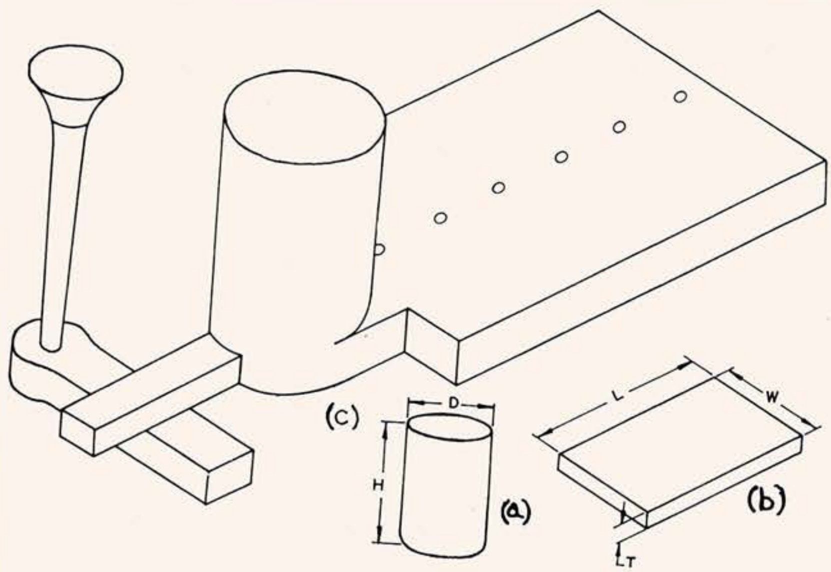
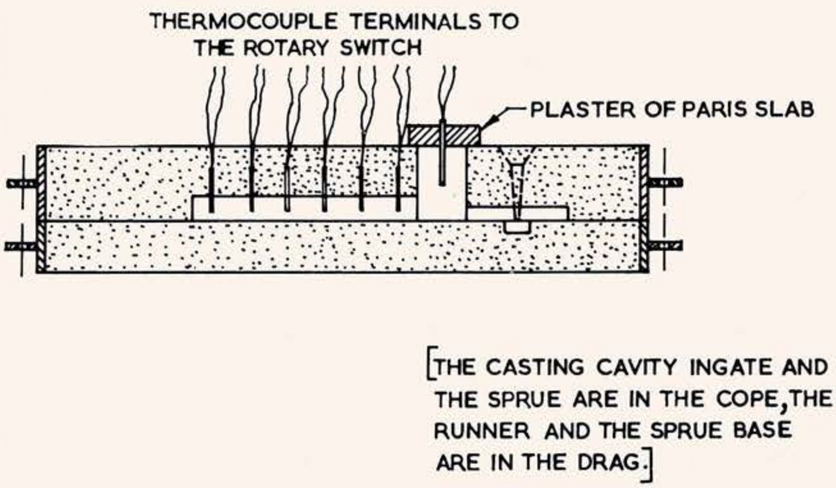


Fig. 1. Cylinder (a), Plate (b) and Cylinder-Plate Combination (c) with the gating system.



Section of the assembled mold for the combined casting.

GRAY AND DUCTILE IRON CASTINGS DESIGN FUNDAMENTALS

The freedom of shape that can be achieved in iron castings simplifies design. Many of the old rules for casting design, such as keeping metal sections uniform, avoiding sharp angles and curving wheel spokes to reduce residual stresses are still valid. However, modern iron castings processes provide a greater design latitude for casting applications.

The article describes some techniques in modifying the shape of a casting to effect some changes in minimum stress, dynamic loads elastic and plastic strain, and stress distribution. **Machine Design September, 1970**

DIMENSIONING OF RISERS FOR LONG FREEZING RANGE ALUMINUM ALLOYS

Feeding is an important parameter influencing casting quality. Owing to their long freezing range, some aluminum alloys such as Al-4.4% Cu (LM 11), and Al-2-4% Cu-4 to 6% Si (LM4) widely used in aircraft and automotive industries, do not feed freely and it is not easy to produce high quality casting. Experiments on feeding plate casting of Al-4.5% Cu and Al-3.03% Cu-4.5% Si top-insulated cylindrical side risers indicate the following: 1) for a particular alloy in a given test casting shape, a direct linear relation exists between the logarithm of solidification time and the logarithm of volume over surface area (V/SA) ratio; 2) for a given alloy, solidification time of the test casting decrease in the order: plate, cylinder of height over diameter (H/D) ratio 1.5 and cylinder of H/D ratio of 1.0; 3) for both alloys, ultimate strength decrease non-linearly with increasing porosity. **AFS Cast Metals Research Journal, June, 1971**

EFFECT OF AUSTENITIZING CONDITIONS ON THE ISOTHERMAL NUCLEATION OF MARTENSITE

The effect of austenitizing time and temperature on the isothermal nucleation of martensite in an Fe-Ni-Cr alloy has been studied. Increasing the final austenitizing temperature caused a reduction in the initial number of martensite embryos and a decrease in the activation energy for the nucleation of martensite. Increasing the austenitizing time also resulted in a reduction in the number of embryos but had no observable effect on the embryo efficiency. These results are consistent with the hypothesis that some form of dislocation configuration acts as the embryo for martensite nucleation. **Journal of The Iron and Steel Institute, September, 1971**

HCIF DEVELOPS CONTINUOUS APPROACH TO INDUCTION INDUSTRY

Continuous melting with little or no air pollution was the objective and the result is the HCIF (horizontal coreless induction furnace). In contrast with conventional induction furnaces, with upright power coils, the HCIF uses a horizontal induction coil so that the melt zone is filled with molten metal at all times.

The HCIF operates on principle of continuous overflow by displacement. As the solid charge is added to the charge end, molten metal at the desired temperature is displaced from the pour end. Power input to the furnace is in proportion to the charge or melt rate, realizing a thermal balance, which is claimed to maintain the tap temperature at $\pm$ 10°F. **Foundry June, 1970**

MORE POWDER-METAL POTENTIAL

A trio of new processes – two chemical routes and a mechanical alloying approach – should help powder-metal makers tailor their existing products closer to new and existing markets.

In the first process, simultaneous and homogeneous gelation of mixed metal halides in alcohol solution is the key. Any transition metal such as nickel, cobalt, iron, copper, etc. and a variety of oxides that do not reduce in hydrogen at the reduction temperature can be used. The other gel reactants are an epoxide such as propylene oxide, and an alcohol such as methanol. The gel is dried to a glassy metal hydroxide gel. The calcining temperature then fixes the particle size of the metal oxide, and the reduction temperature determines the particle size of the metal.

The second process involves chlorination of tungsten-containing material to form chlorides and the tungsten is isolated by fractional distillation. The chlorides can then be reduced with hydrogen to present particle size. The classical route to tungsten powder includes dissolving a high-grade ore in sodium carbonate or hydrochloric acid and ultimately transforming it into ammonium para-tungstate. Tungsten powder produced by this process have narrow particle-size distribution and yield a cemented carbide that is tougher.

The third, that is mechanical alloying, involves the method developed by INCO's J.S. Benjamin and R. L. Cairns. Consolidation of powder is accomplished by hot extrusion. After heat treatment, the mechanically alloyed product had strength levels typical of precipitation hardenable materials below 1500°F. **Chemical Engineering, August, 1970**

TECHNIQUE FOR DIAGNOSIS OF CORROSION FAILURES

To a practical corrosion engineer, the diagnosis of corrosion failures is one of the most important aspects of his work. For the most part, the diagnosis reached determine the preventive steps to be taken in any given problem; hence it is critical that the diagnosis be as close to the truth as possible to insure that correct steps are taken. Because of the combination of discipline involved in the study of corrosion, wide varieties of tools from these disciplines are available to the corrosion failures. Almost any technique available in the fields of metallurgy, physical chemistry, electrochemistry, or surface chemistry can in one way or another be applied to the study of specific corrosion problems. This paper will describe the various techniques that are applicable to the diagnosis of corrosion failures; however a general picture of the usefulness of the methods will be given rather than a detailed commentary. The purpose is to assist the corrosion or materials engineer in selecting the most appropriate method to apply to any problem. **Metals Engineering Quarterly August, 1970**

FLOWABILITY OF MOULDING SANDS

After looking closely at the work carried out by many authorities on aspects of lowability of sand under squeezing, jolting, and jolting followed by squeezing, the author presents details of two methods by which he measured flowability: by measuring the bulk density gradient of a compacted column of sand and by examining the overall density of compacted moulds prepared with patterns of intricate surface detail. It was thought that the second of these two tests embodied, to some degree, all aspects of flowability and methods of compaction. **Foundry Trade Journal, August, 1970**

WB **WARNER BARNES ENGINEERING**

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SIMPLE NONDESTRUCTIVE METHOD FOR IDENTIFYING MOLYBDENUM BEARING STAINLESS STEEL

A simple test procedure for the determination of molybdenum in stainless steel has been developed. To conduct the test, inspection personnel connect the positive terminal from a six-volt battery to the metal to be tested and the negative battery terminal to a carbon rod.

One drop of electrolyte solution (five per cent KCns in one part $SnCl_2$ prepared by dissolving 25 gm of $SnCl_2$ in 20 ml of concentrated HCl and diluting to 100 ml) is then applied to the test metal and the carbon rod is placed against the solution (but not the metal) for two seconds, causing the solution to turn pink.

If molybdenum is present the spot retains its hue. If the spot fades rapidly to a light green or clear liquid, this indicates the absence of the elements. **Industrial Heating, October, 1970**

HIGH-TEMPERATURE OXIDATION OF 30% Cr CAST IRONS

The resistance of 30 per cent Cr cast iron to high-purity O_2 at 650° and 950° and to fuel combustion products in the temperature range 550°-625° has been studied. In both cases the results suggest that in short-term experiments the corrosion resistance of the cast irons is comparable to that of currently used unwrought steels. The presence of two per cent Al in the cast iron may further improve the corrosion resistance but also give rise to detrimental, interdentritic inclusions of Al_2O_3. The Cr-rich carbide phase in the cast iron oxidizer preferentially leads to pitting attack, particularly in the early stage of oxidation. **Journal of Iron and Steel Institute, December, 1969**

THE FIRST PRIVATE SECTOR AND MIDC WORKSHOP SEMINAR

FEBRUARY 11-12, 1972
SAVOY HYATT, PHILIPPINES

MIDC personnel welcome participants.

At the registration table, nametags and brief cases from Mabuhay Vinyl Corporation were distributed.

The moderator was Jose Ma. Galza, shown at the rostrum. Also shown are: Dr. Arizabal, MIDC Director; Florencio A. Medina, Chairman; MIDC Board of Trustees who gave the opening remarks and Brother Benedict P.S.C. of De La Salle College who delivered the invocation.

REGISTRATION

FIRST DAY

Dr. Antonio V. Arizabal, spoke on "MIDC: Its Role in the Development of the Local Industry". Discussants were:

. . . . Lauro Cruz, Vice-President, AG&P

. . . Jose Quema, Vice-President, Atlas Consolidated Mining and Development Corporation.

. . . . Dr. Jose Lawas, Actg. Director, Office of National Planning, NEC

. . . Fernand Dugal, UNIDO Project Manager for MIDC

Lunch at Mindanao and Luzon Rooms of Savoy Hyatt.

Dominador de Jesus, Vice-pres. & Gen. Mgr. of IPI spoke on the "Technical Service Requirements of the Metals Industry". Discussants were:

. . . . Hector Quesada, President, Mantrade Industries, Inc.

. . . . Constante Ventura, Gen. Mgr., Mfg., Honiron (Phils.),

. . . . Pablo Silva, Jr., Asst. Vice-Pres., CPJ Corp.

Robert Bell, ILO Project Manager is shown expounding on "Skills Upgrading Program for the Metals Industry". Discussants were:

. . . . Prof. Estanislao Angeles of Feati Industries

. . . Isabelo Tapia, Assistant General Manager, NASSCO

. . . Prospero Salvacion, General Manager, Philippine Sewing Machine Manufacturing Corporation

Victor G. Guevara, Exec. Vice-Pres. — Mabuhay Vinyl Corporation

Hector Quesada, Pres. — Mantrade Industries

Raul T. Concepcion, President, Concepcion Industries

Dante Santos, Pres. & Gen. Manager — PHILACOR

Peter Lee of MESCO directs a question to the discussants.

Atty. Ricardo Guevara (in printed shirt), President, MCCI was Chairman of the Resolutions Committee for the Workshop Seminar.

Galza accepting nominations for membership in the Business Advisory Committee, assisted by Mrs. Beatriz Orinion of MIDC. Elected were Herbert Dee, Lauro Cruz, DJ de Jesus, Dante Santos, Jose Quema, Eduardo Chanco, Victor Guevara, Hector Quesada and Peter Lee.

Peter Lee, President of MESCO acknowledges applause from seminar participants after he announced the loan of MESCO's Gallicop automatic lathe to MIDC.

SECOND DAY

*The lone woman speaker, Atty. Chita O. Angeles, Legal and Policy Officer of MIDC spoke on "**Legislative Amendments to the Law Creating MIDC.**" Discussants were:*

. . . . Juan Agcaoili, deputy commissioner of the Budget Commission.

. . . . Jorge Juco, Chief Legal Counsel, Senate Committee on Codes & Constitutional Amendments.

. . . . Carmelo Sison, Assistant Prof., U.P. College of Law

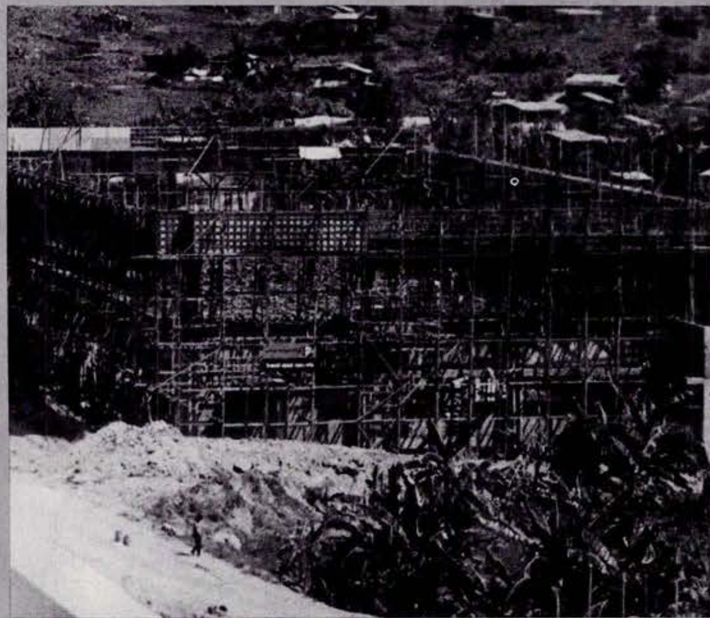
. . . . Victor G. Guevara, Exec. Vice-Pres., Mabuhay Vinyl.

The Participants enjoyed the buffet luncheon at the La Concha of Savoy Hyatt.

BICUTAN

A closer view of the MIDC Pilot Plant building. The plant will be ready for operation in a few months.

To get a better view of the MIDC pilot plant building under construction Raul P. Sulit, led the participants to the roof-top of the NSDB-PTRI Building.



Ruben Pinaroc of MIDC narrates advantages of using the metallograph.

MIDC Engineer demonstrates the manipulation of the Leco carbon and sulfur analyzer to guests.

Dr. A. Arizabal points out the importance of using exact standards in the calibration of the Atomic Absorption Spectrophotometer.

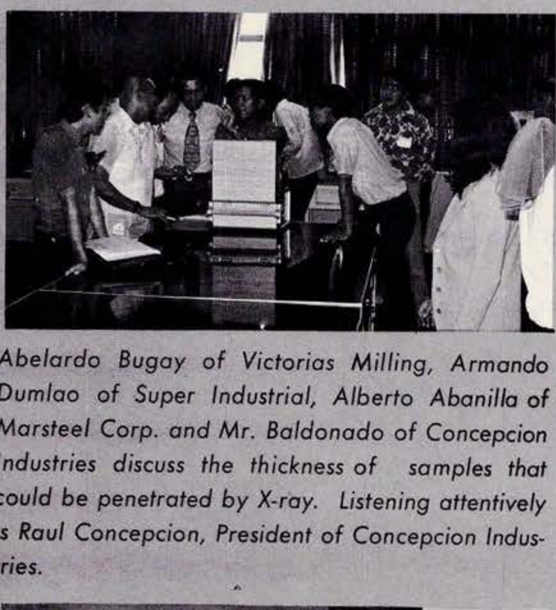
MIDC Chemist explains the analysis of elements using the Atomic Absorption Spectrophotometer.

Victor G. Guevara gets first hand information on hardness tester from Lito Mariñas, MIDC Physical Metallurgist.

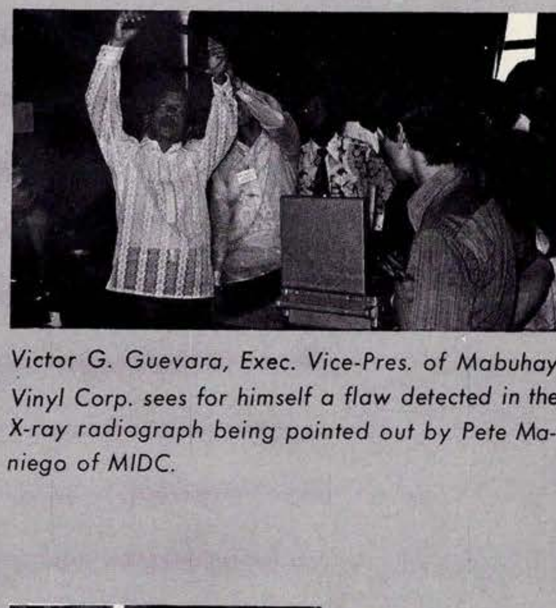
Participants view the calibration station for optical pyrometer.

Dante Santos of PHILACOR tries his hand at operating the microhardness tester. On hand to guide him is Rufino Mantaring of MIDC.

Cesar Santos of MCCI awaits his turn as Dionisio Chua, general manager of Central Steel peeps into the microhardness testers.



Abelardo Bugay of Victorias Milling, Armando Dumlao of Super Industrial, Alberto Abanilla of Marsteel Corp. and Mr. Baldonado of Concepcion Industries discuss the thickness of samples that could be penetrated by X-ray. Listening attentively is Raul Concepcion, President of Concepcion Industries.



Victor G. Guevara, Exec. Vice-Pres. of Mabuhay Vinyl Corp. sees for himself a flaw detected in the X-ray radiograph being pointed out by Pete Maniego of MIDC.

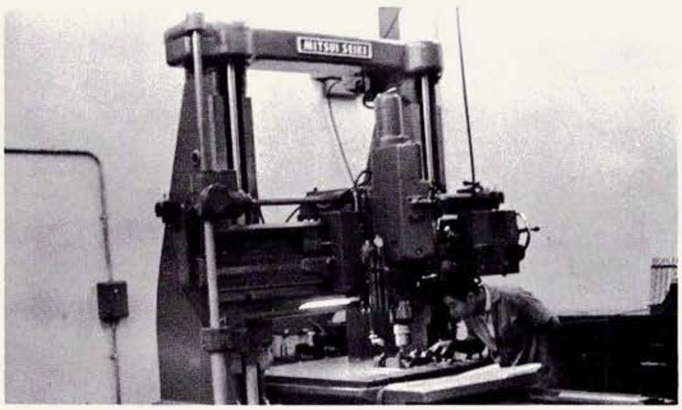
Executives from MESCO examine the drill press.

Rolando Dy of MIDC explains the application of the Ames portable hardness tester.

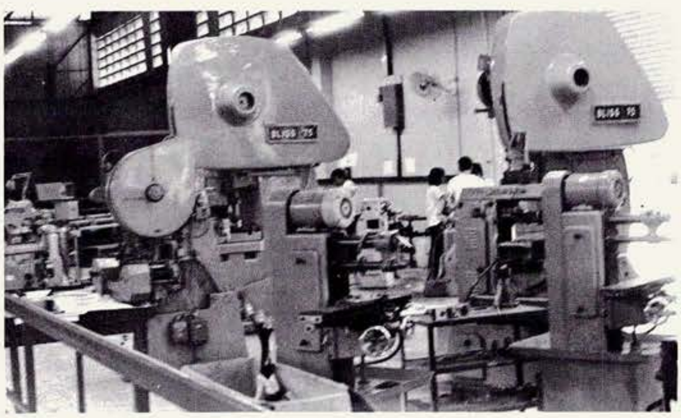
MIDC corner

News Coverage of Important MIDC, NSDB, PISI & SEAISI Happenings.

A portion of the tool Grinding Shop.



A Japanese jig borer.



The Press Shop.

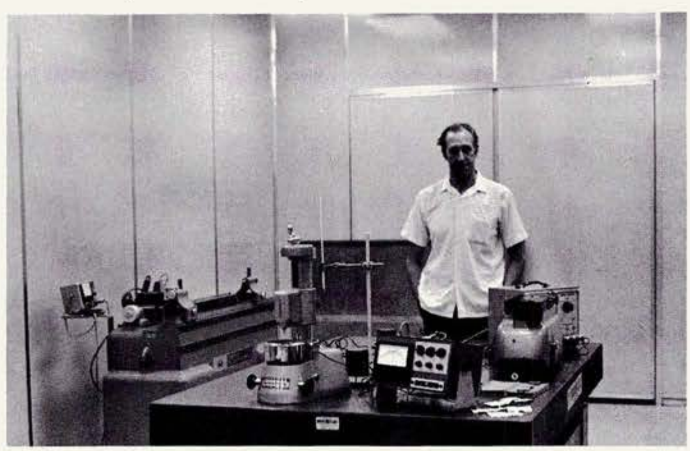
MIDC SINGAPORE

by Raul P. Sulit

MIDC Singapore or Light Industries Services Unit, as it is usually called, was founded in July, 1963 when the government of Singapore and the International Labor Organization signed the Plan of Operation for the project. The purpose was to promote the development and gròwth of light industries by providing training in the upgrading of vocational skills, assistance in improving the skills of management, the demonstration of improved industrial methods and techniques, and extension of advisory services.

The center is situated at River Valley Road and comprises five buildings which house the main office, foundry, mechanical workshop, metallurgical laboratory and canteen. The workshops and laboratories are very well equipped. At the center, production work is considered an integral part of training unlike the MIDC Philippines where the emphasis is on mechanical prototype demonstration, industry planning, technical information exchange, statistics, consulting work, metallograph, chemical analysis, physical tests and training of engineer and technicians.

A total of 527 trainees (counterparts and technicians) have completed 6,678 man-months of training. UNDP experts have spent 286 man-months at the

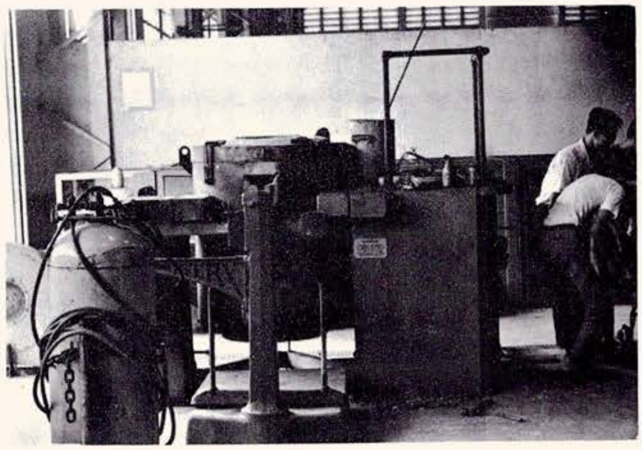


A. J. Scan, UNIDO Metrology expert poses behind sensitive measuring apparatus at MIDC Singapore's Metrology Shop.

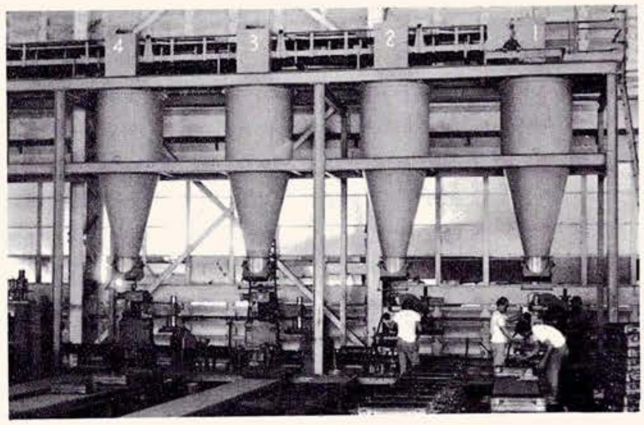
center. These include experts on industrial development and financing, foundry, pattern making, tool and die design, tool and die engineering, and metrology. The center is also a recipient of fellowship grants and so far 17 persons have undergone 84 man-months training abroad.

The UNDP and Government of Singapore contributions are summarized as follows:

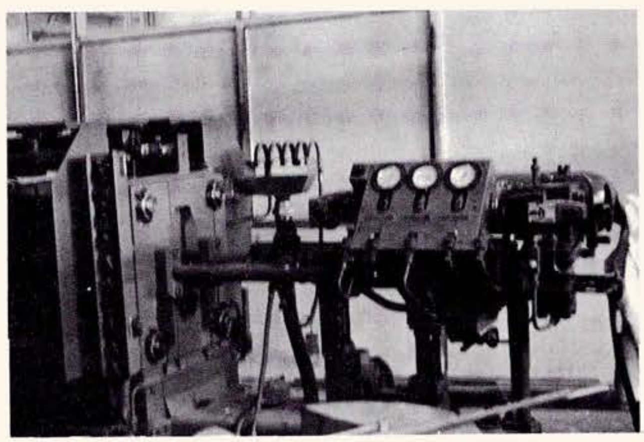
	UNDP	Government of Singapore
Contributions	$1,379,939	$2,149,254
		$3,500,000
Equipment	$ 590,500	$1,425,000
UNDP Experts	$ 562,100 (to be increased by $ 130,000)	
Government Personnel		$ 900,000
Fellowships	$ 50,600	$ 100,000
Reporting Costs	$ 5,000	
Miscellaneous Local Operating Costs	$ 29,500	
Executive Agency Reporting Cost	$ 139,100	
Special Science Fund	$ 6,139	
	$1,379,939	
Land and Building		$1,350,000
Equipment and Supplies		$1,425,000



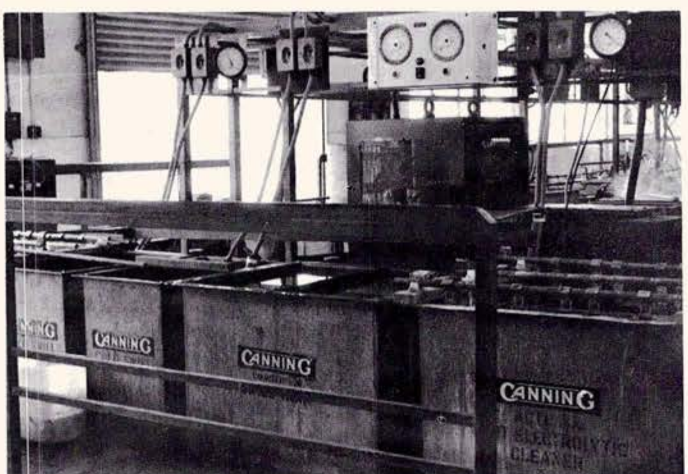
The Nonferrous section has 4 oil-fired crucible furnaces.



Automatic moulding machines and moulding boxes at the foundry.



The die-casting section is equipped with a 180 ton cold chamber Buhler machine. Shown is an 80 ton hot chamber die-casting Shibarra machine.



Surface treatment tanks at the Electroplating Shop.

Egon Gladh, MIDC foundry expert.

FOUNDRY EXPERT FOR MIDC

Mr. Egon Gladh of Sweden, a foundry engineering expert, arrived here last January 14 to join the Metals Industry Development Center. He is here under a UNIDO-Philippine Government plan to, among other things, "assist the Government in establishing a Centre to serve the needs of the metals industry in the fields of technical advisory services, quality control, management and technical training, and also to guide the Government in formulation its policies for the expansion of this sectòr of the national economy."

His duties and responsibilities include the following:

1. Advise and train local counterparts and engineers from industry on the following aspects of metal-casting technology:
   a) sand technology
   b) moulding techniques
   c) core-making techniques
   d) smelting techniques
   e) pattern-making techniques
   f) gating and risering system
   g) casting techniques
   h) fitting and cleaning techniques
   i) material handling in foundries
   j) foundry lay-out and design
   k) product and process development activities
   l) material and equipment selection
   m) foundry management
   n) quality control and inspection
2. Assist in the organization and provide consultation services in the different aspects of metal-casting to solve production problems, improve working conditions and pròduction techniques;
3. Assist in programming and implementing research projects to be undertaken by the Centre;
4. Assist in the evaluation of the performance of the local metal-casting industry;
5. Review the problems confronting the industry and make recommendations to the appropriate authorities on the necessary corrective measures to be undertaken;
6. Assist in the preparation of sectoral studies and the formulation of guidelines for an accelerated and systematic development of the metal-casting industry.

Mr. Gladh has been sales manager, production manager for ASEA, Sweden and is a member of the Board of the Swedish Foundrymen's Association.

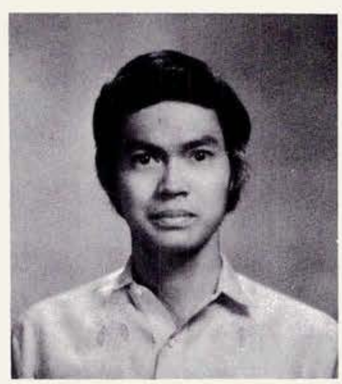
MIDC ENGINEERS TO JAPAN, WEST GERMANY

Antonio F. Lazo, Sand Engineer of MIDC's Industrial Technology department left for Japan last January 9, 1972 to undergo a Group Training Course in Foundry Engineering which will be held from January 10, 1972 to December 18, 1972 under the Colombo Plan. Mr. Lazo, a Victoriano Elicano Awardee for topping the 1970 board examinations for mining engineers, is also a metallurgical engineer and an alumnus of Mapua Institute of Technology.

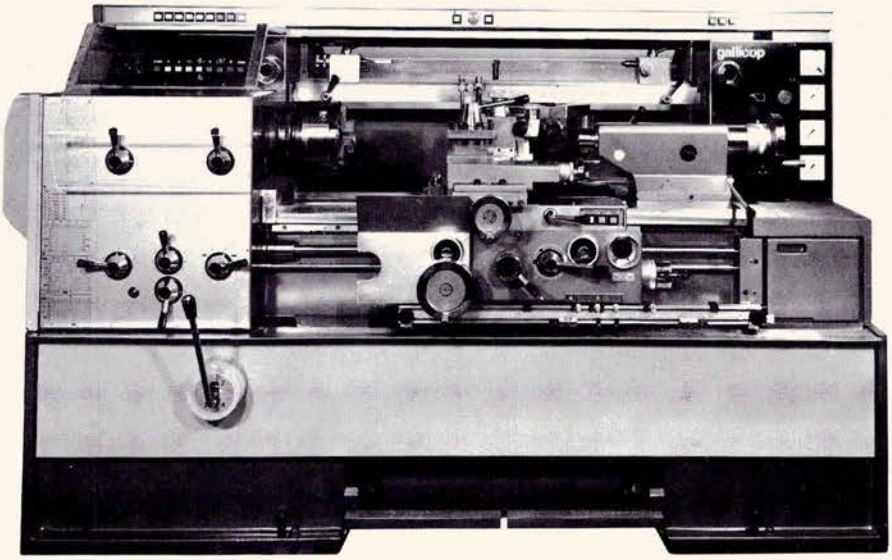
The Group Training Course in Foundry Engineering by the Japanese government aims to contribute to the development of techniques and knowledge of foundry engineering (metal casting) of the developing countries and to promote technical cooperation between these countries and Japan. The course includes language lessons, lectures, discussions, practice at public institutes and private foundries, and field studies.

Pedro H. Maniego, Jr. left for Saarbrucken, West Germany last March 5, 1972 for a 14-month training course in industrial engineering as applied to the me-

Antonio F. Lazo



Pedro H. Maniego



The Mondiale Gallicop Automatic Lathe

tals industry through a bilateral agreement between the Philippines and West German Government.

A college scholar at the University of the Philippines, Mr. Maniego is an industrial engineer and is Planning and Scheduling Officer of the Operations Control Staff of MIDC's Industrial Technology Department. Previous to this, he was senior production engineer at Stanford Associates, Inc. and Instructor at the College of Engineering, University of the Philippines.

Loren S. Bacon

PISI SEMINAR

The Philippine Iron and Steel Institute held a seminar on "The Ultra-High-Power Electric Furnace" at Savoy Hyatt Philippines last December 10, 1971. Mr. Loren Bacon of Union Carbide, using the aid of slides, explained the principles of how to convert the furnace charge into a finished specifications product in the minimum of time with the highest power possible.

Some 26 participants representing different companies of the iron and steel industry were present.

MESCO LENDS AUTOMATIC LATHE TO MIDC

Peter Lee, General Manager of Manufacturers' Equipment & Supply Co. (MESCO) announced at the recent First Private Sector and MIDC Workshop Seminar, the loan of the Mondiale Gallicop Automatic Lathe for MIDC use until December 31, 1973. This includes support in the form of training operators, as well as technical services in the installation. The lathe, one of its kind in the country, has a number of features which are designed to facilitate setting up and operation. With these features the lathe can be employed to advantage for the production of small and medium-size batches of parts. Copy turning is carried out with a hydraulic unit mounted on a bridge piece which is secured to the saddle at the rear and spans the cross slide. With this arrangement, turning and other operations can be performed independently of the copying equipment with tools mounted in a port at the front of the cross slide. In additions, the cross slide may be brought into use without disturbing the setting of the copying unit.

MIDC has already two lathes, but with the addition of this Gallicop lathe the number of people that can be trained at MIDC using this equipment will increase.

Jose S. Sason

Walter Bilek

STAFF ENGINEER BACK FROM RUSSIA

Jose S. Sason, MIDC Metallurgical Engineer arrived last December 11, 1971 from Zaporozhye, Ukraine, U.S.S.R. where he attended the Seventh In-Plant Group Training Program for Technicians in the Iron and Steel Industry held from May 17 to October 31, 1971.

A participant through the UNIDO, Sason underwent rigorous training on foundry practices at the Zaporozhye Steel Plant, which produces different sizes of ingot moulds and replacement parts for steel mills. Aside from attending lectures and observing actual foundry practices at the Zaporozhye Steel Plant, he also visited heavy machinery plants, cast iron foundries for automobile parts, nonferrous foundries of transformer plants and the Donetsk Steel Plant where he observed continuous steel casting techniques.

As moulding engineer at MIDC, Jose Sason will provide expertise along this line to the foundry industry.

AMERICAN OPTICAL SEMINAR ON MeF2

Walter Bilek, Scientific Instruments Marketing Manager of the American Optical Corporation in Asia, was the speaker at a seminar on the correct use, care and applications of the MeF2 for MIDC technical personnel at Bicutan, Taguig, Rizal last February 3, 1972.

Mr. Bilek has been with C. Reichert Optische Werke AG for 20 years where he held responsible positions in sales, service and product planning. After working in the United States and England, Bilek is now in Hongkong to coòrdinate American Optical's expansion in South East Asia.

The MeF2 — Universal camera microscope at MIDC is one of the two that can be found in the country, the other one belonging to the Elizalde Iron and Steel Corporation. It can be used for microstructure analysis by various investigation methods. Investigation methods applicable at the MIDC MeF2 are the light ground, dark ground, polarization, phase contract, grain size measurement, photomicrography, and low-power photomicrography.

ANNOUNCEMENT

The Metals Industry Development Center has come out with a printed 270-page industry study entitled "The Nonferrous Metals Industry of the Philippines". Printed by offset process and containing a lot of pictures, diagrams and illustrations, "The Nonferrous Metals Industry of the Philippines" is an in-depth study of the present status of the local nonferrous industry and attendant problems. It describes local manufacturing trends, explores the feasibility of improved production, presents a profile of the domestic market, correlating it with trends in the international scene, and suggests guidlines which may extricate the industry from processing problems and difficulties. The industry study is the result of a year-long research effort including on-the-spot surveys, plant studies and interviews conducted by MIDC's Industry and Special Studies Section, the research arm of the Center's Information Exchange and Statistics Division.

"The Nonferrous Metals Industry of the Philippines" is available at the Metals Industry Development Center Publications Section at P40.00 each.

metals NEWS

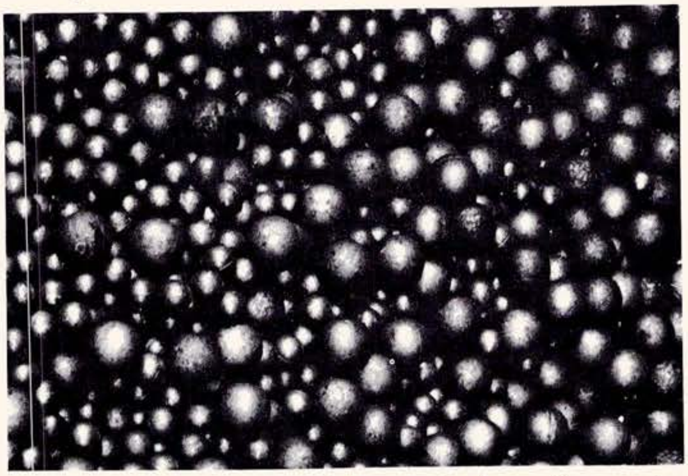
& RELATED EVENTS

MARSTEEL FORGES TIES WITH ARMCO STEEL OF U.S.A.

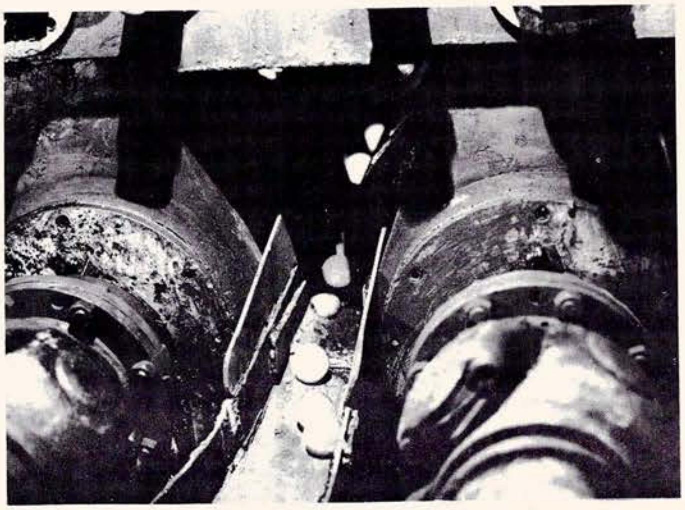
MARSTEEL CORPORATION recently entered into a technical collaboration agreement with ARMCO Steel Corporation of U.S.A., a leading world producer of special steel products.

Under the contract, Armco will furnish MARSTEEL consultation and advice regarding the production of grinding balls, vital spherical steel balls of various dimensions used by the mining and cement industries in their grinding operations. The agreement includes the areas of metallurgy, rolling, ball forging, quality control, and testing procedures. Armco has been producing grinding balls extensively for some time now under the trade name "MOLY COP".

MARSTEEL's Grinding Balls Project is registered with and approved by the Board of Investments with a registered capacity of 7,500 M.T. per annum. A new ball forging machinery complex, the acquisition of which has been approved by the BOI will shortly be installed at the project site in Baesa, Novaliches, Quezon City. Armco will likewise furnish advice on the layout of the new complex.



Grinding balls from Marsteel Corporation have sizes ranging from 1" to 4" in diameter.



The production of grinding balls by the roll forging method at Marsteel Corp.

STEEL CASTERS TO PRODUCE BILLETS BY CON-CAST METHOD

As a new steel venture, the Steel Casters of the Philippines has decided to produce 55,000 metric tons of billets per year and two furnaces with a total capacity of 33 metric tons per heat have arrived to meet this requirement. To this end, Steel Casters has placed an order with Concast AG, Zuerich for a concast machine of two strands, 18 tons heat size, and section diameters 75,115 mm.

The plant is expected to operate before the year ends or early 1973.

MARCELO STEEL CORPORATION

Marcelo Steel Corporation will be producing in a few months grinding balls with diameters ranging from 1¼ to 4 inches for the local mining and cement industries. The pilot plant on this project has been operating successfully and machinery and equipment for the plant with an annual capacity of more than 7,500 MT are now being installed. The grinding ball plant is located at Punta, Sta. Ana, Manila.

The contract for the structural steel framing for the GMTFM Wholesalers' Building was signed recently by the Construction and Development Corporation of the Philippines and AG&P. Signing the contract (seated from left) Pedro O. Valdez, CDCP Chairman; Rodolfo M. Cuenca, CDCP president; Alex J. Lukban vice president AG&P Metals Fabrication Group; and Lauro M. Cruz, vice president AG&P Steel Fabrication Division. Witnessing the contract signing (standing from left) B. V. Buencamino, CDCP general superintendent; A. V. Asuncion, CDCP general manager; E. M. Patenia, A. L. Arguelles, C. N. de Castro, and E. P. Rojas, Jr. of AG&P Metals Fabrication Group.

STEEL CONTRACT — GMTFM WHOLESALERS' BUILDING

The contract for the supply, fabrication, and erection of the structural steel framing for the wholesalers' building to be constructed for the Greater Manila Terminal Food Market was signed recently by the Construction and Development Corporation of the Philippines, the building contractors; and Atlantic, Gulf & Pacific Company of Manila, Inc.

The structural steel framing for the building, to be constructed in Taguig, Rizal, will be fabricated at AG&P Steel Fabrication Division's plant at Punta, Sta. Ana and will be erected by AG&P General Contracting Division at the building site.

Each of the two units of the building is 65 feet wide by 708 feet in length with a lean to on both sides spanning 15 feet and 11 inches wide center to center of supports by 708 feet in length including two pedestrian bridges, each 19 feet and 8¼ inches wide by 164 feet span.

ZINC-LEAD-COPPER MILL TO OPERATE SOON

Zambales Base Metals, Inc. is establishing a new beneficiating mill which will process ores to produce zinc, lead and copper concentrates for export to Japan.

Construction of the plant buildings, housing and transportation facilities are on its finishing stages at Ayala district which is approximately 25 kilometers from Zamboanga City. Company executives have started ordering equipment for the venture which is expected to operate on the latter part of 1973 with a capacity of 1,000 metric tons per day.

The complex ore contains lead, zinc and copper which are obtained separately by the selective flotation process. It is expected to produce concentrates of 55% zinc and 55% lead as main products and not less than 18% copper, as by product.

Ventura D. Ducut

Felicito C. Payumo

Daniel Borlongan

ENGINEERING EQUIPMENT, INC.

The Board of Directors of Engineering Equipment, Inc. recently announced the following promotions.

VENTURA O. DUCUT — from Senior Vice President to Executive Vice President and member of the Board of Directors. Holder of a B. S. Civil Engineering degree, Ducut joined EEI as a junior draftsman in 1953 and later became general manager of the Steel Fabrication & Steel Foundry Divisions. He will now assume responsibility for all sales and marketing activities of EEI.

FELICITO C. PAYUMO — from Vice President Administration to Senior Vice President and member of the Management Committee. A Harvard MBA degree holder and a B. S. Economics **cum laude** graduate from Ateneo, Payumo joined EEI as procurement manager in 1965. He will now be in charge of all administrative and planning activities of the company.

Meanwhile, Jaime V. Ongpin, Engineering Equipment, Inc. president announced the appointment of DANIEL C. BORLONGAN as company Treasurer. Borlongan will supervise and direct the accounting, credit and treasury functions. Borlongan finished his MBA at Wharton Graduate School, University of Pennsylvania. He also topped the 1964 Chemical Engineering Board Examinations after taking AB Engineering at Ateneo and B. S. Chemical Engineering at La Salle.

At the Foundry Division, RUBEN C. BARTOLOME was promoted to Quality Control Manager. Bartolome started at EEI as Quality Control Assistant immediately after getting his BSME degree from Mapua five years ago. He recently finished a six month training and observation tour of Russian Iron and Steel plants sponsored by the U.N. Industrial Development Organization.

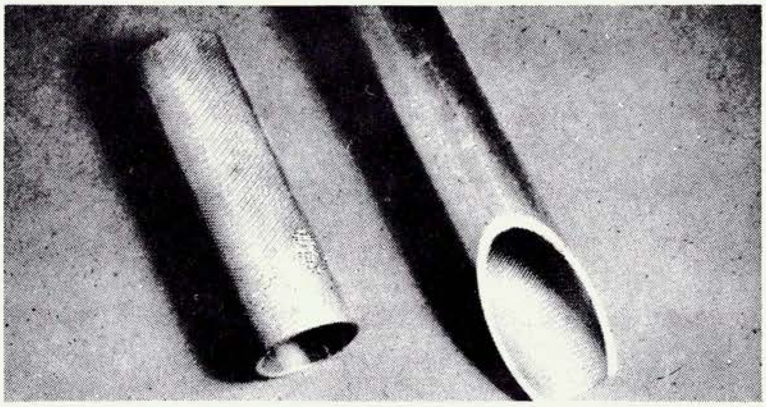
Vic N. Muñoz, Operations Group Manager — EEI Foundry Division, arrived from the United States after a three-month training observation tour to learn the latest methods in foundry shop operations and the newest foundry product lines. Shown above is Muñoz with Betty Seaman and Larry Venne in ESCO Laboratories discussing spectrograph analysis results.

ARMANDO S. ZALAMEA was appointed Production Manager. He graduated from Mapua with a Bachelor's degree in Mechanical Engineering. Prior to his appointment, Zalamea was plant manager of a Machinery and Parts manufacturing firm.

Foreign

NEW TUBING APPLICATIONS FOR COPPER-NICKEL

Ever since copper nickel enter into the market as a corrosion-resistant seawater material, a wide range of improved copper alloys for tubular applications were developed containing nickel from five per cent to 30 per cent such as for power utility steam-water surface condensers, feedwater heaters, industrial heat exchangers, oil refinery condensers, air conditioning and refrigeration and continued shipboard applications. A very new application for copper-nickel alloys is Alloy 706 (90-10 copper-nickel) as welded tube for fresh water condensers in the power industry. A new heat exchanger application for copper-nickel exists in the desalination market where designers are considering 200-400 foot tubes for heaters and the production of long welded tubes is economically attractive. One of the technical advantages of welded tube is that the strip from which it is made has a high degree of metallurgical soundness and that the strip can be preformed or roll-embossed with patterns for decorative and functional applications prior to welding and forming. Also, welded tubes can be produced in very long lengths.



Internally and externally patterned tube produced from strip illustrates versatility of welded copper-nickel tubes.

NIPPON LIGHT METAL DEVELOPS EPOCHAL ALUMINUM ALLOY

Nippon Light Metal Co. recently announced that it has developed and has placed on sale "HR alloy", a high quality manganese-base aluminum alloy which is strongly resistant to heat and corrosion and easy to produce.

The new alloy which is expected to have wide use in the manufacture of heat exchangers, curtain walls and marine containers, is said to cost less. It is superior to 2219 alloy, in heat resistance.

Nippon Light Metal said that satisfactory results were obtained in comparative corrosion tests of HR alloy and 8083, 3003 and 5052 alloys which have been developed for resisting corrosion by sea water.

JAPAN STEEL INDUSTRY PLANS TO EXPAND TRADE WITH CHINA

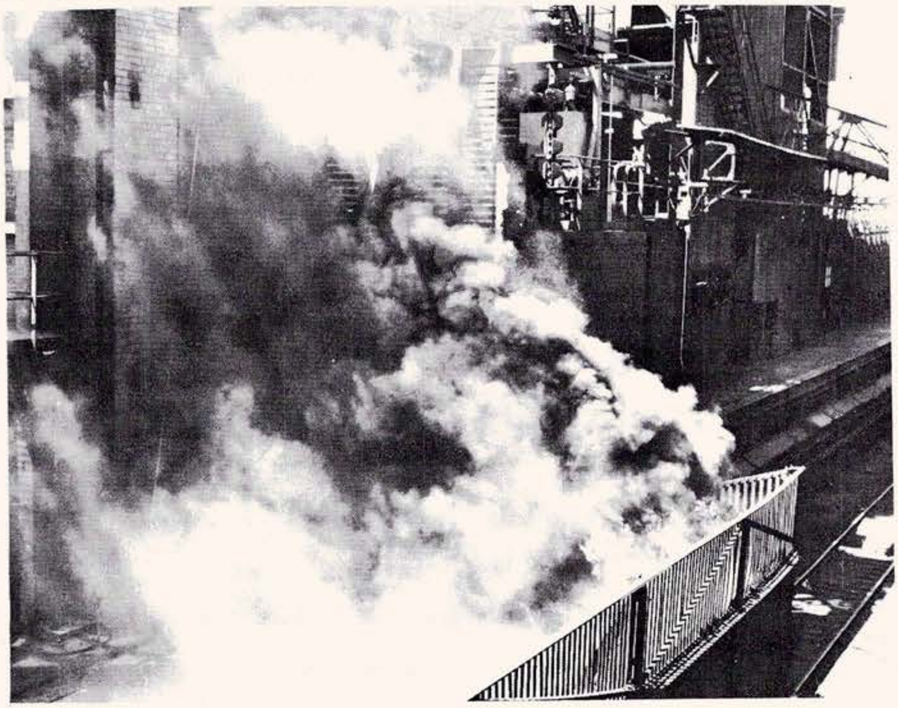
The Japan Steel Industry is showing a strong tendency to increase its shipment last year of 1,569,000,000 tons of steel to China. In this connection, Nippon Steel Corporation is preparing to resume trade with China and Sumitomo Industries, Ltd. has proposed a joint development of coal resources with the same country.

China's demand for steel in 1975 is expected to amount to 35 million tons in terms of crude steel which will be needed in the machine and shipbuilding, truck and tractor industries.

"CLEAN" COKE PELLET PROCESS

A five-company group, made up of Bethlehem Steel Corporation, Consolidation Coal Co., Granite City Steel Co., National Steel Corporation and Republic Steel Corporation is undertaking the demonstration-scale project involving the test of a new coke pellet manufacturing process. The group has already spent $7 million in experimental work in developing the new coke manufacturing process and will spend $20 million for the construction of a 500 ton-per-day demonstration plant, and operation of the plant and full-scale blast furnace tests.

The coke pellet manufacturing process wherein coal is heated and pelletized, is a closed system thereby eliminating emissions associated with slot-type ovens currently in use.



Clouds of foul-smelling smoke rise as coke leaves the baking oven.

NEW ALLOYS DEVELOPED FOR THE PETROLEUM INDUSTRY

Six newly-developed nickel alloys are holding promise for the petroleum industry. The new alloys, developed by the International Nickel Company, Inc. are "IN-519" heat resistant cast alloy; "IN-744" high-tensile strength, and corrosion – and fatigue-resistant alloy with good weldability; "IN-787" age-hardenable low-alloy steel "IN-793" improved sulfidation-resistant alloy; "IN-732" high strength copper-nickel alloy for marine piping; and "IN-768", cast counterpart of "IN-732".

EXPLOSION-BONDING PROCESS FOR CLADDING USE

Since its introduction in 1964, Du Pon's "Detaclad" explosion-bonding process has made headway in wide clad metal combinations to the metals industry. The process metallurgically bonds dissimilar materials and alloys such as aluminum to steel without heat or the use of intermediate materials. The resulting metal clads are uniform in composition, have sufficient ductility and impact strength and are readily fabricated by conventional methods without changing the properties of the components. The technique is most commonly used in the fabrication of process vessels for the chemical, petrochemical, and petroleum industries. Cladding metals used in this area include stainless steels, nickel, nickel alloys, copper, copper alloys, titanium and tantalum. Explosion bonding has also made available the economical production of tri-layer, integrally bonded tube sheets.

ELECTRODEPOSITED ALUMINUM OXIDE DECORATES, PROTECTS METALS

A new process for applying decorative coatings that protect and beautify metals and alloys such as aluminum, zinc, copper and magnesium has been invented for the metal finishers by Fulmer Research Institute of Buckinghamshire, England. The coating consists of electrodeposited aluminum oxide which may be dyed during or after deposition to create attractive colored finish. Standard chemical sealing and lacquering treatments can also be applied to improve further the protective and decorative qualities of the coating.

The new process can be accomplished in conventional plating equipment, taking about ten minutes to complete.

INTERNAL STRUCTURE OF METALS VISIBLE WITH NEW MICROSCOPE

Scientists of the General Electric Research and Development Center, at Schenectady, New York, have accomplished the first direct magnification of a sample by one million times. This makes possible a better understanding of the internal structure of metals including copper, aluminum, silver, gold and platinum, because planes of atoms, imperfections in the spacings or irregularities can be observed. Using a specially modified microscope, researchers have observed details as tiny as eight billionths of an inch wide on the instrument's viewing screen — an achievement since conventional electron microscopes can enlarge the size of a sample only by 300,000 to 6,000,000 times.

Working with a specially modified electron microscope, Dr. Victor A. Phillips (right) and John A. Hugo have observed details as tiny as eight billionths of an inch wide on the instruments viewing screen.

The portable sampler.

SAMPLER IMPROVES AL ANALYSIS

A portable vacuum sampler newly developed by Alcoa Research Laboratories is said to have improved reproducibility between individual analyses when compared with Type A book mold sampler and permits – more accurate spectrochemical analysis.

Samples 1½ inches in diameter and ½ inch thick are drawn into a porous bronze and copper composite mold under vacuum. The sample solidifies quickly to minimize segregation of compositional elements. A sample, which weighs about 40 grams, is prepared for analysis by machining to a smooth finish .080 inch below the as cast surface.

ALUMINUM POWDER METALLURGY FEASIBLE

Sinteral Corporation has developed a new air-sintering process that makes commercially feasible the use of aluminum in powder metallurgy. The new sintering technique makes use of simple air atmosphere in contrast to the costly hydrgen or nitrogen installations required by present aluminum sintering methods. A wide application for the Sinteral technique is forecasted because of the benefits of aluminum and the fabrication advantages of powder metallurgy in the production of precision parts and components as cams, gears, self-lubricating bearings, valves, connecting rods, capacitor anodes, flanges, control knobs and bushings. The new process enable aluminum to compete in price with iron and copper which currently dominate the market.

HOT ISOSTATIC PROCESS FOR HIGH-DENSITY TUNGSTEN CARBIDE PRODUCTION

Sandvik Steel Co's plant in Stockholm, Sweden will produce high-density tungsten carbide, using the hot isostatic press method developed by ASEA, a Swedish heavy-electrical-equipment manufacturer. The new method compacts tungsten carbide powder in an inert gas (argon) under high pressers of up to 14,500 psi and at temperature up to 1,450 degrees Centigrade. According to Sandvik's plant manager, the hot method produces a product with a pore percentage of no more than 0.0001%, compared with up to 10% pore volume for carbides made by the conventional method which uses cold isostatic compaction.

RECLAMATION OF FOUNDRY SAND POSSIBLE

A study made by the U.S. Interior Department's Bureau of Mines details in the recovery and indefinite reuse of chromite and silica sand from steel foundry waste molding sand. It was found out that heating the waste sand for 15 minutes at 700°C burns off the carbon impurities (during casting, carbon is produced from the binder, adhering to the sand, impairing its fineness, heat resistance and other qualities required during molding) and restores the sand to molding quality. Foundry sand is not too costly but due to the volume used and the cost of hauling and disposal. reclamation is economically attractive.

Tolerances on gold-striped strip stampings for electronic devices are held to as close as 50 millionths of inch thickness.

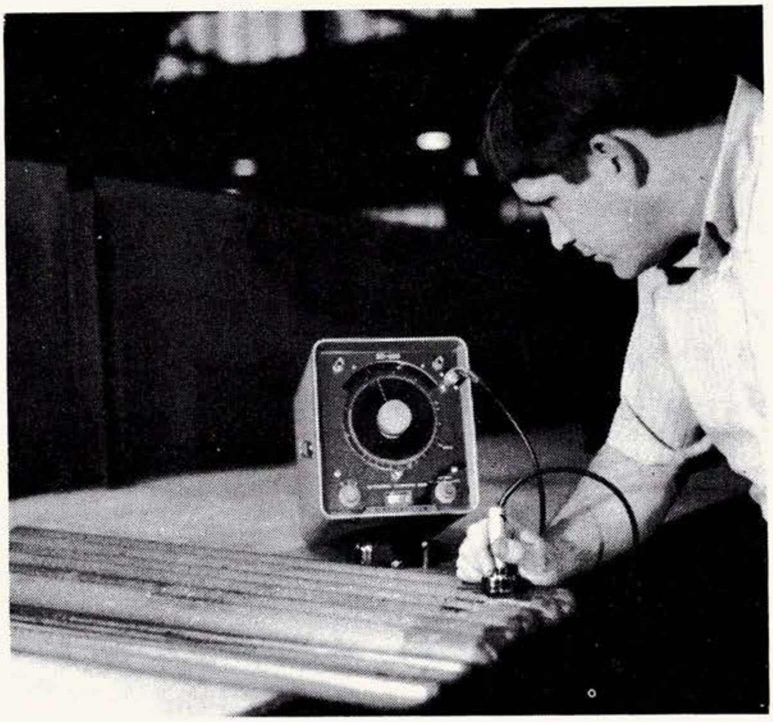
NEW GOLD PLATING METHOD

Two new gold plating processes have been developed by Engelhard's Research and Development Department in answer to the long standing needs of faster plating of strip and wire, and an effective non-cyanide plating method. A high-purity, bright and relatively pore-free deposits of highly ductile gold could be produced at the rate of 100 microinches per minute. In addition, the exclusive E-H-S process gold solution compound can assure constant pH and specific gravity of the plating bath.

The new cyanide-free gold plating process, ECF-60, makes use of an alkaline, non-cyanide electrolyte that is formulated to produce gold-metal electrolyte formulated to produce gold-metal electrodeposits. The process has also the ability to distribute gold evenly on parts having complex geometry and to level imperfections in the base material.

LIGNITE IN NONFERROUS-METAL-EXTRACTION PROCESS

The Department of Metallurgy of Melbourne University, Australia, is developing a nonferrous-metals-extraction process utilizing lignite as absorbent. Feedstock is an ammoniacal solution of the metal being recovered. This solution is allowed to impregnate lignite (called brown coal in Australia). Copper, nickel or silver can be recovered by simply burning the lignite; more volatile metals such as zinc or cadmium are recovered by heating the impregnated coal until the metal vaporizes.



Thermocouple protective tubes, used to measure the temperature of molten aluminum, are tested for uniformity and integrity with a Magnaflux SO-400.

NON-DESTRUCTIVE TESTING OF IRON TUBES

Magnaflux SO-400, a product of Magnaflux, Corp. of Chicago, U.S.A. is a direct reading ultrasonic gage which measures accurately the concentricity of the hole and wall thickness througout the length of a tube, without damaging the casting. The gage eliminates destructive testing which turns the broken up tube into scrap, resulting in valuable savings.

NEW ALUMINUM ALLOY CONDUCTOR

Henry C. Chia, manager of the Metallurgical Laboratory at Southwire, U.S.A. recently announced at the opening sessions of the 1971 Conference on Electrical Insulation and Wire Technology, the development by Southwire Co. of a new aluminum alloy called "Super T".

The alloy will provide a wire of tensile strength of over 18,000 psi with an elongation of about 20 percent in the fully annealed condition, while possessing electrical conductivity in excess of 61 per cent of the International Annealed Copper Standard (IACS). Properties of "Super T" indicate applications as to communication, cable, power transformer construction, magnet wire, appliance wire, modular circuit boards and aircraft wire.

JAPAN STEEL INDUSTRY REDUCES PRODUCTION

The entire steel industry of Japan including major steelmakers, special steel producers and open hearth and electric furnaces, will cut down production in compliance with the advice of the Ministry of International Trade and Industry. This was confirmed by the Steering Committee of the Japan Iron and Steel Federation who agreed that the steel producers would carry out cutbacks through mutual cooperation.

ELECTRIC ARC METALLIZING RECLAIMS WORN METAL ROLL

An Electro Spray dual-wire electric arc metallizing unit is continuously gaining importance in applying stainless steel coating to worn metal rolls. The metallizing material commonly used is Wall Colmonoy's Walcoloy No. 2, a martensitic stainless steel wire with good wear properties.

The ElectroSpray arc, capable of reaching a temperature of about 7000°F, melts wire faster and deposits particles which are hotter and more fluid. It is also possible to achieve a good coating to metal bond without much surface preparation because of the greater bonding capacity of the fluid particles sprayed. The coating, which is very dense, is relatively non-porous and requires no sealing.

HOLELESS DIE-CASTING PROCESS DEVELOPED

Nippon Light Metal Co. and the International Lead, Zinc Research Organization (ILZRO) have started negotiations to supply technical know-how on the holeless die-casting process to General Motors Corp., Ford Motor Co. and Chrysler Corp. of the U.S. and more than ten companies in Japan.

The process, involving large scale oxygen gas treatment of melted metals will be widely used in the manufacture of automobile and aircraft parts. A special feature of the process is that holes are not found on the cross sections of cast alloy products.

The basic theory was discovered by ILZRO and mass-production technology was developed by Nippon Light Metal Co.

THE CUPOLA IN 1971

In recent years, cupola designers, builders and users have been busy in their search for more efficient techniques of producing high-quality cupola iron at lower cost. Some recent innovations to be employed on the 1971-style cupola are:

- High temperature blast by means of external heating or blast regeneration to increase the melting rate, permit the use of lower grade metallics, reduce silicon loss and save lightup time.
- Water cooling.
- Liningless cupola operating with basic, acid or neutral slag.
- New charging methods making use of vibrating feeders instead of the conventional skip hoist.
- New tuyere design and cooling system improvements.
- Reduce openings in charge door to restrict entry of air.
- The use of metallurgical control in large volume tonnage foundries.
- Relatively continuous operation wherein cupolas are banked overnight and bottoms dropped only after six or seven weeks.

Still in the pilot stage, a revolutionary cupola design, the so-called "upside-down" cupola wherein air is blown in near the top of the stack and drawn-out with the molten iron at the bottom, is taking place.

COPPER TAILINGS CAN BE TURNED INTO BRICKS

Building bricks that meet the specifications for general use in exposed indoor and outdoor masonry walls can now be produced from copper tailings, according to a study made by the U.S. Bureau of Mines at their fly-ash pilot plant at Morgantown, West Virginia.

To make bricks, the tailings composed chiefly of quartz, feldspar, clay and sericite are first dried in an oven at 110 degrees Centigrade, then screened to break up lumps. Water and a bonding agent, calcium lignosulfate are added. The bricks are then fired at 1,150 degrees Centigrade for nine hours.

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PHILIPPINE metals

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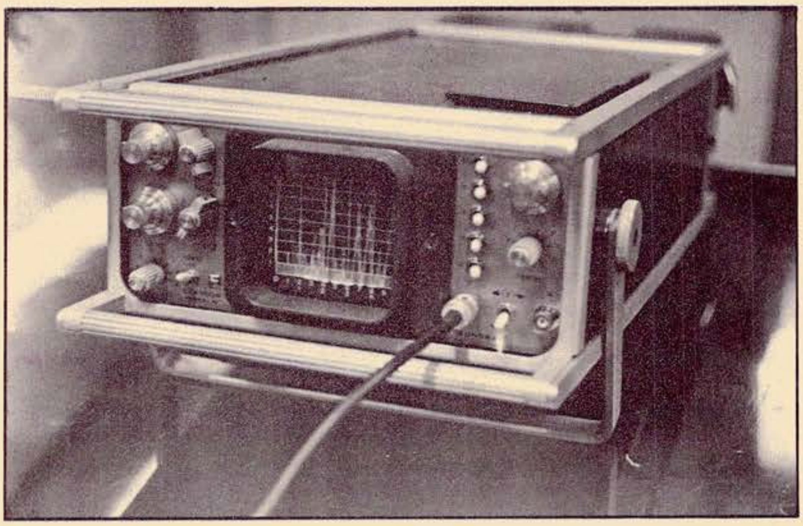
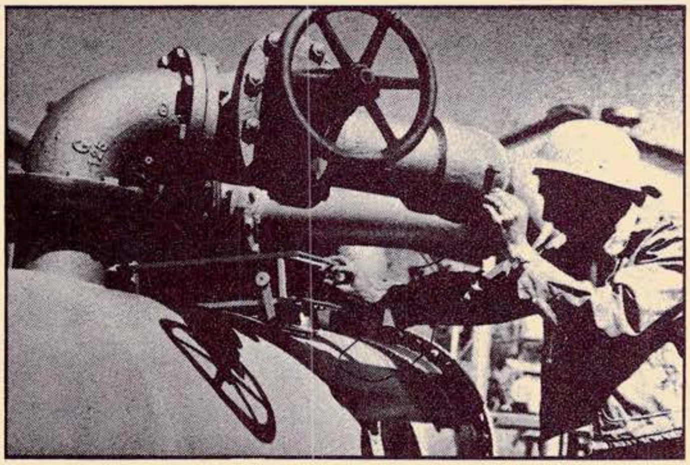
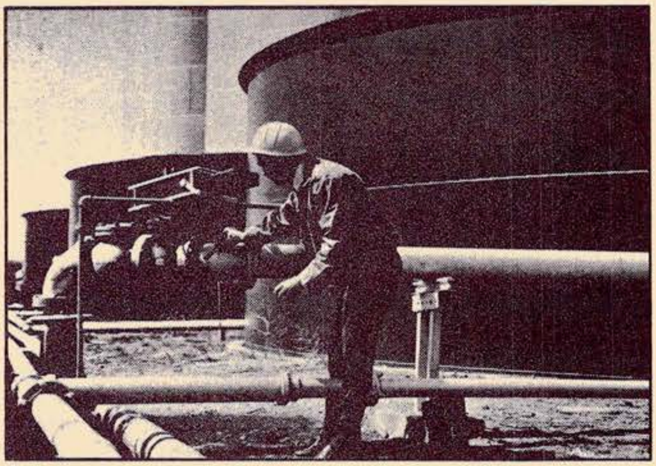
ULTRASONIC FLAW AND THICKNESS TEST







On-site, non-destructive method of testing can be at your disposal when referring jobs to us. Specifically,

On pressure vessels, pipelines, highway bridges, building frames and all heavy structural welds — **we can detect, locate and evaluate cracks, lack of fusion, lack of penetration and slag inclusion in all types of welds.**

On basic metals, rubber and plastics used by metal fabricators, petrochemicals, automotive, aircraft, shipbuilding, railroads, and mining — **we detect, locate and measure discontinuities.**

On boiler tubes, pulp digesters, pressure vessels, plate and sheet, non-metallics, ship hulls, storage tanks, piping system and aircraft or on such degenerated conditions like wall thinning, corrosion, erosion flaws, and hydrogen embrittlement — **we conduct thickness readings and corrosion surveys.**

Turn to us for your

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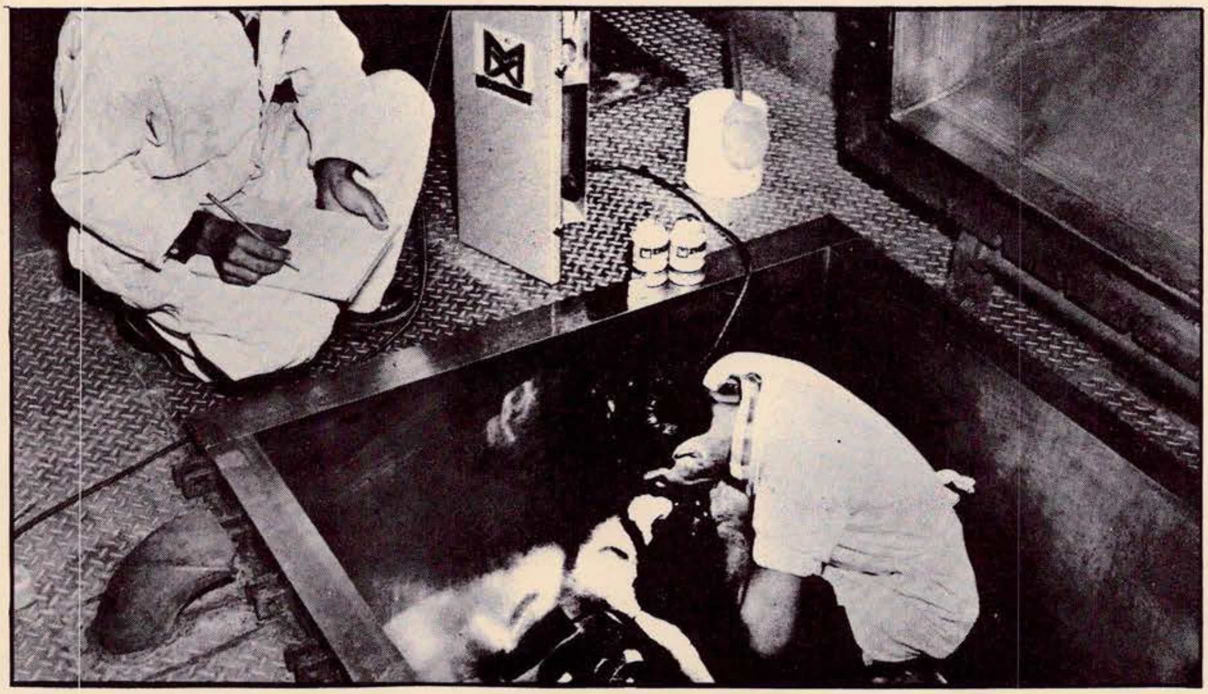
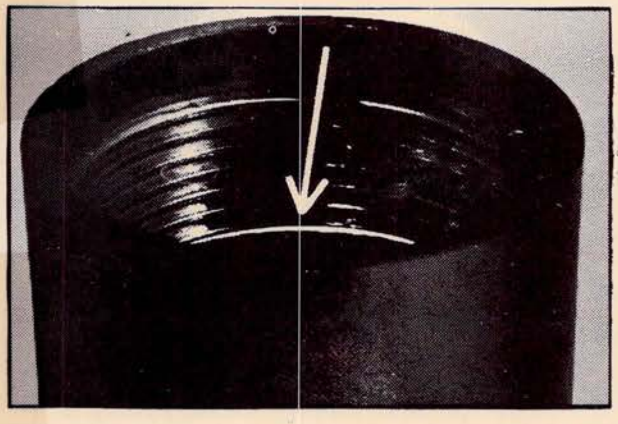
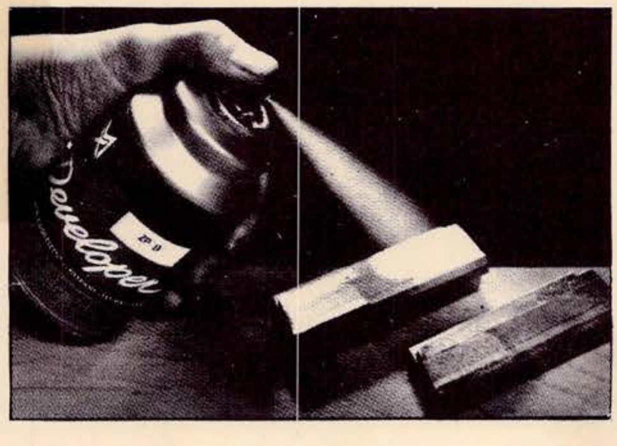
DYE PENETRANT







We are equipped with the latest in testing facilities and techniques to spot trouble before it plagues an otherwise smooth operation, contaminate good deliveries and affect projected profits. You could call on us for our dye penetrant tests—a versatile on-the-spot-testing method for:

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- Limited volume production
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- Equipment maintenance and overhaul
- Pilot runs and "problem" parts
- Tools and handling equipment

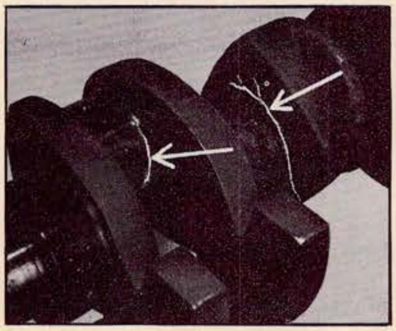
With this method, we locate defects in practically any part or shape in any non-porous material, including:

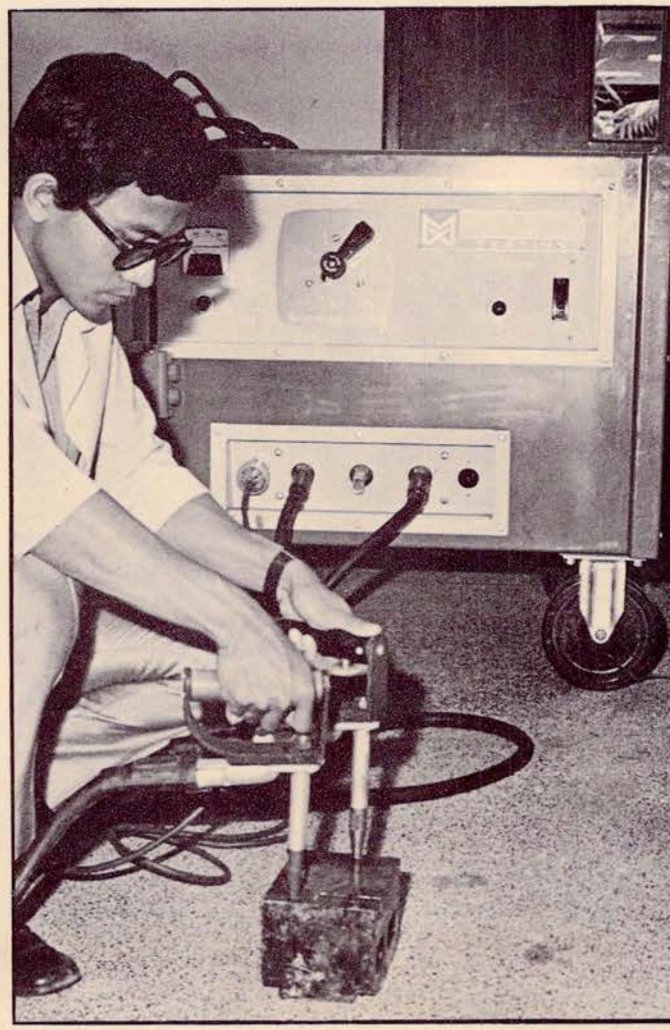
Castings	Weldments
Forgings	Carbide Tools
Machined parts	Insulators
Sheets	Pipes

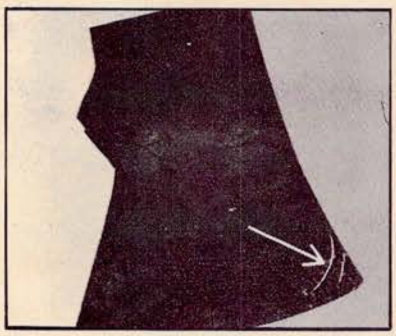
Applying dye penetrant testing, we detect and mark all types of external cracks including:

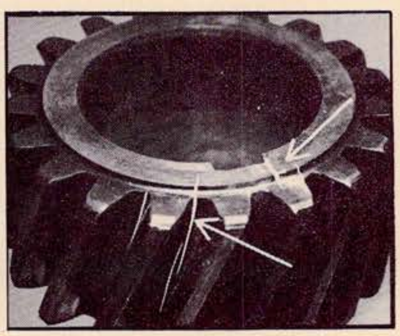
Grinding	Burst	Porosity
Stamping	Forging laps	Seams
Fatigue	Lack of bond	
Corrosion	Through-leaks	
Shrinkage	Cold shuts	

MAGNETIC PARTICLE TEST









CAN BE AVAILED OF

In the Foundry: Defects are detected before they occur and serve as basis in the improvement of mold design, techniques, in pouring, gating and risering, and the like.

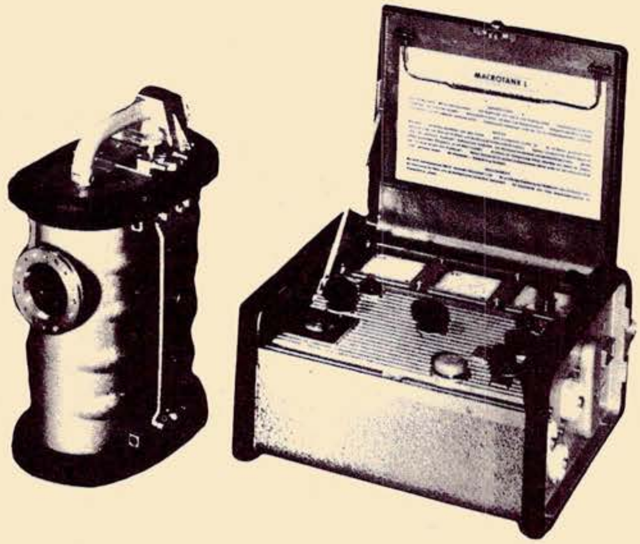
In Welding: Cracks due to thermal stresses and gas pockets, lack of fusion, slag inclusions could be detected and clearly identified obviously better than the hit-or-miss visual inspection.

In Heat Treating: To prevent subsequent waste of time and labor on defective parts or to salvage it without unnecessary reworking.

In Grinding: Recurring cracks due to, among other causes, improper wheels or wheel speed, are detected and prevented.

In Handling: Materials and components could be inadvertently handled roughly when moved from one operation to the next but magnetic particle testing will determine defects in handling system so corrective measures can be adapted.

X-RAY RADIOGRAPHY



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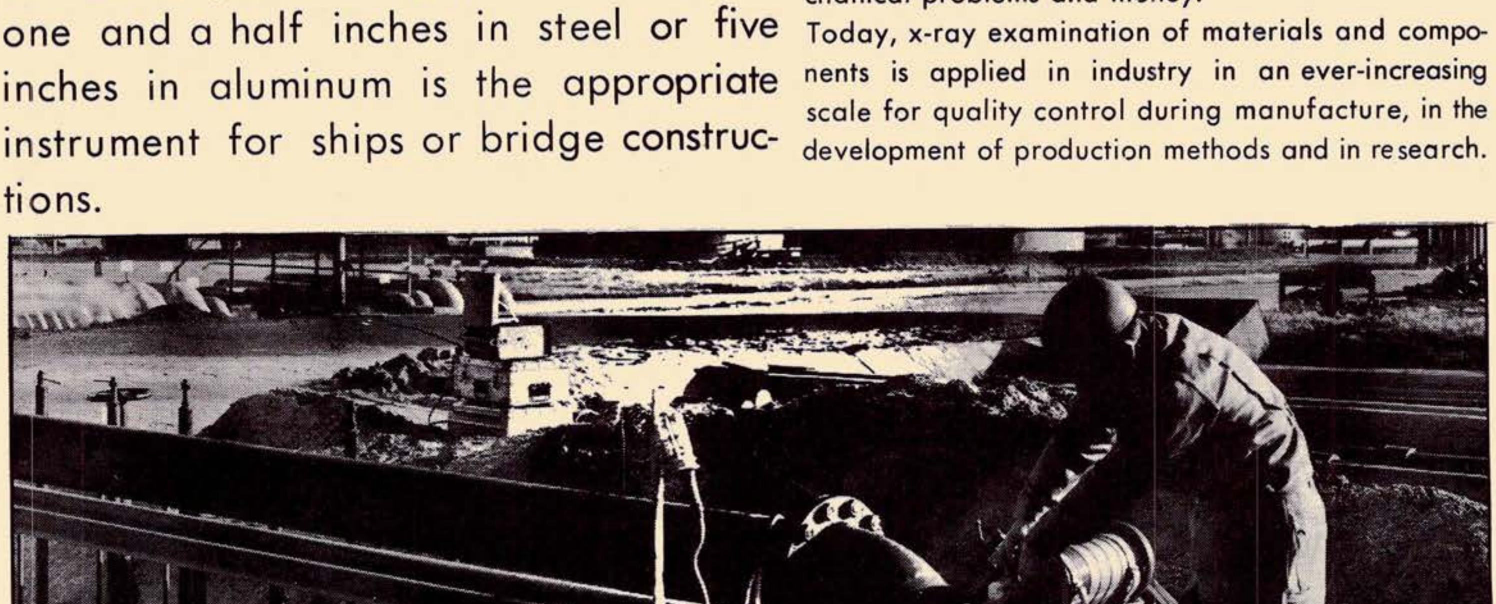
Early detection of flaws will save you plenty of mechanical problems and money.

Today, x-ray examination of materials and components is applied in industry in an ever-increasing scale for quality control during manufacture, in the development of production methods and in research.



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PHILIPPINE metals

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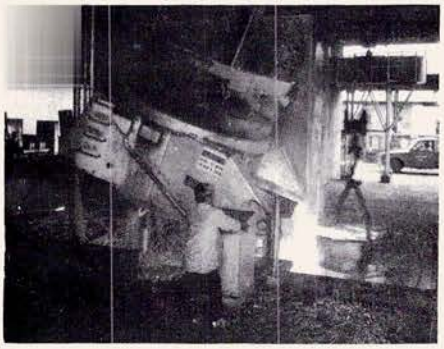

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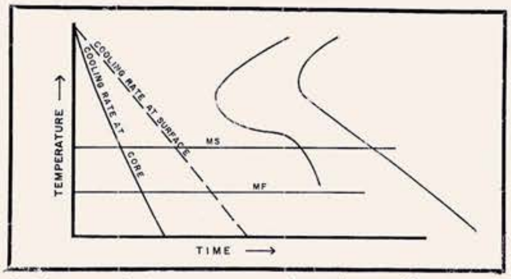

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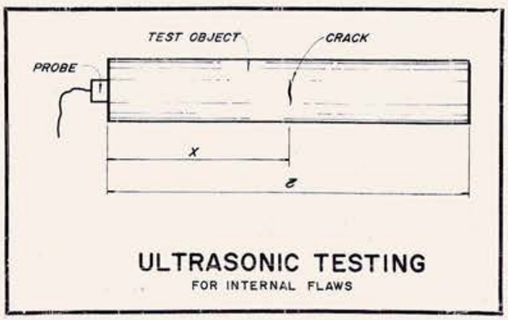

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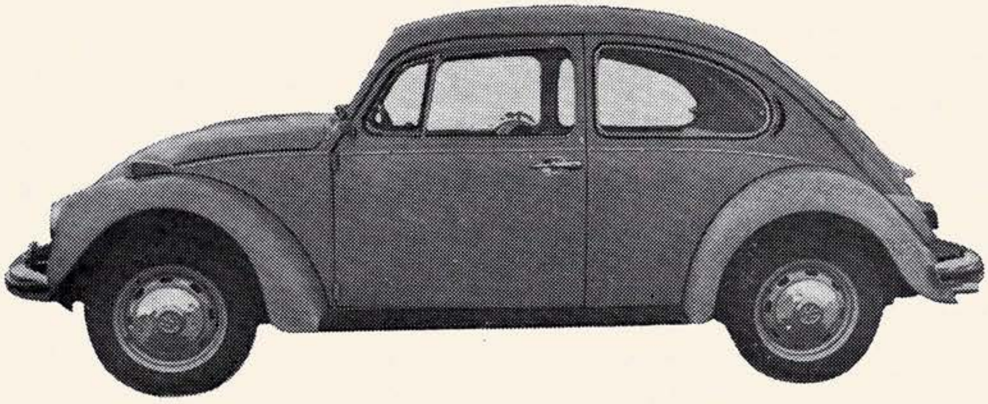
The lowest-priced economy car you can buy because



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editorial

For the Center, not the End nor the Beginning but a Continued Drive Towards Rendering Greater Assistance to the Metals Industry

The Metals Industry Development Center gets a new lease on life. Thanks to the overwhelming response and support of the private sector, a forward-looking Congress, the new law amending the previous measure creating the Center has been approved and signed by the President of the Philippines last May 31, 1972 thus prolonging its life and giving it a new name—Metals Industry Research and Development Center or MIRDC.

Except for a few added responsibilities, there are no substantial changes in the objectives and functions of the Center. The MIRDC will continue the work — adjudged a good work at that — of the Center serving the metals industry as nonprofit research and technological institution to provide both government and private sector with technical expertise on such vital activities that will foster the development of the metals industry such as the training of engineers and technicians, skills accreditation, quality control and testing of metal products, information exchange, and research and business economic advisory services. Making technical services available at reasonable cost particularly to medium and small scale firms in the metals industry is the Center's avowed mission.

The overriding consideration behind congressional and Presidential approval of the bill is the fact that the government is and will be the principal beneficiary of the activities of the Center. This is so because the mixture of technological services that it offers is vital to national security and to the overall national economy. Other considerations follow. That metals industry employs the greatest number of people in industrialized countries like the U.S., Russia, Japan, West Germany, and others, points to the vital role of metals in industrialization. The Philippines with its rich mineral resources (an edge it has over most of its neighbors) can fully develop its metals industry — which in turn will boost mechanization and industrialization, help alleviate the unemployment problem, increase our export trade and improve the overall economy — if the country's leaders would but take the important steps in vigorously implementing relevant and progressive statutes and policies on industrialization.

Meanwhile, with the assurance of continuing government support and private sector participation in maintenance and management, the Center again buzzes with renewed vigor. Looking up to the Center for technological guidance and assistance, the private sector continues to patronize its technical services such as submitting measuring instruments and material samples for testing, among other things. The Center has been judged by Congressional and Presidential approval, despite its inability to go into full steam because of piecemeal funding, for what it has done. Because it has stood by its performance, the authorities concerned have not been blind to its worth. This is not, for the Center, the end nor the beginning but a continued drive towards rendering greater assistance to the metals, engineering and allied industries. The name of the endeavor is MIRDC.

Shown is President Ferdinand E. Marcos, about to sign into law the bill amending RA 4724 and establishing the Metals Industry Research and Development Center (MIRDC). To his right is Dr. Antonio V. Arizabal, MIRDC Director. Shown witnessing the event are from left to right: Congressman Lucas Cauton; Senator Mamintal Tamano; Professor Estanislao Angeles, Vice-Chairman of the MIRDC Board of Trustees; Chita Angeles, MIRDC legal and policy counsel; Victor Guevara, Executive Vice-President of Mabuhay Vinyl Corporation; Winnie D. Deslate, MIRDC head for Planning, Economics & Information; and Lauro Cruz, Vice-President of AG & P. Also present during the signing were: Dominador de Jesus, Vice-President and General Manager, International Pipe Industries Corp.; Constante Ventura, General Manager of HONIRON's Manufacturing Division; Atty. Irineo Aguirre, Presidential Staff Assistant for Legislative Affairs; and Atty. Jose Bautista, Jr., MIRDC Administrative Officer. The Sponsors of the MIRDC law (R.A. 6428) are Senator Emmanuel Pelaez and Congressman Lucas Cauton.

LOW SHAFT FURNACE SMELTING OF FERRUGINOUS MATERIALS

PART IV

by ESTEFANIO M. GACAD

B. FERRO-ALLOY PRODUCTION IN LOW-SHAFT FURNACES

1. FERRO-CHROME PRODUCTION IN THE TROSTBERG LOW-SHAFT FURNACE (1)

In 1945, a smelting trial was carried out for a short period in the Trostberg low-shaft furnace for the production of ferro-chrome. The principal charge was low grade Bavarian chrome ore with the following composition:

Cr	18.0%
Mg	22.0%
Si	10.2%
Al	11.5%
Fe	9.0%

The burden consisted of 55% chrome ore, 40% Erzburg ore, 3% fine ore and 2% quartz. The blast was enriched with oxygen up to 55% total oxygen content.

The ferro-chrome produced had the following composition:

Cr	28-32%
C	4.3 %
Mn	1.5 %
Si	2.5 %
S	0.03%
P	0.08%
Fe	balance

The slag contained 0.1% Cr. The specific coke consumption was 2,420 kg. per ton of ferro-chrome.

The top gas characteristics were as follows:

Temperature	200-250°C
Analysis:	
CO_2	5.5%
CO	59.0%
H_2	0.5%
N_2	34.4%
Calorific value	1,700 kcal/m^3

2. FERRO-MANGANESE PRODUCTION IN THE OBERHAUSEN LOW-SHAFT FURNACE (1)

This furnace was reconstructed in 1951 from the experimental blast furnace of the "Gute Hofnungs Hutte" at Oberhausen (used from 1933 up to the 2nd World War for comprehensive series of trials for the production of ferroalloy using oxygen enriched blast).

The height of the low-shaft furnace from the floor to the top of the throat was 8.00 m. The hearth and bosh heights were 1.47 m. and 1.68 m., respectively. The diameters of the hearth, barrel and throat were 2.40 m., 3.05 m. and 2.20 m., respectively. This furnace was mainly used for ferro-manganese production (45% Mn content) with oxygen enriched blast and was shown to operate effectively and economically. Two smelting test results for the production of ferro-manganese with and without oxygen enriched blast are shown in Table XVII.

The use of oxygen resulted in 10.2% reduction in coke consumption. The oxygen used was 73% pure.

The coke throughput increased with oxygen enrichment of the blast. Based on the same coke throughput the production rate increased by 29%. The top gas calorific value increased by 38% while the total volume decreased by 40%. The increased top gas calorific value was due to the increased CO content as a result of the decrease in the amount of indirect reduction. The top gas temperature also decreased as a result of the steeper temperature gradient.

3. SPIEGELEISEN PRODUCTION IN THE MAXHUTTEE LOW-SHAFT FURNACE (3)

Smelting tests for the production of spiegeleisen (low-grade ferro-manganese with 15-30% Mn and 4.5-7.5% C) were carried out in the Maxhutte low-shaft furnace in 1957. The results are summarized in Table XVIII. The first series of experiments was carried out with ordinary blast, unscreened burden and coke of 40-80 mm granulometry. In the second experiments the oxygen of the blast was enriched to 24.5%. In the third experiments the burden was screened to 5-40 mm. In the fourth experiments smaller coke of 20-40 mm was used.

Comparing the results of the first and second experiments, the manganese extraction decreased by 3.6% and the yield of spiegeleisen decreased by 0.6%. The 3.5% oxygen enrichment of the blast increased the spiegeleisen production by 11.8 tons per day. Calculations based on accurate material balance showed very little increase in the degree of indirect reduction (or decrease in degree of direct reduction).

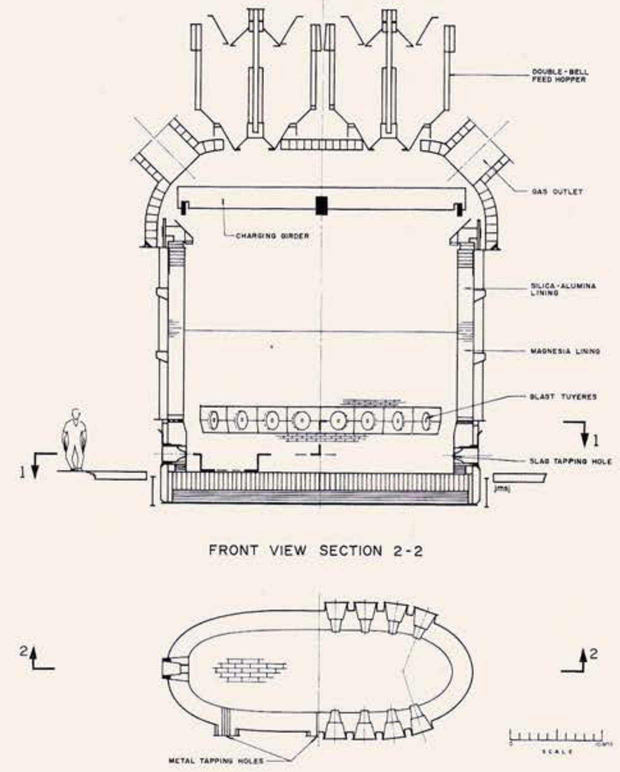
Better preparation of the burden in the third experiments resulted in further increase in output by 3.8 tons per day, increase of indirect reduction to 47% and increase in manganese yield by 5.2% compared to the second experiments.

The use of smaller-sized coke in the fourth tests resulted in a slightly lower production because of the decreased blast consumption. The degree of indirect reduction, the yield of spiegeleisen and manganese extraction however increased slightly.

C. IRON-NICKEL MATTE PRODUCTION IN LOW-SHAFT FURNACES (13)

The Doniambo smelter of "Societé Anonyme Le Nickel" near Noumea, New Caledonia had three low-shaft furnaces for the production of iron-nickel matte from mixed oxide ore. Each furnace had a capacity of about 80 tons of matte per day.

The raw ore feed was a hydrated nickel-iron magnesium silicate with a free moisture content of 20 to 30%. A typical analysis of the dry smelter feed is as follows:



FRONT VIEW SECTION 2-2

PLAN VIEW SECTION 1-1

Figure 7
LOW-SHAFT BLAST FURNACE AT DONIAMBO

	Wt.%
Ni	2.8
Co	0.06
Fe	13.0
Cr_2O_3	2.0
SiO_2	37.0
MgO	24.0
Al_2O_3	2.0
Ignition loss	12.0

The preparation of the ore consisted of crushing and screening then sintering on Dwight-Lloyd type sintering machines. Lower grade ore was pelletized and hardened using the grate-kiln method.

The low-shaft furnaces were of identical design and construction. The cross-section was in the form of an elongated ellipse, its major and minor axes were about 7.3 m. and 2.3 m., respectively. The shaft height from the plane of the tuyeres to the top was 4.5 m. Each of the long sides of the furnace had eight tuyeres. The rounded ends had slag notches and there were three tapholes on the front side for tapping matte or metal, two of which were normally in use. The hearth and lower shaft refractories were of magnesia brick while that of the upper shaft were silica-alumina brick. Each furnace was externally cooled by water sprays flowing down its steel casing.

Each furnace had two standard hot blast stoves which preheated the blast to 870°C. The hot blast stoves were heated by the combustion of mixed cleaned top gas and coke oven gas.

The top charging mechanism consisted of two feed hoppers provided with double bells each. A girder of triangular cross-section, running the length of the major axis was located below the feed hoppers which helped to spread the charge evenly. The charge consisted of hot sinter, pellets, revert slags, coke, limestone and gypsum. Coke and gypsum were used in controlled quantities so as to produce an iron-nickel sulfide containing about 25% Ni with a nickel: sulfur weight ratio of about 2.7:1. The amount of coke used was approximately 10 times the weight of the nickel contained. Each ton of dry ore required about 230 kg. of coke, 200 kg. of limestone, and 80 kg. of gypsum The gypsum was omitted when producing ferro-nickle.

The slag was continuously flushed and discarded. The matte was tapped periodically at a temperature of about 1370°C. About 820 kg of slag was produced per ton of dry ore. It contained about 0.3% nickel plus cobalt, an average of about 50% SiO_2, with iron, magnesium and calcium oxides comprising most of the balance. The matte yield was about 90 kg per ton of dry ore and averaged 27%Ni + Co, 63% Fe and 10% S. This represented a recovery of about 90% of the nickel in the ore.

The top gas temperature was about 320°C. The top gas had a CO content of 20% with an average heating value of 620 kcal/m^3. The gas was cleaned in the gas cleaning plant. A part of the cleaned gas was mixed with the coke oven gas for heating the hot blast stoves and the rest was used for power generation.

These furnaces were phased out and replaced with electric furnaces in the late sixties.

II. OPERATIONAL ASPECTS OF LOW-SHAFT FURNACES

A. BURDEN AND COKE GRANULOMETRY

The low-shaft furnace, like the blast furnace, operates more efficiently and smoothly with prepared raw materials. The granulometry of the charge materials is the most important variable affecting the operation of and the processes taking place in low-shaft furnaces. Too much fine materials (materials less than 5mm in size) lead to excessive dust losses, fluidization of the charge and irregular burden descent (hangings followed by slips) which in turn tremendously disturb the thermal, physical and chemical processes in the shaft and hearth. On the other hand, too coarse materials particularly the iron ore have detrimental effects on the thermal processes in the working zone and the chemical processes in the whole furnace. The materials' residence time in the working zone is not sufficient to complete the reduction of the burden particles. Reduction takes place mostly in the hearth principally by direct reduction which results in high fuel rate, high FeO content of the slag and poor desulfurization and quality of the pig iron.

Heat exchange is more efficient with smaller-sized charge than with coarse-sized charged assuming the charge stock height, moisture content of the charge, blowing rate and gas distribution are the same. Using the same burden granulometry but different coke granulometry, the use of coarse-sized coke results in a larger combustion zone in the bosh and higher temperature of the top gas compared to the results obtained with smaller-sized coke. This results in a less steep vertical temperature profile and the thermal reserve zone is not well defined. Use of coarse-sized coke decreases the tendency towards irregular burden descent (hangings and slips) and with increased blowing or driving rate, production is higher.

The granulometry of the coke is the primary factor controlling charge stock permeability and has an important effect on the descent of the charge. Coke occupies the biggest space in the furnace and it is the only solid material in the lower bosh and hearth which supports the burden stock column. The volume of the bosh and hearth occupied by coke is known as the coke reserve zone. The coke reserve zone limits the liquid-holding capacity of the hearth. The molten slag and iron occupies the viods or interstices.

Hence, the smaller the coke particles, the smaller are the voids so that the effective capacity of the hearth is decreased and the possibility of a hearth blockage is accentuated. **(Hearth blockage** is the condition when voids between coke particles in the hearth are blocked with fine particles, viscous materials or frozen slag such that the hot metal and slag could not percolate to the bottom of the hearth. The blockage is termed partial if either the taphole or slag notch becomes isolated, that is neither hot metal nor slag flow out during tapping and slag-off). With smaller coke particles, the charge stock permeability is decreased. This results in reduced blowing rate and lower production. Furthermore, the tendency towards irregular charge descent and hanging is pronounced due to localized fluidization of the small coke particles coke being the lightest material in the charge. These conditions were observed during campaign no. 7 of the Panganiban low-shaft furnace when the fuel was changed from the screened 10-30mm to the insufficiently screened 10-20 mm coke. The average daily production decrased from 34.6 to 19.5 per day accompanied by irregular charge descent and other operating troubles.

The low-shaft furnace, therefore, like the blast furnace, can tolerate a certain quantity of fines which when exceeded results in irregularity in operation. Each particular low-shaft furnace, for a specific type of operation imposes a minimum and maximum size of its raw materials particularly the fuel. The granulometry of the raw materials determines the maximum height of the charge stock for optimum performance in the low-shaft furnace, or stated in another way, with a given shaft height the granulometry of the raw materials can be adapted to that particular height. The smaller the granulometry, the shorter is the charge stock height but the charge is less permeable and the tendency towards operational trouble is greater.

The advantage of very uniform fuel granulometry was remarkably demonstrated in the operational tests using different types of coke briquettes (produced from non-coking coal) in the Ougrée experimental blast furnace. [14] As of December, 1969, five tests have been conducted using four types of briquettes produced from non-coking coals by different processes. The overall results showed that the briquettes were as good and even better than screened metallurgical coke. At high blowing rates and using similar sinter burdens the productivities obtained in the tests using briquettes were superior to those obtained using screened metallurgical coke. The tests also revealed the effect of reactivity of the briquettes on furnace operation. Reactivity is a function of the type of coal and manufacturing process, and also of physical characteristics such as size, shape, density, cohesion and abrasion.

B. BLOWING RATE AND PRESSURE

The blowing rate of the furnace is the principal variable controlling the charging rate, the descent of the charge stock and the production rate. It determines the quantity of coke burned per unit time. The blowing rate as previously stated is a function of the charge stock permeability.

For a particular granulometry of the charge, the low-shaft furnace has a narrow range of blowing rate, or effective gas velocity in the stack, for optimum performance. Below this range the gas flow is not sufficient to assure equal distribution throughout the cross section of the charge stock and for efficient reduction of the burden. Also, the hearth tends to chill progressively because the heat input from the combustion of coke assuming a constant blast temperature is not sufficient to compensate the rate of heat loss through the hearth walls and floor and heat required for reduction. For the Panganiban and Ougrée oval low-shaft furnaces the minimum combustion rate is around 30 tons of coke per day.

Above the optimum range of the blowing rate there is an increased tendency towards preferential gas flow, channeling, localized fluidization of the charge, hangings, increased coke rate and poor metal quality. By operating the furnace under high pressure, the effective gas velocity in the stock can be maintained within the limits for optimum operation. Operation under high pressure at increased blowing rate results in increased production without an appreciable increase in coke rate as long as the chemical reserve zone in the furnace stack has not disappeared. The operating limit of the low-shaft furnace is attained when the maximum effective gas velocity is exceeded and either the whole charge stock or the primary slag formed in the bosh is fluidized.

These facts were verified from the results of tests conducted in the Ougrée low-shaft furnace. [9] So far this was the only low-shaft furnace operated under high pressure.

The maximum productivity of a low-shaft furnace on record at high blowing rate is held so far by the Ougrée furnace. This was attained when it was operated under high pressure using sinter and coke-briquettes. The productivity was 9.8 tons of pig iron per cubic meter of working volume. In the same furnace, the record productivity with a charge of metallurgical coke screened to 10-25 mm and similar sinter was 5.6 tons of pig iron/m^3 of working volume per day. [14] For blast furnaces, the record productivity so far is 3.2 tons of pig iron/m^3 of working volume per day.

C. CHARGE STOCK DESCENT

Under normal operating conditions the rate of descent of the charge-stock is uniform and gradual as measured by the stockline indicating rods or gages. Irregular descent of the stock occurs when the stockline remains at the same level for several minutes and then "slips", that is, the stock falls spontaneously a few centimeters.

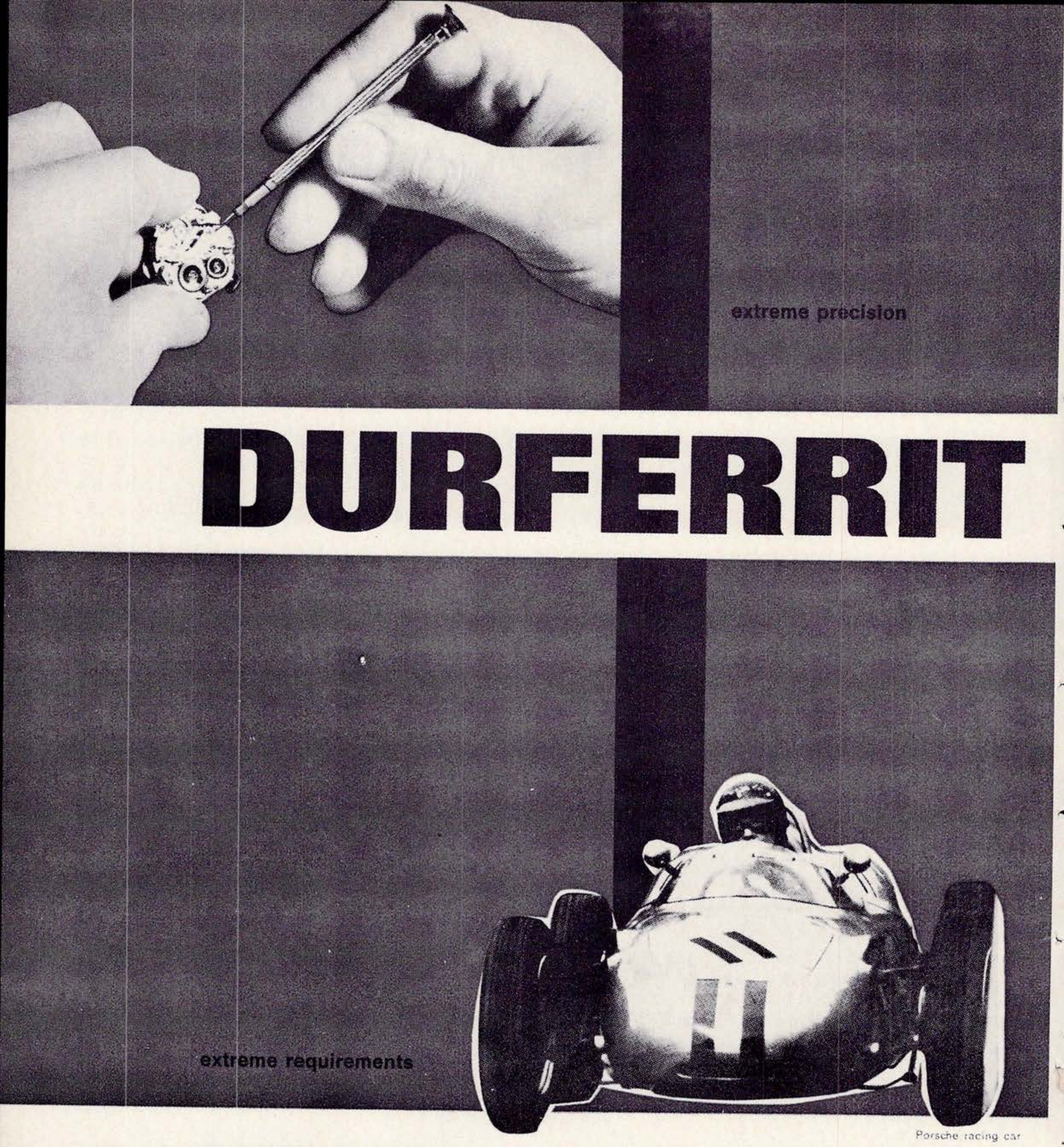
The stock is said to be "hanging" when the stockline remains at the same level and does not fall spontaneously. Hanging is accompanied by increased pressure and decreased flow of the blast. Under this condition the stock is brought down by "checking" the furnace, that is by suddenly decreasing the blast pressure and flow into the furnace until the stock falls (slips). The slip is immediately followed by a sudden surge of gas flow and pressure in the furnace top and gas lines. The extent of the slip varies from 1/2 to 2 meters depending on the length of time that the stock was hanging. Checking of a furnace is done with extreme precaution and only after the hearth has been flushed, that is after slag-off or preferably after tapping.

The risk of blockage and chilling of the hearth due to slips especially after a hanging is high. The relatively cold mass of insufficiently prepared or viscous slag and fine particles of incompletely burned coke fall into the hearth and plug the voids of the coke reserve thus making it difficult for the hot metal and slag subsequently produced to percolate to the bottom of the hearth. This condition is very dangerous because the hot metal may erode or melt the slag tuyere and explode upon contact with the cooling water. This happened during campaign no. 4 and was the main reason for stopping campaign no. 5 of the Panganiban low-shaft furnace.

The shape of a particular low-shaft furnace imposes certain peculiarities in its charge stock movement. Less problem is encountered with a circular than an oval or rectangular cross-section. With a circular cross-section the descent of the stock is more uniform. In an oval cross-section the stock descends faster along the extremities of the short axis and hangings tend to start at the ends of the long axis. Refractory wear is therefore faster on the sides of the shorter axis while deposits tend to form on the sides of the longer axis; thus there is a tendency to form a circular cross-section. In a rectangular cross-section the charge descends faster at both ends than in the center of the furnace which results in different conditions of reduction and smelting indifferent zones of the furnace over its length and cross-section.

D. CHARGING PRACTICE-TYPE OF CHARGE

Due to the short stack height of low-shaft furnaces and short residence time of the charge in the stack, the iron ore, sinter or pellets to be used must have high reducibility characteristics. Magnetite is not a good material for the low-shaft furnace because of its poor reduction characteristics.



Porsche racing car

PART II

Some Elementary Problems in the Heat Treatment of Steel

by H. Wicke of Messrs. DEGUSSA, Frankfurt/M., Germany

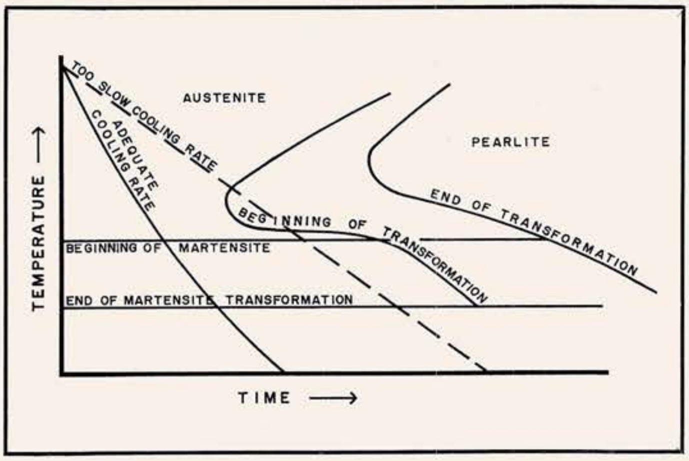
This comparison shows that — special cases apart— the salt bath can be considered as an ideal method for the heat treatment of steel.

In practice we will encounter difficulties not only during the heating up process but also while quenching from hardening temperature down to room temperature. Though a quench, in water for instance, takes a few seconds only, it is obvious that the surface of the steel coming into direct contact with water will transform into Martensite ahead of its core. Due to the Martensite's increase in volume this temporal difference of Martensite transformation will inevitably produce internal stresses which in turn may cause distortions or even cracks. These dangers have the tendency to occur more seriously on intricate pieces with varying cross-sections.

To investigate the proceedings during quenching the following test can be made: a number of steel samples (of equal analysis) will be heated to a temperature above the critical range (i.e. austenitized) and then each individual sample quenched to a certain temperature between 700 and 20°C, so that the whole range of temperature is covered by samples. On these various temperatures the samples will be soaked while their individual transformations will be checked dilatometrically in relation to time. Their final structure will then be examined metallographically. The resulting diagram will give us an exact indication as to kind of transformation that must be expected at a given temperature after a certain period of time. It may well be called "T.T.T." (Time, Temperature, Transformation) diagram. It must be added that the results are valid only for the kind of steel tested, i.e. each kind of steel has its own TTT-diagram.

As an illustration, a diagram which roughly correspond to a high carbon steel, is shown as follows:

The TTT curves in general show that in the temperature range of approximately 500-600°C transformation begins and ends rather fast while in the lower



range of 200-300°C, it starts and ends after a considerable length of time. Then at a slightly lower temperature the transformation into Martensite begins (and further down, it ends) irrespective of the time elapsed after the quench. (As the Martensite transformation is independent of the time factor we ought to talk about a Martensite point though we are for convenience depicting it as a line).

Practical application of these findings: To produce full hardness (i.e. homogeneous Martensite) the cooling rate must be quick enough not to cut the starting line of Pearlite transformation before reaching the Martensite point. If the quench is too slow, its curve (as shown above) will inevitably cross the starting line of Pearlite transformation, at least at the latter's nose in the temperature range of around 500°C, which means that at least part of the structure will become pearlitic before the rest is transformed into Martensite. Pearlite, however, is soft and even traces of it reduce tensile and transverse strength of the steel which may consequently break under stress. The above diagram, therefore, shows that the quench must always be sharp enough for its curve to pass on the left hand side of the dangerous nose, i.e. a steel of the above mentioned characteristic (narrow gap) will have to be quenched in water or brine.

However, the sharper the quench the farther will the temperature fall of the core lag behind that of the surface as there is no time left for equalization of temperature within the steel.

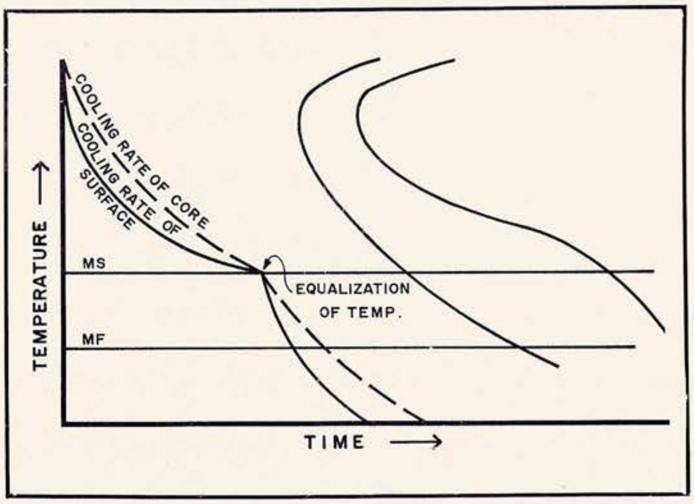
The different temperature declines of surface and core are shown below in a "TTT" diagram.

The degree of the temporal difference between the Martensite transformation in the surface on one hand and in the core on the other hand gives an indication of the resulting internal stresses or the distortions and cracks to be expected.

Apparently we are caught in a dilemma as any attempt to reduce the internal stresses by a milder quench (for example, in mineral oil) would inevitably lead to the formation of Pearlite and vice-versa. One way to avoid this would be to change the cooling characteristic of the steel so that its transformation curve (particularly the dangerous nose in the starting line of Pearlite transformation) are shifted to the right hand side of the TTT diagram, so that all transformations during quenching are delayed and a milder quench rendered possible. In practice this can be achieved by alloying the steel with other metals such as chromium and nickel. Such alloy steels are fully hardenable by an oil quench such that they are commonly called oil hardening steels, i.e. plain carbon steels. For these reasons such alloy or oil hardening steels are exposed to considerably less internal stresses after quenching than plain carbon or water hardening steels.

Alloy steels, however, apart from being more expensive, may have disadvantages for particular jobs where plain carbon steels are preferred in spite of their inherent difficulties. In such cases there is another way to avoid the above described dilemma by means of the so-called "interrupted quench". The TTT diagram shows that a sharp quench is required only in the first part of the cooling process to prevent its curve from cutting the dangerous nose between 400 and 600°C. In the lower temperature range down to the Martensite point there is ample time for a mild quench. We can take advantage of this phenomenon in the following manner: first, quenching the previously austenitized plain carbon steel in water or better, brine until its temperature has fallen to approximately 250°C (which requires an experienced eye to judge), and then quickly transferring it into oil for a mild quench during Martensite transformation.

A close examination of the quenching curves of the TTT diagram for any oil hardening steel will show that the internal stresses expected in the steel are much reduced, though not completely done away with, i.e. some stresses are inherent in the oil quench.



The same considerations that led us to the interrupted quench also offer a way to reduce the internal stresses still further by applying a new quenching medium which can be kept at a temperature just above the Martensite point. For this purpose a special salt bath has been adopted which has a quenching effect sharp enough to make all alloy steels pass off the dangerous nose of the Pearlite transformation curve and at the same time ensures a complete temperature equalization between surface and core or varying cross-sections before the Martensite transformation is allowed to start by subsequently letting the work slowly cool down to room temperature in still air. As the Martensite transformation will now take place gradually and almost simultaneously over the whole cross-section of the steel, internal stresses will be reduced tò a minimum. By this method, called "Martempering", intricate sections can be hardened without undue distortion. It may be mentioned that even plain carbon steels with small cross-sections can be successfully martempered.

In practice it will not be necessary to adjust the temperature of the quenching bath to the exact Martensite point of each kind of steel; as the Martensite transformation proceeds gradually over a longer range of temperature it will normally be quite sufficient to keep the quenching bath at a temperature between 180 and 200°C.

In this context it must be emphasized that even under the optimal conditions of martempering, certain internal stresses cannot be avoided as they are inherent in the formation of the Martensite (increase in volume) as such. It will be advisable to always finish the hardening process (even after martempering) by a subsequent tempering operation either at a comparatively low temperature (approximately 200°C) for stress relieving only or at higher temperature (depending on kind of steel and job at hand) to reduce excessive hardness (brittleness) and increase toughness. Special cases of so-called "tempering brittleness" apart, toughness increases while hardness decreases with the rise of tempering temperature. The optimal compromise between hardness and toughness depends on the kind of work at hand. It stands to reason that satisfactory and uniform results will depend on homogeneous structure which can best be achieved by tempering in a salt bath which ensures absolute uniformity of temperature and accurate temperature control.

To round off this treatise we must mention two special problems which have considerable importance for the practice. First, there is the problem of case hardening.

There is a variety of parts of which hardness (preferably surface hardness) and at the same time utmost toughness are required, i.e. properties no homogeneous steel can possess simultaneously. As it will rarely be possible to make such a part out of two different kinds of steel, a special type of steel has been developed which, after appropriate treatment, will meet these requirements: the case hardening steels.* These are alloy or unalloy steels with a low carbon content which, after austenitization and quenching, would possess insignificant hardness but great toughness. To provide such a steel with a hard and wear resistant surface, carbon will be made to penetrate into its surface after the steel has been machined.

On quenching this additional carbon will produce full hardness in the top layer of the part whereas its core will remain comparatively soft but tough.

To understand how the carbon is put into the steel we must remember that in austenitized steel (steel at a temperature above the critical range) carbon atoms are not only able to move comparatively freely but also to leave the steel, whenever the latter gets into contact with oxidizing media (decarburization). If, however, the steel is surrounded by a highly carbonaceous medium the diffusion process will take place in a reversed direction, i.e. the surrounding carbon will penetrate into the austenitized steel until a carbon equilibrium between the surrounding medium and steel is reached. A carburizing effect can, therefore, be achieved by heating the steel to a temperature above the critical range and at the same time bringing it into contact with carbon in a suitable form. Hence the amount of carbon diffused into the steel depends, apart from temperature, upon the intensity of the carburizing medium and the time the steel is exposed to it. The speed of carbon diffusion in steel depends on temperature only.

Formerly the only carburizing method used is to pack the steel in a box filled with charcoal and to heat it up in a muffle furnace to a temperature of approximately 900°C where it is soaked for hours. Though the charcoal would prevent scaling, the treatment in a muffle or chamber furnace still entails all the deficiences described above under points 2 and 3, the detrimental effects being even worse because inaccurate and uneven temperature will produce uneven case depths (depths of carburization).

It has now become possible to introduce carbon to the austenitized steel by immersing it into a suitable salt bath whereby the above described deficiencies are overcome in an ideal manner. In addition, the salt bath renders possible carburizing speed, faster than that of any other technically practicable method. During the last three decades the salt bath, for all these reasons, has developed into the most universally applicable carburizing medium.

In this context it must be mentioned that the gas carburizing method (carburization by carbonaceous gases), which has been developed in the USA, can hardly supercede the salt bath carburizing method as the former will be economically applicable only where every large amounts of one and the same part have to be treated — conditions which are not too often met in Europe.

Second problem: hardening of high speed steels. The practician treating high speed steels might have gotten confused by our considerations about the iron-carbon equilibrium diagram as he is used to heat up these steels to much higher temperatures for hardening. However, our previous inferences from the iron-carbon equilibrium diagram were not disregarded as the hardening temperatures of the high speed steels are due to their being alloyed with other metals. These alloying elements have greater affinity to carbon than iron has so that most of the carbon is not available (in the annealed state) as iron carbide but rather as chromium carbide, tungsten carbide, etc. These carbides, however, would not dissolve at normal hardening temperatures just above the critical range, i.e. not much carbon will be able to go into solution during austenitization so that after quenching only a slight bracing of the Martensite structure will occur. As a consequence, an insignificant hardness could be achieved.

It must be mentioned that for proper hardness only the carbon which has gone into solution during the preceding austenitization is responsible. All other alloying materials do not directly increase hardness but have other tasks and to explain them would be going beyond the scope of this treatise.

To furnish the iron matrix of high speed steel with sufficient carbon atoms, it has to be heated to a temperature range of 1200-1300°C where the above mentioned carbides will dissolve (at least partly) and release their carbon for dispersal in the austenitic iron matrix. Such high temperatures can be reached in muffle or chamber furnaces but the treatment of high speed steels in such furnaces is obsolete since this method has all the deficiencies already described. In addition such high temperatures inevitably caused considerable growth of grain size if allowed to prevail for more than some seconds. Here again the salt bath method is the ideal means to overcome all these difficulties. Apart from ensuring protection against scaling and decarburization and offering uniform heating and accurate temperature control, it also keeps the grain size to a minimum. Growth of grain size depends on temperature and time. Therefore, the more accurate the temperature and the shorter the soaking time on temperature the more fine-grained will be the high speed steel. In a salt bath, the soaking time — which has, of course, to be long enough to achieve the required dissolution of at least part of the carbides — can easily be determined and kept to the required minimum.

It stands to reason that the quenching and tempering (secondary hardening) of high speed steels will best be performed in a salt bath as well.

To wind up the question of hardening of high speed steel — which could only slightly be touched here — it can fairly be said that the salt method is nowadays indispensable for the production of quality high speed tool steels.

By BARRY W. POPPLE

We can cover an enormous amount of testing within the field of construction and maintenance but, whereas, the title may suggest its own limitations; for example it does not cover quality control for manufacturing — castings, forgings, etc. one thing is for sure, and that is any type of known test mentionable to the manufacturer will also be known and applicable to construction and maintenance testing. For the purpose of condensation, this paper will discuss testing in the field of construction and maintenance, but, please be reminded that the type of tests about to be described will certainly not be limited to this field only.

The field requires continuous testing, essentially mechanical, electrical, metallurgical, chemical, physical, and civil testing and, whereas, it would be difficult for any one engineer to cover the whole field; in some cases, for example, in universal testing laboratories, it would be necessary for some engineer at least, though he may be qualified in only one or two lines of engineering, to broaden his mind to the entire field, because, oftentimes, one or two tests are not enough to satisfy the "doubting Thomases". How many times have you heard the expression "oh, it must be okay because it has been x-rayed". The component is put back into service, fails after a short period of time and it is concluded that its recent type of operation was the cause of failure. The fact is that x-rays are not always conclusive evidence and often require supplementary testing.

Such testing which absorbs engineers of all types, can be divided into two categories, thus, destructitve and non-destructive. Most engineering colleges are adequately equipped with destructive testing equipment (e.g. universal testing machine for bending, tension and compression tests, fatigue testing machines and creep testing machines, etc.) but, as we venture out into industry, we find that non-destructive is fastly replacing the conventional destructive, although it will never completely replace it. Since it can be reasonably assumed that the engineer is usually familiar with the common conventional destructive testing methods, this paper will elaborate more on the most modern methods of non-destructive testing.

Non-Destructive Testing

Most articles written on non-destructive testing will express it as a new engineering field which has developed with great rapidity. Actually if you consider the fact that most of our techniques used are thirty years old or more, it is about time that we accepted the presence of non-destructive testing (NDT) as readily as our children accept television. Television has not changed much in thirty years except in dimensions due to the introduction of capacitors and printed circuitry. Likewise, many NDT equipment have shrunk in size, allowing easy portability, leading to wider versatility and sophisticated design. Why is it then that still today, NDT is new to the ears of many engineers? Why is it that its growth has been rapid only in the past decade? It is

CONSTRUCTION & MAINTENANCE TESTING

only until now that we find ourselves hardly able to cope with the vast demand for NDT services, why did it therefore take so long to become recognized as an essential component of production processes, construction and maintenance work? It would be unfair to directly blame our older generation but it is a fact that World War II did have much to do with stunting the growth of NDT. Shortly after the war, money was scarce all over the world, so scarce that a majority were forced into being "Penny wise-pound foolish". Pennies today can easily buy us pounds of insurance. Just after the war, there were pennies enough for bread only.

With the advent of mass production and general trend towards larger investment, NDT became a must in order to avoid loss of markets and reputations. Disaster and loss of life or of costly investments in complex engineering developments can result from the omission of necessary tests on components. Errors in judgment, which result in failure to use non-destructive testing adequate to insure system integrity and reliability can not be tolerated in modern production and engineering management.

NON-DESTRUCTIVE TESTS ARE USED BY COMPANIES FOR THE FOLLOWING REASONS

1. To insure product reliability.
2. To prevent accident and save human lives.
3. To make a profit for the user
   a. To insure customer satisfaction and to maintain the company's reputation.
   b. To control manufacturing processes, construction and maintenance.
   c. To aid in better product design.
   d. To lower manufacturing costs.
   e. To maintain a uniform quality level.

APPLICATIONS

A. Construction:

Maybe 90% or more of NDT applied during construction, particularly to heavy industry is to weld-

Barry W. Popple, manager of the Testing and Inspection Department, Philippine Engineering and Construction Corporation is a holder of a Higher National Diploma in Mechanical Engineering from the Peterborough College of Technology, England and is a member of the Non-Destructive Testing Society of Great Britain. He was formerly consultant for the Non-Destructive Unit, Department of Testing and Industrial Services of the Manila Electric Company.

ments and to material parts just before they are welded. The higher the temperature and/or pressure that these parts will be subjected to, the higher becomes the inspection frequency and the specifications more rigid. Likewise, should the materials and weldments have to conceal dangerous chemicals or elements such as installations within nuclear reactors, where the costs of failure could be intangible, undoubtedly you will find NDT being applied to the same component (in different forms) for double checking purposes.

B. Maintenance:

Even from the time of the wheel, when it was soon realized that an occasional drop of grease onto its axle considerably lengthened its life span, so became the necessity for scheduled maintenance and inspection. We have to keep the wheels going, the whole plant going, everybody going. We try to get the maximum use out of a component before it fails and maybe causing other components to fail, but most important of all to discover defects before it fails and to repair or replace it during the scheduled service period to avoid untimely shutdowns.

NDT applied to maintenance inspection in general is for the purpose of detecting fatigue cracks, heat cracks, stress corrosion, blistering, thinning and corrosion pits, although often, defects are found not caused by service, but from inherent defects in the materials or processing faults.

**By definition, non-destructive tests differ from all tests and measurements which damage or impair the service ability of the items tested.*

Radiography

1. X-rays & Gamma Rays:

X-rays and gamma rays can be of the same intensity, the same wave length and have the same penetration ability. They differ only in their source of generation. X-rays are produced from an electrical source and gamma rays are produced from the spontaneous disintegration of atomic nuclei from radioactive materials which we call isotopes although not all isotopes of a particular element need be radioactive.

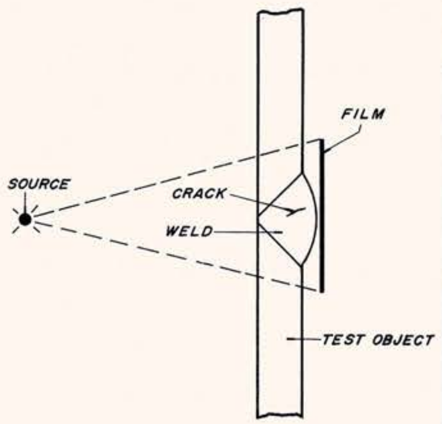
For purposes of radiography you will find in the medical profession x-ray predominant — gamma radiography is used more in industry, although in some industries for example, space travel, nuclear power and L. P. G. handling x-rays is specified. In general, a radiograph produced by x-rays will be more "sensitive" than a radiograph produced by gamma exposure i.e. smaller changes in cross-section or smaller internal inclusions, defects or abnormalities can be detected. But, we find in industry that when a "gammagraph" is acceptable, due to portability of the isotope, radiography becomes easier and faster. In the Philippines, however, where any isotope over one curie has to be imported, the cost may be higher than x-radiography unless the isotope can expose film continuously. The smaller the half-life of the isotope, the more expensive becomes gamma radiography. Therefore, unless a particular company requires continuous radiographic inspection, it will not benefit itself economically by setting up its own facilities for radiography, it would be far cheaper to contract out the testing and inspection.

WHAT, WHEN, WHERE, HOW AND WHY DO WE RADIOGRAPH

It is very possible to programme radiography for construction and maintenance although there will also crop up the inevitable unforeseen emergencies that require inspection. During a scheduled shutdown, we know for example exactly what we are going to radiograph, where, when, how and why, mostly from experience of previous failures. Take for example maintenance testing on a turbine, we can radiograph anything from the smallest set screw for cracks to the largest babbit-lined bearing for internal voids, incomplete penetration or blocking of oil channels preventing important lubrication to the shafting. Previous records of the particular components' life tells us when to inspect, in fact, best programming is based on a lot of history. History will also explain why we inspect, how to inspect of course can only be arrived at after a good deal of intensive training in NDT.

With regard to construction radiography, as already mentioned, 90% or more of the work is on weldments. Internal discontinuities commonly encountered in interpreting weld radiographs include gas holes and porosity, slag inclusions, lack of penetration, cracks, lack of fusion, burn through and undercutting.

Both internal and external discontinuities are revealed in radiography of butt welds. Although internal discontinuities are often of greatest interest, external surface discontinuities can sometimes be detected only by radiography, as in pipe welding. Other common peculiarities revealed in radiographs, although not necessarily weld defects, also need interpretation by the radiographer. Since every discontinuity shown on the radiography may not be rejectable, the word "defect" is not used until the interpreter makes a decision after comparison with the applicable standard.



RADIOGRAPHY
TYPICAL SINGLE WALL/SINGLE IMAGE SET UP

After the inspector has satisfied himself that the finished radiograph has the required definition, density, contrast, or latitude and sensitivity, he uses his trained eye and knowledge gained from years of experience to detect flaws, to recognize its type, size, location and orientation and evaluate its severity, relative to or directly to known universally accepted standards. It is then filed with the radiographic report and serves as a permanent record. It is even accepted in court as black and white evidence in the same way as an ordinary photograph may be exhibited.

Ultrasonics

Supplements radiographic inspection of butt welded joints and sometimes completely replaces it. Fillet welds (ultrasonically tested) are particularly more reliable than radiography in detecting incomplete penetration, lack of side wall fusion and tight cracks, too small for the naked eye to detect on the radiograph. It can accurately pinpoint the location of discontinuities facilitating repair work.

APPLICATION OF ULTRASONIC TECHNIQUES

Because ultrasonic techniques are basically mechanical phenomena, they are particularly adaptable to the determination of structural integrity of engineering materials, their principal applications are:

a. Flaw detection
b. Thickness measurement
c. Determination of elastic moduli
d. Study of metallurgical structure
e. Evaluation of the influence of processing variables on the specimen

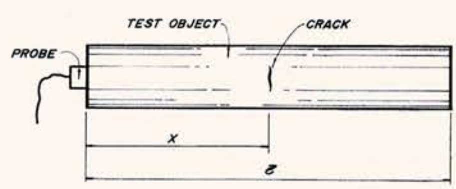
ADVANTAGES OF ULTRASONIC TESTS OVER RADIOGRAPHY

The desirable features of ultrasonic tests include:

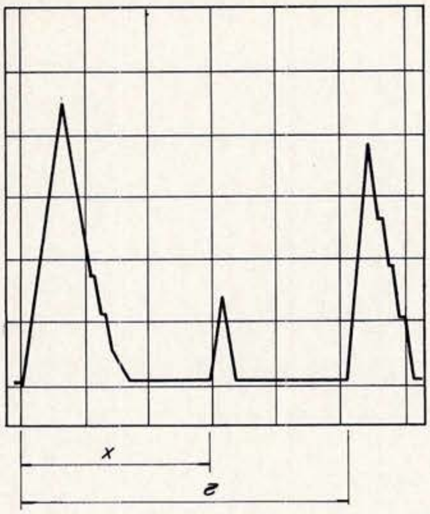
a. High sensitivity, permitting detection of minute defects.
b. Great penetrating power, allowing examination of extremely thick sections.
c. Accuracy in the measurement of flaw position and estimation of flaw size.
d. Fast response, permitting rapid and automated inspection.
e. Need for access to only one surface of the specimen.

On the structural side of construction, we find that the majority of welds on frameworks are fillet welds which are invariably tested by ultrasonics. Even the heavy section butt welds and rivetted sections which are too thick for penetration of radiation waves or too time-consuming are very quickly scanned with the ultrasonic probe. Unlike radiography however, where the radiograph is submitted as positive proof, we have only the ultrasonic technician's report to go on, therefore, just as a welder is subjected to a welders pre-qualification test, likewise the ultrasonic technician must be subjected to various weld test specimens whereby he must prove to the examiner that he can find internal flaws, describe its nature, size and position in the weld and evaluate its acceptance to a given standard.

In maintenance ultrasonics often play a larger role than radiography. For example in shutting down of a power plant unit for 3 to 4 weeks, the ultrasonic set may hardly have time to be switch off. It is used for testing boiler tubes for wall thickness, corrosion, and hydrogen embrittlement, etc. and on the turbine blades, diaphragms, rotor shaft, bearings, couplings, bolts and the steam chest itself for cracks caused from fatigue, erosion or severe thermal stresses.



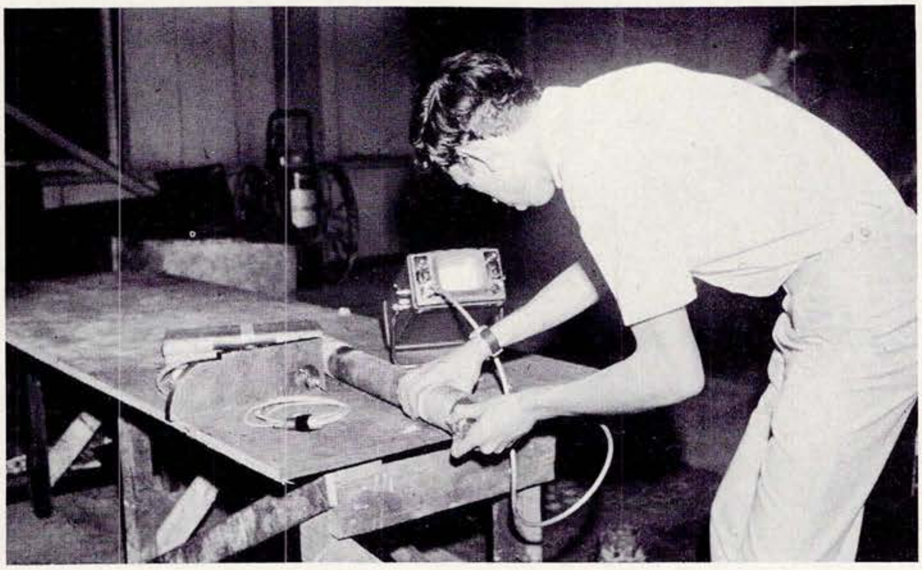
ULTRASONIC TESTING
FOR INTERNAL FLAWS



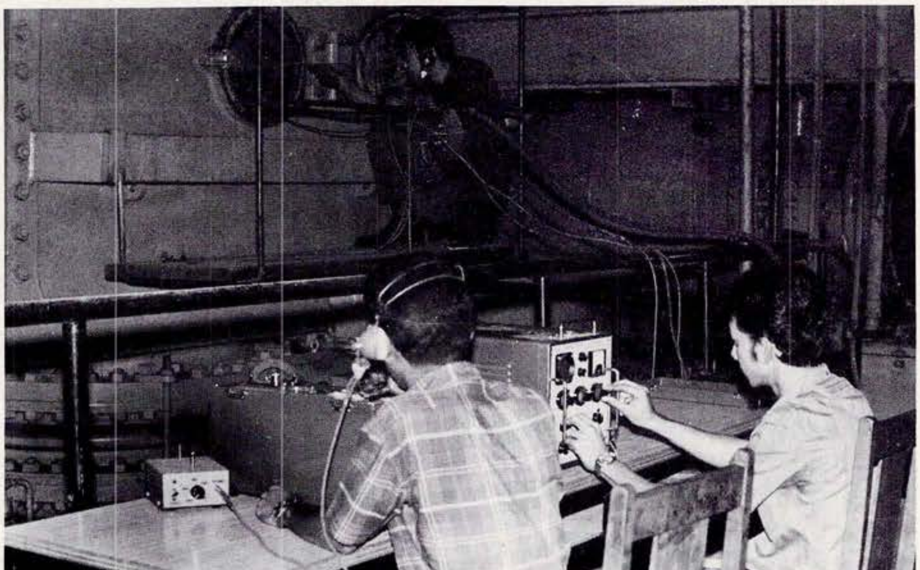
ULTRASONIC SCREEN

Eddy Current Testing

The use of metallic tubes in industry is increasing continuously. Typical applications include the construction of boilers and heat exchangers, reactors, refrigerating system, chemical and oil refining plants and many process industries. Therefore, non-destructive testing of large qualities of tubular products for discontinuities, eccentricity, wall thickness, alloy hardness and other properties is an especially important problem. The testing of tubes has been the first mentioned application since eddy-current testing is the only means of testing small enclosed tubes. Ultrasonics have been employed on the quality control of mass–produced small bore tubes during manufacture but the tube can be easily handled during testing purposes. We can hardly take out 10,000 tubes from a condenser in order to ultrasonically test them, they usually get crimped. Instead we pass an eddy-current probe through its length and measure its contours. As the probe is pulled through the tube, an eddy-current graph is traced, indicating the non-uniformity of the material. With reference to calibration tubes and one or two sampled tubes pulled out of the condenser, the condition of the whole condenser can be evaluated from the eddy-current graphs.



Ultrasonic testing of a turbine bolt.



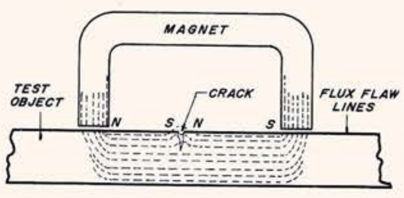
Eddy-current testing of condenser tubes.

Eddy-current fields are not only set up and standardized for tube testing. Other types of coils are designed and housed by suitably shaped probes for measuring diameters, permeability, conductivity, shape, width, depth, length and position of flaws, thickness of sheets, plates, foils and insulating coatings.

This method of testing is not as popular as radiography or ultrasonics for construction testing, but although older in principle, the type is still strongly holding its own in the field of maintenance and quality control of mass production.

Magnetic Crack Detection

Depending on the magnetic properties of the test object, this method can detect all discontinuities at the surface and under certain conditions, those which lie directly below the "skin". Having established a sufficient magnetic field in the test object, magnetic particles



A HORSE-SHOE MAGNET USED TO PROVIDE FLUX

Magnetic testing of a steam chest.

are applied to its surface where it is examined for accumulations of the particles and the service ability of the test object is evaluated.

This technique is of course limited to crack detection on ferrous materials only and could not help in determining the cause for cracking. After testing, recommendations will be given either for acceptance, rejection or repair and even on repairs, the depth cannot be measured. Ultrasonics usually takes over at this point to measure the size, depth and orientation of the crack tò facilitate repair work if repair is possible.

Why not therefore completely replace magnetic tests with ultrasonics and search at the same time for internal defects? Well, magnetic tests are usually performed very fast over irregular surfaces and except for shrinkage cracking in castings, cracks are usually found to begin at surfaces since it is the surfaces of the object which usually receive the maximum mechanical or thermal stresses. And besides, ultrasonics become cumbersome over irregular surfaces. It is therefore often used as a quick scan search prior to ultrasonic measurement.

APPLICATIONS

Out on the construction site, particularly where high standards of welding is specified, you may also find magnetic crack detection specitied on fillet welds to search for transverse cracks. Butt welds are also occasionally subjected to magnetic tests when cracking may be suspected due to improper welding, cooling, stress-relieving or mechanical damage specially if the section is too thick for radiographic inspection.

It is however more commonly used in maintenance inspection particularly on irregular ferritic castings but, as mentioned before, it is usually a quick scan prior to ultrasonic tests. One such example to shòw how magnetic tests can be more than ten times faster than any other known test is crack detection on a complete turbine rotor. A test coil (if long enough) can completely envelop the rotòr, the current is switched on and visual inspection begins whilst applying the magnetic dust. Repeat in the other plane and the job is done.

Dye-Penetrant

This method is used entirely for detecting surface discontinuities. Provided that the surface is very clean, it can give us the same results as the magnetic crack detector and it is not limited to ferrous materials. Various grades of penetrants can be used (varying penetrating power) depending on the importance of function of the test object. More sophisticated dye penetrant inspection requires penetrants which flouresce under black light increasing flaw detection sensitivity.

Not being limited to ferrous materials means of course that we can apply dye-penetrant tests to almost anything provided that we have enough access to clean the testing surface. And the advantage of this simple test is that by a mere squeeze of an aerosol can, by an unnecessarily skilled inspector, gives results in five minutes. Oftentimes, the object being tested need not be removed from its fixture, thus saving a lot in maintenance time. Other inspections, however, for example in the aviation industry where the test may be considered highly sensitive, components are completely removed from their fixtures and immersed in a bath of high penetrating solution for comparatively longer periods of time. The component is then placed in a dark area and the entrapped penetrant which is sensitive to ultra-violet light will flouresce when subjected to this during visual inspection.

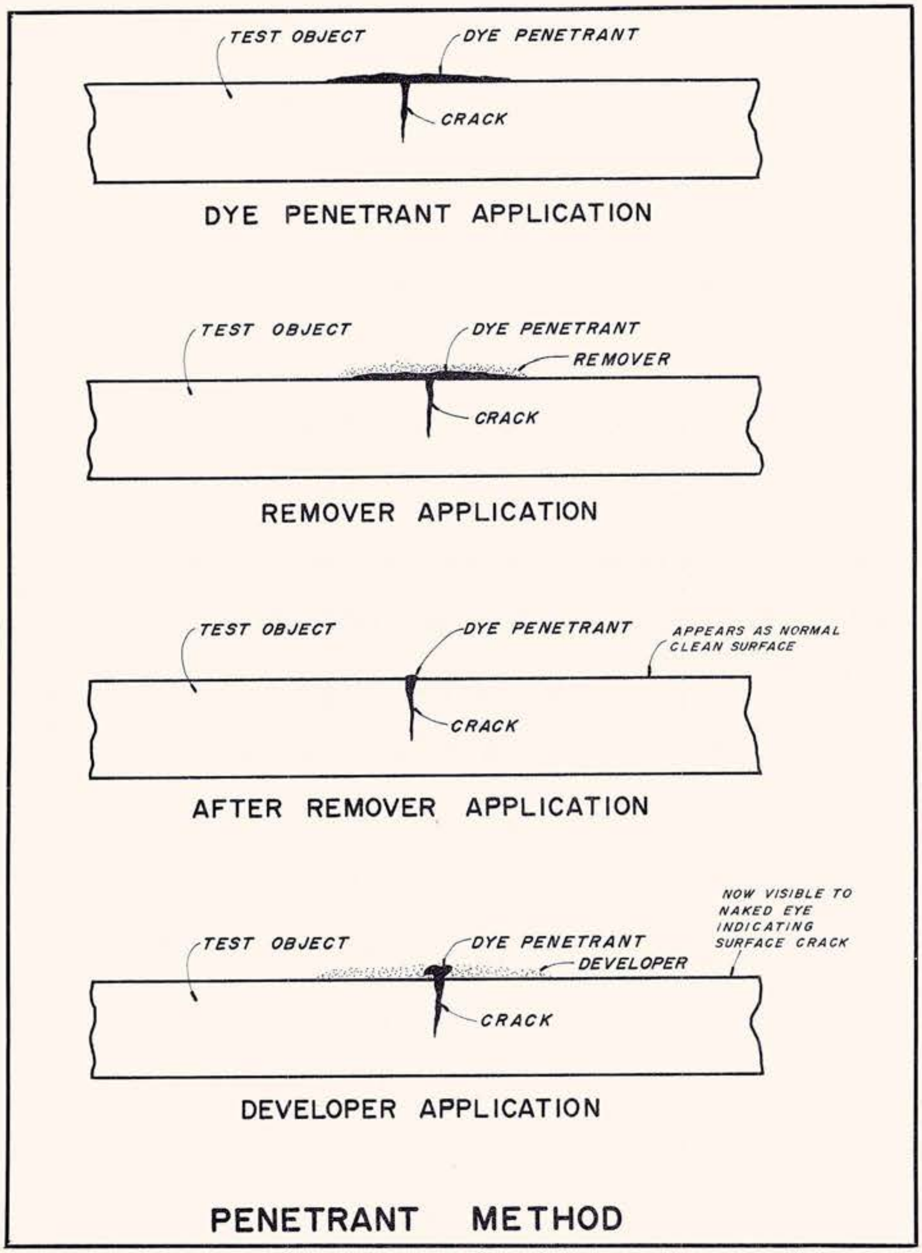
APPLICATIONS

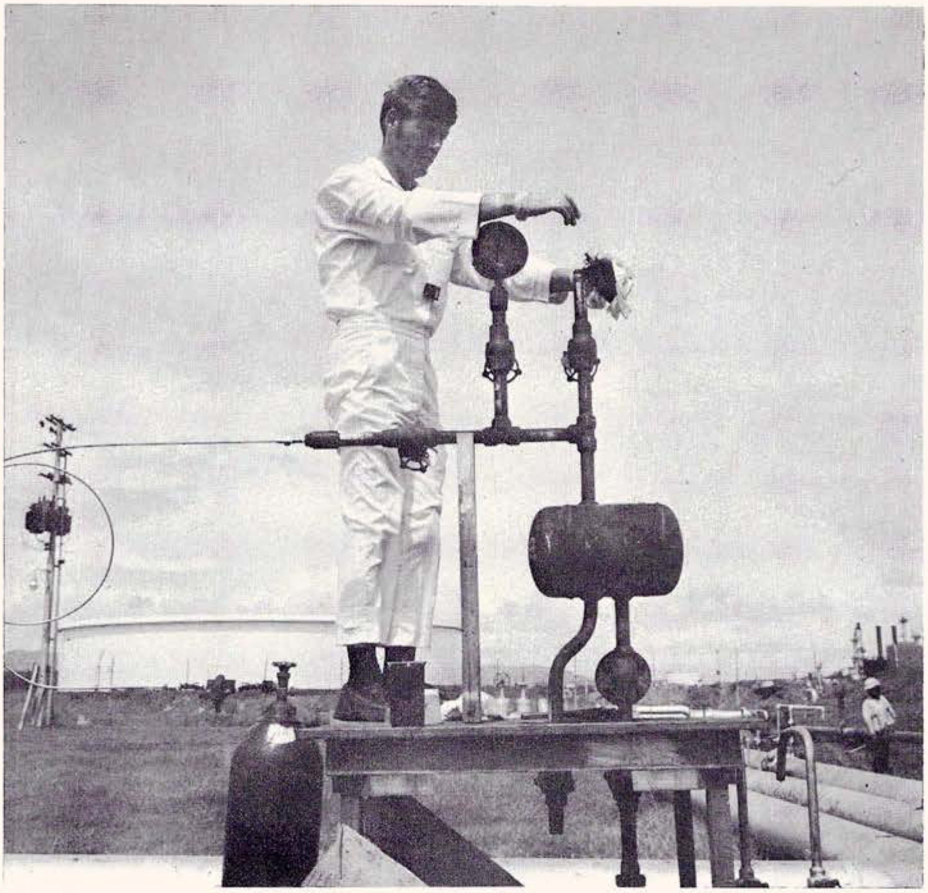
Dye-penetrant tests are most common during maintenance inspection since surface cracking can propagate from a number of causes during operation e.g. cracking can be caused by fatigue, thermal stresses, corrosion and/or erosiòn or even from inherent defect within the material. During construction, however, it is usually confined to fillet welding of structures, small high pressure piping butt welds and accidentally damaged materials. One example of dye-penetrant testing over ultrasonics or radiography of fillet welding is that heavy undercutting can be easily differentiated from cracking or lack of side wall fusion despite its relatively simple application.

Nucleonic Tests

These tests utilize radioactive isotopes in the millicurie range although their half-life may vary from a few minutes only to a number of years, depending on the application. The only other basic essential is a gamma or beta ray detector which is usually highly sensitive. The active sources are either integral, collimated, captivated or of the tracer type. The Philippines is quite limited at present since their only reactor is not always capable of producing the required specific activity or the flux from its core is not enough to activate completely substances with short half-lives (i.e. it dies faster than it can be activated). On the other hand, it would be useless to try and import the active material which may be completely depleted on arrival. Despite these limitations however, you will find most of the oil companies in the Philippines are familiar with such tests.

Dye penetrant testing of a turbine diaphragm.





Nucleonic testing.

One can not really outline any advantages of nucleonic tests over the previous mentioned NDT methods since one usually finds that some tests can only be made using this method. Of those tests which could be performed by other methods (for example-wall thickness measurement by radiography or ultrasonics) one must always compare the accuracy of each method and of course the time involved or the overall cost. Nucleonic tests involving short half-life radioactive materials could prove to be very expensive compared to other methods whereas those with long half-lives (50 years or more) may turn out to be ridiculously cheap.

APPLICATIONS

They fall into three major categories:

a. *Material affecting radiation:* Some common applications are liquid level measurement (long half life required), moisture content and compaction test of soils and wall-thickness measurement (uncommon now since ultrasonics was introduced)

b. *Radiation affecting materials:* examples of application are: radiography as previously discussed and neutron activation analysis which involves the bombardment of materials with neutrons to measure its compositions, age or durability.

c. *Tracers:* they can measure effectiveness of catalysts, detect clogs or leaks, be used for liquid interface analysis and erosion detection (e.g. refractories).

The above applications are of course relative to construction and maintenance testing. One could mention many more applications in the field of research alone and for sure there are a hundred more applications unthought of yet.

SUMMARY

This paper has condensed construction and maintenance testing emphasizing non-destructive testing to such an extent that the reader is bound to have come across other equipment and valuable tests within his own specialized field (and, the paper would appear incomplete). The portable microscope is itself an important piece of non-destructive testing equipment, or the infra-red camera which can measure hot spots detecting blockages, overheating in transformers and poor cable connections or the coating thickness gauge etc. (no mention of them), except that the piece of apparatus not mentioned here that you may have in mind is for sure a very specialized one. The paper has tried to offer you a little information regarding the most versatile of modern testing equipment, of which, there is no doubt, could be used in your own line of business to either insure product reliability, prevent accidents, and to either increase your profits and/or cut down your losses. Remember — he who hesitates is lost, don't wait until it's too late, TEST IT whilst you are in time to repair it or replace it.

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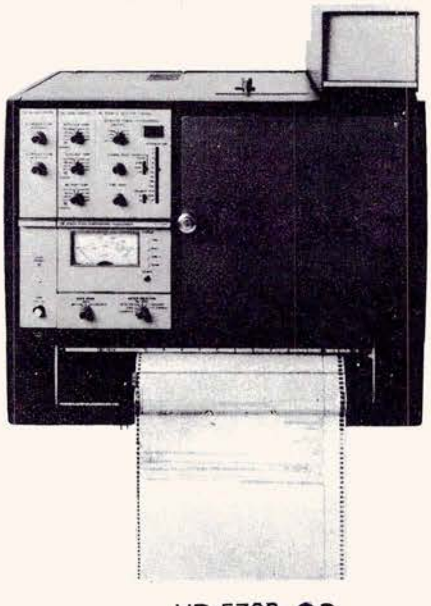

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ANALYTICAL INSTRUMENTS

EMERGING PRACTICES AND PROBLEMS IN QUALITY CONTROL IN THE MANUFACTURING INDUSTRY

The manufacturing industry had in its employ a little less than one and one-half million workers, representing approximately 11 per cent of the total labor force. Barely in its third decade of normal operation, it was found to be growing rapidly as indicated by its net domestic products (NDP) from 5.5 per cent in 1946 to 17.3 per cent in 1968, in spite of uncertainties brought about by decontrol. The physical volume of pròduction was progressively increasing while employment was digressively increasing. Plants were mostly of the multi-product line type and industries of the fully-integrated type were rare. The major sources of raw and semi-processed materials were mostly from foreign countries. Complex application of company-wide quality control in general was rather scanty and limited except for those foreign-based companies.

ORGANIZATION OF INDUSTRIAL QUALITY CONTROL

Quality control in the manufacturing industry was generally set up to achieve, among others, ten basic quality objectives, namely:

1. the assurance that quality is built into the products
2. the setting up of quality standards
3. the development of quality-mindedness
4. the control of processes
5. the reduction of òperation costs
6. the prevention of rejects
7. the preparation of reports on quality levels
8. the establishment of good vendor relations
9. planning for scientific inspection
10. better dissemination of quality data to shop supervision

By DR. BERNARDO F. ADIVISO

The author is a technical consultant to the Metals Industry Development Center. At present, he is assistant professor II at the Philippine College of Arts and Trades and at the same time the Head of the Building and Wood Technology Division.

Dr. Adiviso obtained his Doctorate in Education, major in Educational Administration from the Centro Escolar University. A holder of a Master of Arts degree in education, he also took up post graduate courses in Quality Control at the International Quality Centre, in Rotterdam, Netherlands.

Differences in point of quality objectives were rare except as noted in varied reactions to quality priorities inherent in each type of industry.

The more prevalent patterns of upper quality organization were either that quality control was a function under production or that it was coordinated with upper functional groups. Another fairly dominant pattern was that of quality control being placed directly under top management.

The various forms of inspection common to all industries were:

1. incoming material control
2. sorting inspection
3. process inspection
4. gage inspection
5. final product inspection
6. test laboratory and
7. field inspection

The general methods of inspection were the so-called 100 per cent or piece inspection, sampling, or a combination of both. Inspection intervals depended, however, on the materials, processes, and types of products. On the average, inspections were made every two hours a day.

Various quality control positions were found to be already existing in our major industries such as:

1. Quality Directors
2. Quality Managers
3. Quality Supervisors
4. Quality Engineers
5. Inspectors
6. Quality Analysts
7. Laboratory Technicians

Most of these positions were occupied by holders of appropriate degrees in Engineering and Chemistry. Moreover, these personnel mostly leaned in quality control through on-the-job training. Inspection jobs favored to employment of high school, trade school, and technical course graduates, and other undergraduates. A ratio from 20 workers per inspector was generally considered adequate.

The existing quality-control personnel generally possessed the requisite training and experience. However, a need for additional quality control personnel was indicated by the textile, non-metallic, rubber, basic metal, and food industries. On the average, about 5 inspectors were initially needed by every firm in the manufacturing sector today.

The various methods of screening applicants and/or promoting quality control personnel as practised by most firms were:

1. knowledge and skill test
2. physical or medical test
3. interview
4. intelligence test and
5. personality test

Essential physical requirements were normal vision and hearing, manual dexterity, and sometimes, strength. Among the personality traits considered were firm opinions, drive and good salesmanship. The skills and knowledge considered as essential qualifications were: read and write legibly, understand drawing and specifications, use complex gage, understand gage design and process, and knowledge in statistics, materials of industry and technical report writing.

The incentives available to the quality control personnel were:

1. attendance to short-term seminars
2. priority in upgrading or promotion
3. participation in in-plant training programs
4. better remuneration
5. free membership in technical organizations; and in some cases, a quality bonus system and scholarship award

Most of the tools for quality control found in industry were for general use. Central laboratories were however, found in most companies. Measuring tools and instruments were found adequately checked or maintained for precision By and large, the quality control tools and equipment in use were considered adequate. However, deficiencies were observed with respect to the analytical tools being presently used. The more common analytical tools available were:

1. control charts
2. sample tables
3. frequency distribution
4. product reliability test, and
5. statistical tolerance analysis.

Not commonly in use yet were the process-study methods, such as

1. operating characteristics curve
2. correlation

3. significance test
4 Pareto analysis
5. probability paper graphing
6. sequential analysis
7. cause and effect diagrams
8. stratification
9. Cusum charts and others

QUALITY PROBLEMS IN THE MANUFACTURING INDUSTRY

Major quality failures in the manufacturing industry were severally attributed to materials, workers or operators, handling and packing, measuring or rating errors, lax supervision, designs and specifications, process or production errors, and lack of fixed quality standards. Other causes of chronic defects during production were indifference of management, poor machines and inadequate quality-systems. Minor complaints were due to mislabelling, lack of product warranty or certification, and poor after-sales service.

The corrective measures adopted by most industries that received feedback on quality defects were:

1. sending immediate quality report to all functional groups in production whenever problem arises
2. sending reports to suppliers in case of rejection or complaint
3. forwarding quality level reports to top management for decision and
4. staff meeting when major quality problems arise.

Field defects were handled mostly through swift product service or outright recall or change of defective product. Another form of anticipating customer complaints was the initiation of field audit.

EDUCATIONAL AND TRAINING PROGRAMS IN QUALITY CONTROL

Various proposals were endorsed by the manufacturing industry as regards the forms of training programs in quality control. With the immediacy of the need for the trained manpower as the crucial factor, the forms most popular were short-term courses in-plant training programs. Other proposals which received considerable endorsement were the offering of quality control as a professional subject, or as a one-year specialized course, or as a curriculum leading to a baccalaureate degree.

Subjects or topics in quality control which were considered as essential were the following:

1. Economics of Quality
2. Responsibilities for Quality
3. Actual Approaches to Quality Problems
4. The Foreman and Quality
5. Motivating for Quality
6. Quality Planning
7. Optimizing Quality Costs
8. Standards and Tolerances
9. Company Organization for Quality
10. Basic Statistics
11. Administration of Sampling
12. Preventing of Chronic Defects
13. Process Capability Study
14. Quality Information Equipment

Many related subjects were proposed as constituting an essential background for effective quality control and inspection, although, the emphasis differs by levels of work and position. These subjects were:

1. Materials of Industry
2. Engineering and Production Methods
3. Products and Processes
4. Technical Report Writing
5. Safety and Accident Prevention
6. Seminar on Quality
7. Non-destructive Test, etc.

NEW DIRECTIONS IN QUALITY CONTROL MOVEMENT

There are bright indications that the quality control movement in this country may prosper with the overwhelming support fròm both the government and the private sectors. In point of fact, a national committee on Quality Control and Standardizatiòn was born out of the needs to consolidate all quality efforts in the country. This committee is composed of the PSQC, MIDC, PCAT, UPISSI, BOI, DCI, PDC, and Philippine Standards Association.

The Philippine Society for Quality Control (PSQC) took the lead in this movement with the backing of the Productivity and Development Center which is the productivity arm of the government. An ambitious plan ahead is to bring in as many foreign quality control experts to help rapidly disseminate and transfer technically the concepts and practice of quality technology, with the ultimate goal of putting up a Quality Management Development Center for training, consultancy, research, and information services.

Foundries in the Philippines rely heavily on the local supply of scrap metal as basic raw materials. The degree of efficiency in procurement, handling, warehousing, preparation, and finally, melting of these items greatly affect both cost and quality of the finished products. Both cost and quality controls of metal castings commence with scrap control. The need therefore to focus attention on this important aspect of scrap metal handling and its management in foundry operation is in order.

THE IMPORTANCE OF "PROPER SCRAP SELECTION" IN FOUNDRY OPERATIONS

Servillano Lim is presently the General Manager of Master Steel Products, Inc. which is engaged in detinning and steel foundry business. He is also the President of Ropells, Inc. a company engaged in marketing of motor oils.

WHAT IS SCRAP METAL?

Scrap metal is a metal in the form of scrap or fragments, valuable only as raw material.

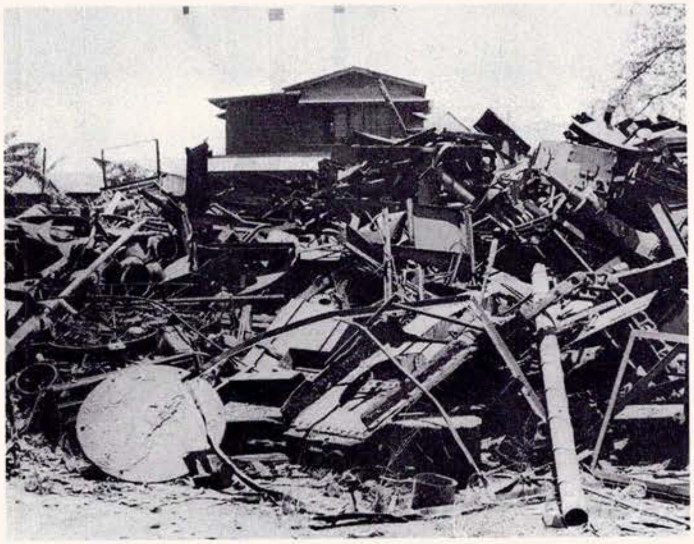
There are as many kinds of scrap as there are metal products so long as they have served their useful life and are discarded by their users.

They are usually classified into ferrous and non-ferrous. Under the former group, there are the gray iron, white iron, carbon steel, stainless steel and other alloy steel scrap. Under the latter there are aluminum, copper-based alloys like brass and bronze, lead and others.

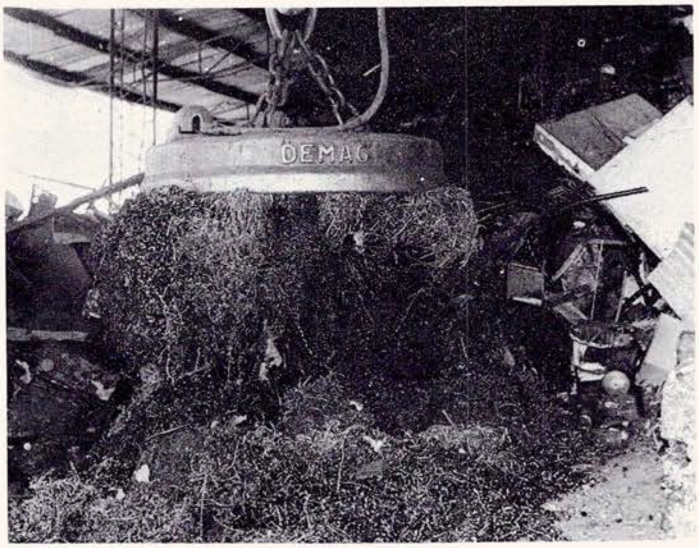
SOURCES

Scrap metal is everywhere. They are found in the bottom of the sea as sunken ships, in the jungles and mountains of war torn countries, and of course, in every household, plant, factory and garbage dump which abound with scrap discards. Presently there are even scrap metal in outer space discarded by space programs. To gather these materials involves of collection the economics. In the Philippines, the scrap metal level is estimated to be worth more than a billion pesos.

Due to the unavailability of statistics, the annual scrap collection in the country can not be determined. Some ₱100 million worth of scrap metal collected annually is a conservative estimate, with iron and steel accounting for about 50 per cent, copper and its alloy about 15 per cent and the remaining 25 per cent from other sources.



A huge pile of exposed, unassorted steel scrap for melting.



Steel borings and turnings to be charged into an electric arc furnace by means of an electromagnet.

PROCUREMENT PROBLEMS

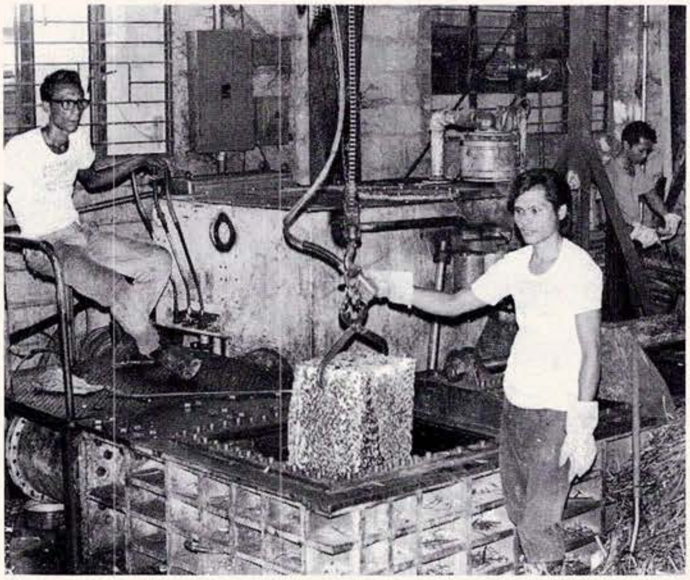
The responsibility of scrap buying in a foundry is a tall order to the procurement personnel due to the numerous problems that go with it especially when the buying is done locally and if it is not expertly done. Foremost among these problems are the unreliability of supply and lack of quality scrap particularly so with steel scrap. Consequently, some of the big steel melters have gone to the extent of importing a part of their scrap needs in spite of higher prices.

It is often difficult and time-consuming for a foundry to buy scrap discreetly, selectively and directly in retail from different establishments that generate the types of scrap metal desired. With the big amount of work involved it does not normally pay to buy from these numerous small sources. As a result most foundries depend on wholesale scrap dealers for a greater part of their scrap requirements. The problem of quality in scrap metal is compounded by quantity-buying since most local wholesalers do not sort out or classify their scrap metals properly. A good example would be a delivery of steel scrap. This usually contains assortments of scrap such as used pipes, old carrier frames, plate cuttings, worn-out spare parts, broken machines, etc. and if it comes in bundles, their surfaces may be covered with black iron sheets, punchings and trimmings but the inside is often stuffed with rusty iron and steel borings and turnings or used tin cans. This kind of scrap mixtures vary physically in size, weight and shape, and chemical composition.

The decision whether to accept or reject an offer of the metal is determined not only by price and terms of sales but also by the extent of cleaning, cutting, sorting and baling needed to render the scrap usable and by the percentage of rejects or those that could not be used including contaminated ones, those containing undesirable elements like non-ferrous inclusions or austenitic (Hadfield) manganese steel scrap mixed with stainless steel scrap. Before making any decision, incoming scrap should be subjected to careful scrutiny or analytical test in the chemical laboratory. Its acceptance must be made based on certain predetermined standards and the inspection on a shipment-to-shipment basis. By the time the presence of small percentages of contaminated scrap is discovered which is either allowed to pass over or is overlooked during buying and classifying, off-heat is being or has been made. As a starting point, foundrymen should never use samples in buying and pricing scrap. They are seldom representative of the whole lot. Properly prepared, well classified and ready to use scrap metal are hardly available in the local market and if ever available the supply is unreliable and often in limited quantities.

VARIABLE COST FACTORS

Some of the variable costs in foundry operation are found in the scrap metal and the melt's treatment costs. These treatment costs are in turn dependent on



One-half ton densely baled detinned scrap measuring 30″ × 24″ × 22″ for melting in the induction furnace.

Shown are detinned scrap baled by Master Steel Products' 400-ton scrap baling press.

the kind, class or quality of scrap metal purchased. Some of those treatment costs are as follows:

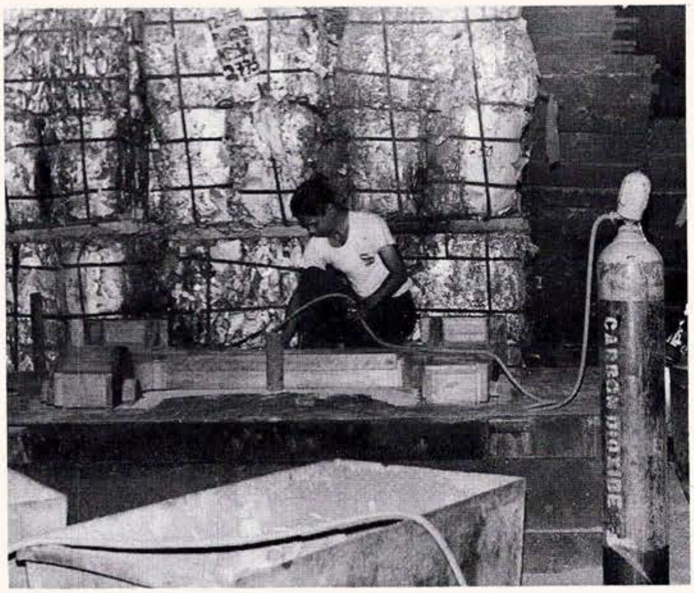
1. The cleaning, selecting and sorting costs
2. Cost of transporting and handling
3. Cost of warehousing or storage facilities
4. Cost of cutting or baling
5. Cost of additional alloying elements and fluxes used
6. Cost of additional power and lining wear due to longer holding period for composition adjustments
7. Losses due to oxidation and pilferage
8. Losses caused by accidents and explosions
9. Metal losses due to low recovery arising from rusty or dirty scrap
10. Losses on casting rejects due to contaminated scraps
11. Other overhead costs and expenses.

These treatment costs could be more than the cost of the scrap itself or a rack-bottom low of less than ten pesos per ton of scrap metal treated. Many of these costs could be avoided through selective buying by paying premiums to dealers for uniform composition and high quality metal scrap. But avoiding the treatment of scrap when necessary could cost a lot more money than expected. The treatment cost might be negligible compared to the loss of a complete heat or losses on casting rejects.

DEPENDENCE OF CAPITAL EQUIPMENT

The type of scrap that is available or what is cheaper to a foundry affects the capital equipment required for processing and handling scrap.

In starting a new foundry, before deciding on the kind of melting equipment to acquire, the problems associated with scrap must first be taken into serious consideration. As an example, an induction furnace will require a much cleaner and heavier scrap because of its lack of refining process in melting and its demand for a denser charge in order to draw more



Bundles of scrap weighing approximately 3,000 pounds each at Master Steel Products, Inc.

power to melt its charge faster while an electric arc furnace has more tolerance as to the grade of the scrap due to its ability to eliminate impurities during the refining process and to handle bigger size of scrap in its inherent larger bath.

Handling equipment would depend on the type of scrap acquired.

Truck-mounted or overhead crane, electromagnet and shearing machine are necessary to handle heavy and bulky scrap efficiently while a baling machine can very well take care of light plate and wire scraps.

It is not unusual to see some local foundries without scrap metal treatment equipment. As a consequence, inefficient cutting tools are oftentimes used as substitutes. This, of course, is more labor-intensive, wasteful, slow and costly.

SCRAP BUYING FUND

Practically all scrap metal purchases are made on cash such that a certain amount of cash revolving fund has always to be maintained. The amount will depend on the average scrap metal consumption as the case may be and on the required level of inventory. Because most locally available scrap can not be used as it is, advance buying is necessary to give some allowance for scrap preparations. This in turn will necessitate a bigger buying fund. However, too much money put in for scrap piling the quantity of which is more than enough to keep the melting furnace in continuous operation, can lead to the unnecessary accumulation of scrap to the point of losing effective control over inventory and other variable costs, aside from freezing a substantial amount of operating capital in excessive scrap piles that could last for a year or more — only to rust and rot.

CONCLUSION

In any kind of foundry, the scrap works is as important and vital as any of its operations.

Perhaps the use of the word SCRAP is wrong when its use as charge material for the foundry is concerned. Treating these important materials by simply dumping them to be exposed to the elements is a wrong notion. And when it is melted, what does one get? Maybe another batch of scrap.

The success or failure, therefore, of a foundry business is hinged on how good its scrap management is in the preparation of an acceptable charging material to ultimately produce sound castings at the lowest possible cost.

Due to the inability of some small and medium-sized foundries in dealing with their scrap problems effectively, it might be better off for quality, uniformity and economy to resort to the use of certified alloy ingots.

men in the metals industry

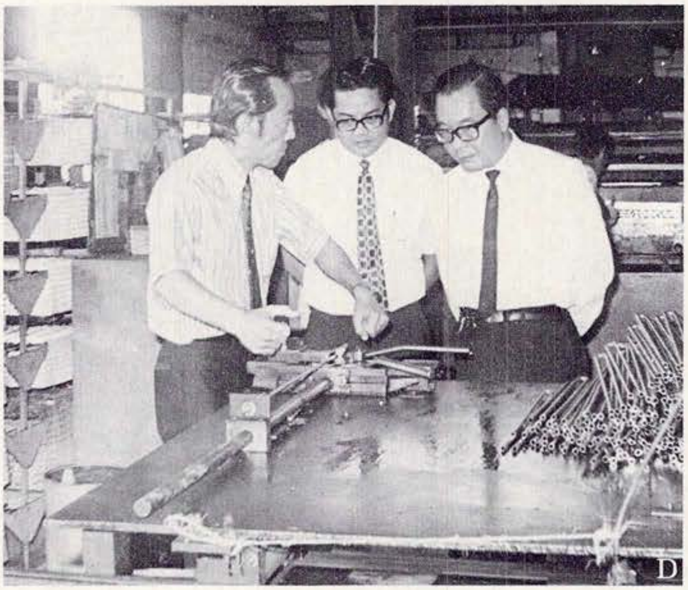
DANTE G. SANTOS

Dante G. Santos is typical of the self-made man. At age 46, he has already achieved the kind of success envisioned by every businessman, though he did not expect it to be that spectacular. For, Dante Santos is founder, president and incorporator of the Philippine Appliance Corporation, an all-Filipino firm that began literally from scratch.

From the 13-employee outfit organized in August 1963, Philacor has ballooned into a multi-million-peso industrial concern that ranks today as one of the biggest in the country and in Southeast Asia. And this is why: Dante Santos thinks big.

Thinking big in 1965, he steered Philacor into a field of business already choking with competition. "I fully appreciated the risks and uncertainties of such a late entry considering that there were a number of internationally famous brands of appliances serving a fairly small market in 1963," the Philacor president recalled.

But Santos relied on his belief that no market is too small for good merchandise. Philacor made do with its locally-manufactured and assembled Westinghouse refrigerators and air-conditioners and Santos hemmed, hawed, stretched meager finances and planned with dogged concentration. Four years later, Santos adjusted his plans, increasing the manufacture and assembly of electronic equipment.



A *Mr. Santos is shown explaining some points on the shell tangent bender to the top ranking executives of Westinghouse Electric International during the ocular inspection tour of PHILACOR's plant facilities.*

B *He is seen above showing the "white line" refrigerator models at PHILACOR's Marketing showroom.*

C *Mr. Santos explains the intricacies of a process in the manufacture of air-conditioners to visitors from neighboring ASEAN countries.*

D *Dante Santos is caught by the camera with his guests from the international office while touring PHILACOR's mechanical press shop.*

E *Deeply involved in charity work, Mr. Santos is shown distributing gifts to orphans at St. Rita's Orphanage with Mr. Joseph Kinder, Philacor's Vice-President for Finance & Administration.*

Intensive research initiated by Santos enabled Philacor to develop and adopt successfully a foamed-in-place polyurethane insulation for refrigerators and freezers, something which no other appliance firm in Southeast Asia has been able to do successfully.

In October 1971, the Board of Investments approved Philacor's application for registration under the Export Incentives Act, crystallizing Santos' dream to open markets in Hongkong, Indonesia, Thailand, and Singapore, among other countries.

Philacor is still growing and not even Santos knows where it will all lead to, but he will not forego a good night's sleep to ponder over his firm's future. For Santos is still the family man, homey despite his success. His homelife is dominated by the swirl of skirts and feminine touch, a fact that he does not mind so much. Married to the former Henrietta Regala, Santos also knuckles under Marsha, Patricia, Virginia, Henrietta and Felicia—daughters who dearly love to nag their father.

For the president and general manager of the Philippine Appliance Corporation, it was a long climb to success from the sleepy hollow of San Joaquin in Iloilo.

Born on March 28, 1925, Santos spent much of his early life in the seclusion of schools, an uneventful, monotonous chapter that ended only when he left for the United States to broaden his academic background. He graduated with a Bachelor of Science degree in Mechanical Engineering from the University of Washington in Seatle in March 1949, and acquired another degree in electrical engineering from the same institution five months later.

Shopping around for jobs, he was taken as production engineer (1950-51), with the Electricity Meters & Allied Industries, Ltd. in Sydney, Australia.

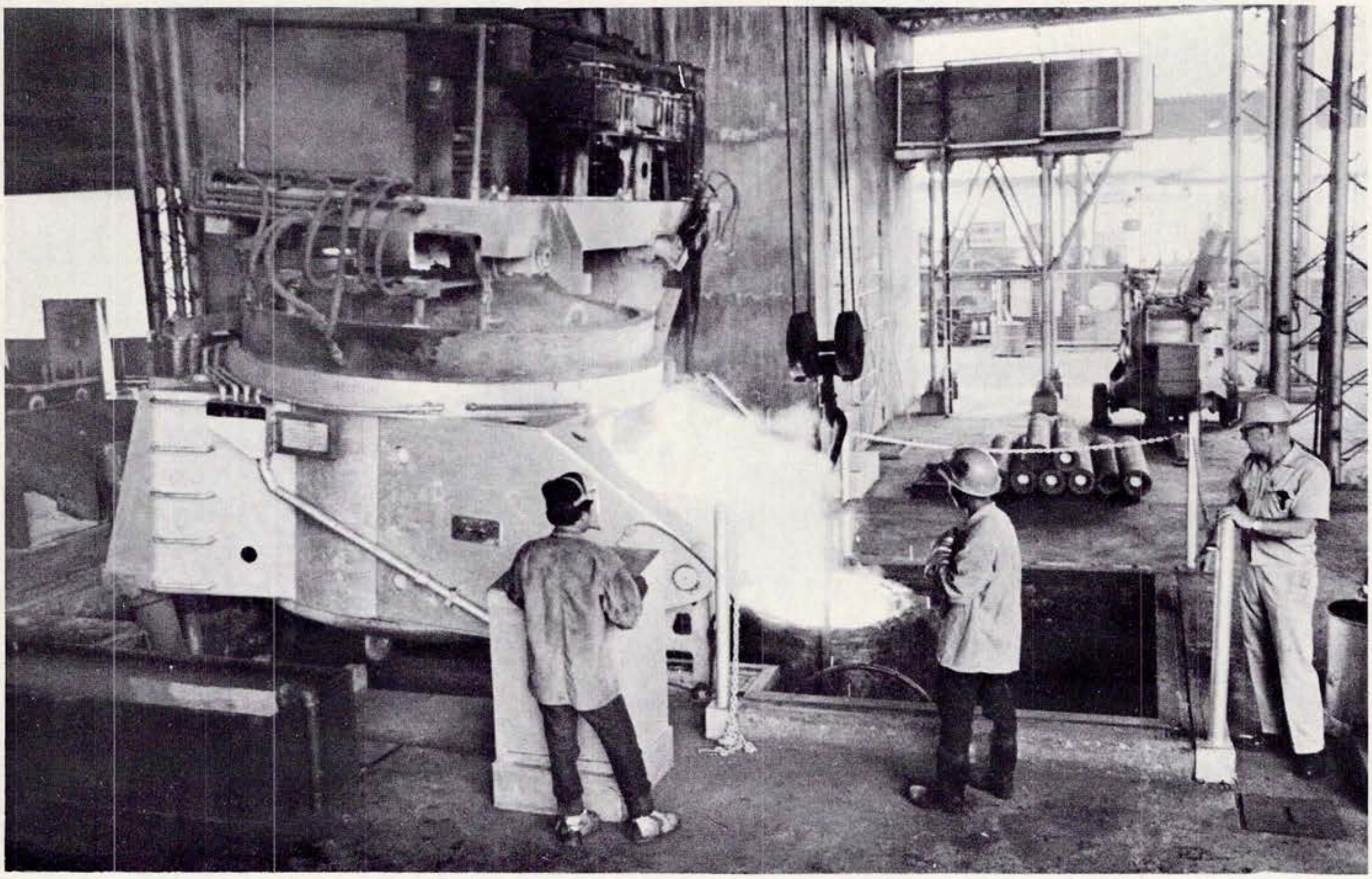
But the call of Manila and indeed for home was too strong to be ignored. Thus, after only a year in Sydney, Santos returned to join Ysmael Steel Manufacturing Co. as vice-president for operations, a position he held up to 1963.

From 1952 to 1955, he taught subjects in mechanical and electrical engineering at Adamson University and De La Salle College.

Today, he is a portrait of success, the result of his own.

Firm Feature

ATLAS CONSOLIDATED MINING AND DEVELOPMENT CORPORATION



The melting operation in the electric furnace is climaxed by the tapping of molten metal into pouring ladle.

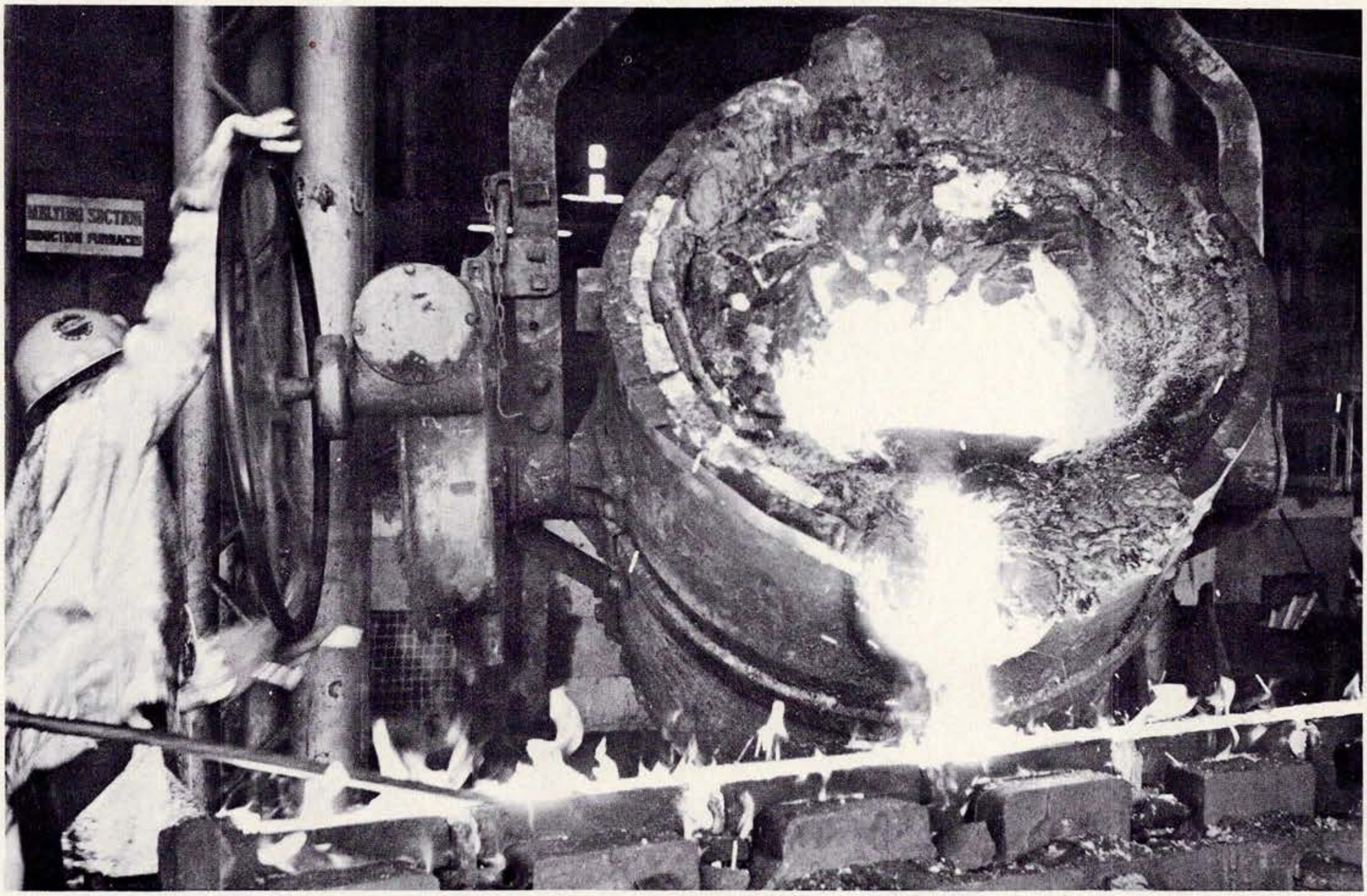
For the past 12 years, Atlas Consolidated Mining and Development Corporation (ACMDC) has been engaged in the production of foundry products for consumption in its mining and milling operations. ACMDC finds it economically justifiable to operate its own foundry.

The cast grinding ball project was initiated in the early 1960's. In 1965, the Atlas Foundry started the production of 3-inch cast steel grinding balls in an improvised wheel casting machine. Subsequent service tests in the DAS Concentrator ball mills gave encouraging results, and the ball production facilities were improved and expanded to supply the needs of the concentrator (then milling at the rate of 15,000 tpd). A 750-KW Inductotherm melting unit was installed in 1966 to increase the capacity for ball production. Another expansion in the succeeding year was undertaken, and by 1968 a 1100-KW main frequency induction melting unit, two wheel casting machines, molding, heat treatment and finishing equipment were added to give the Atlas Foundry a production capacity of 600 tons per month. By then, the total requirement in grinding balls of the DAS Concentrator (milling capacity at that time was 30,000 tpd) was fully supplied from cast balls produced in the Sangi Foundry, and the importation of grinding balls from abroad was stopped.

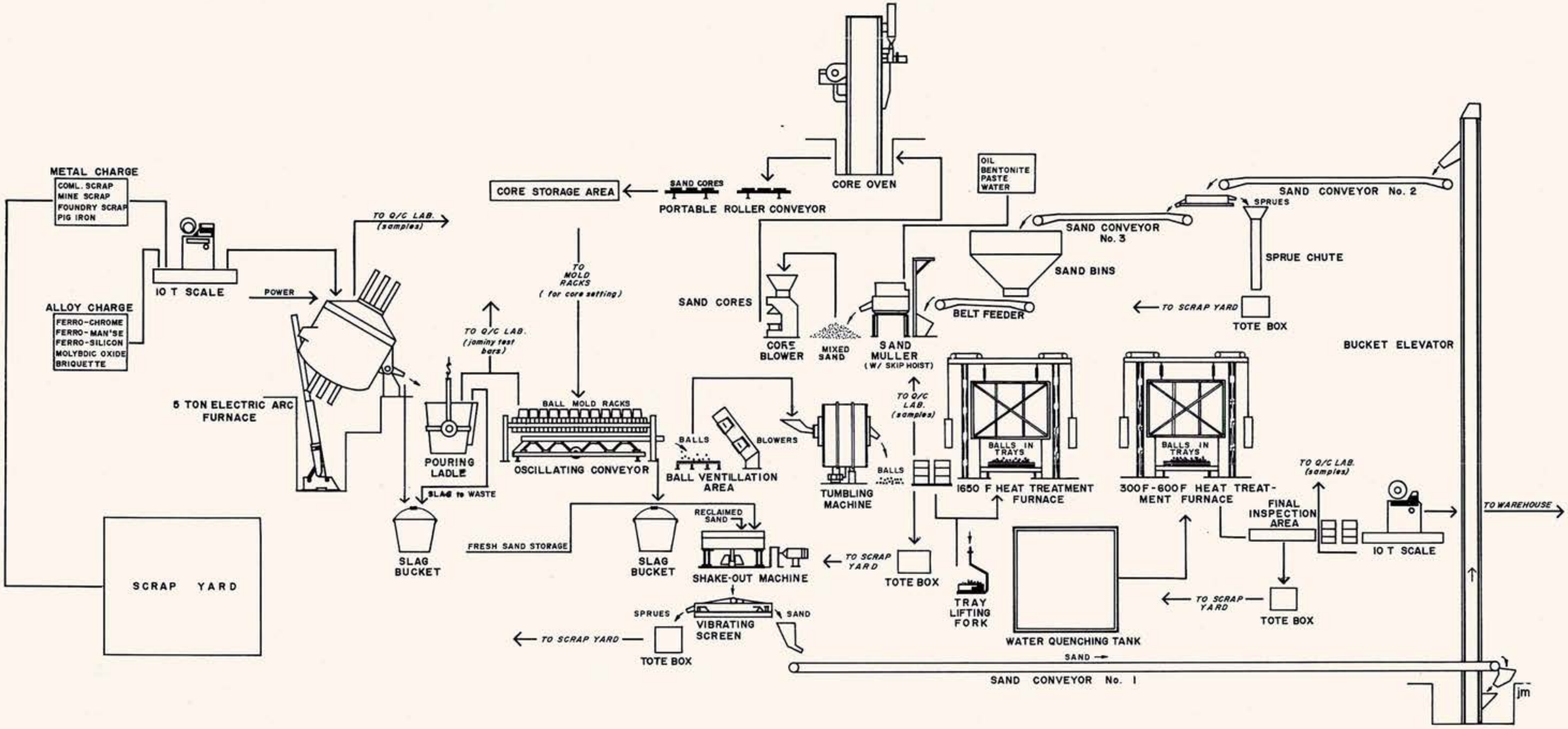
Another expansion of the DAS Concentrator to its present milling capacity was undertaken in 1970. The Biga Còncentrator Project was pursued and completed in early 1971 to double its milling capacity, thus placing Atlas among the largest copper mines in the world. And so, the Atlas Foundry had to undertake another major expansion project. This project was completed in November, 1971 to give the Atlas Foundry sufficient capacity to meet the increased requirements for grinding balls and foundry products which reached over 2,000 metric tons per month.

STEEL BALL PRODUCTION

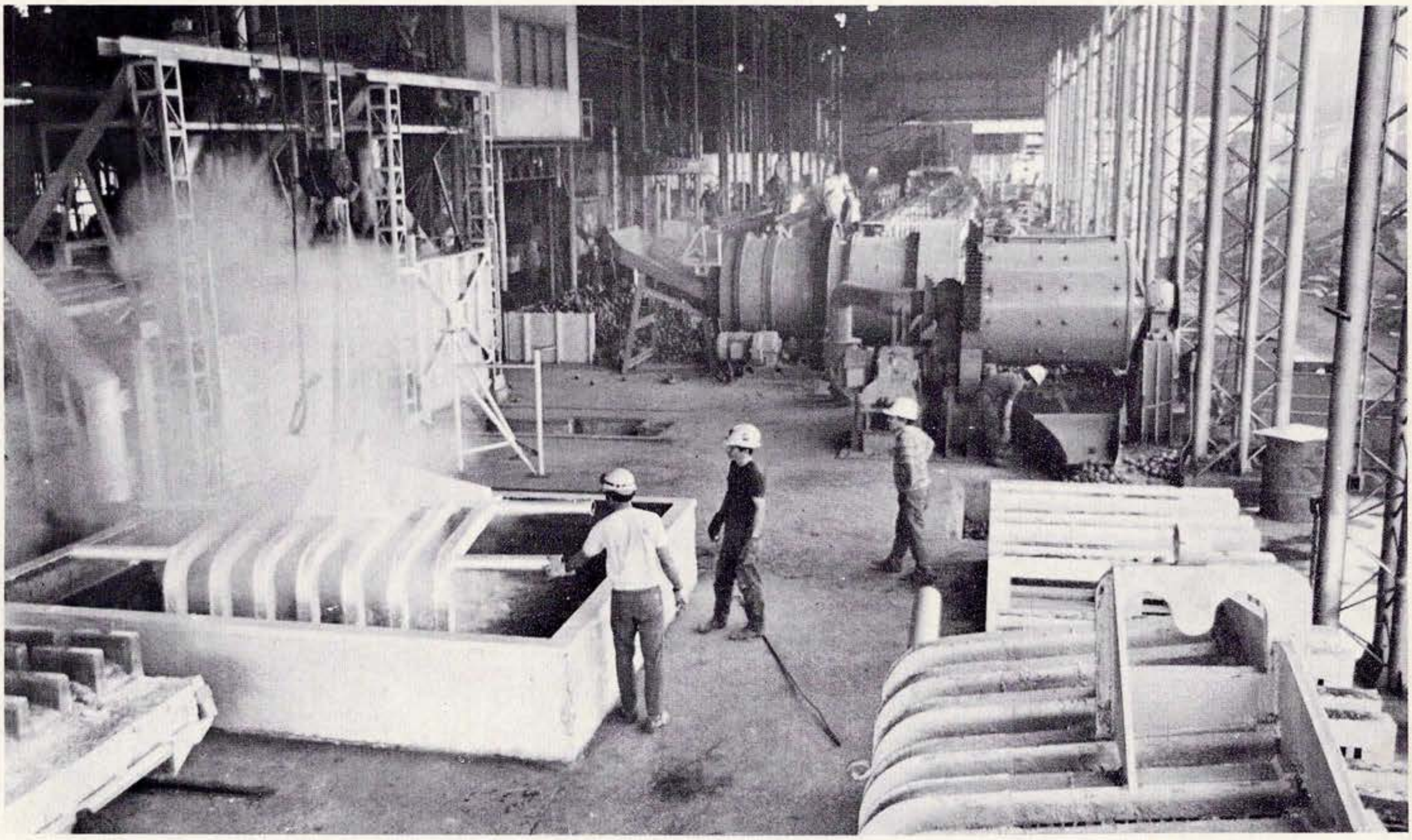
Before the advent of the present method of casting steel balls in rack molds, the Atlas Foundry pro-



The present ball casting system used in the foundry is the rack process. Each rack is composed of ten mold assemblies.



FLOWSHEET FOR STEEL BALL PRODUCTION



A tray of balls in the quenching tank. At left are two of the five heat treatment furnaces. In background is the breaking barrel.

duced cast balls in a wheel casting machine. The air-quenched balls had an average hardness of 48 Rc (477 BHN) with a pearlitic structure. At times the balls were occasionally produced and used as cast; the hardness of the as-cast balls ranged from 38 to 40 Rc (364 to 381 BHN). Aside from the low hardness values, ball rejection caused by casting defects was very high due to mechanical difficulties inherent in the process.

With the new rack process, the ACMDC Foundry is producing harder and tougher grinding balls at a much greater output volume than was achieved with the old process. Basically, the new process consists of casting the balls in the racks. Each rack is composed of 10 mold assemblies, which in turn are made up of two cores in between a pair of permanent steel molds. Each mold assembly produces 12 balls of three-inch diameter. At its rated capacity, the present ball plant can produce about 1,500 metric tons of steel balls per month, sufficient to supply the full requirements of both Atlas concentrators.

Production

The rack ball casting process starts with the melting operation using arc and induction furnaces. Initial furnace charges consist of purchased steel scrap, foundry returns and plant-generated scrap. These are melted down and samples are obtained for rapid analysis with a computerized Baird-Atomic spectrometer and an automatic Leco carbon determinator. Based on analysis results, obtained within a few minutes after sampling time, adjustment of metal composition is made by adding the necessary ferroalloys. A refining sample is then taken and analyzed in the same manner. When the desired composition is attained, the metal is super-heated and then tapped at 2850°F into a pre-heated ladle.

Preparation of the ball cores is a closely controlled procedure. The core sand is composed of an aggregate of dry, properly-sized silica sand, flour, and core oil mixed thoroughly in sand mullers at the ratio of 32:2:3/4. Samples of batch mixes are taken at regular intervals and tested in the Sand Laboratory, using standard AFS procedures and equipment, to assure that physical qualities are held within the standard limits specified for the cores.

The cores are produced mechanically using two core blowers. Baking of the cores takes place in a tower-type core oven for one hour and fifteen minutes at temperatures sufficient to develop full strength while they are carried through one cycle of the conveyor.

The baked cores are transported to the pouring area using forklift trucks, and assembled into the chill molds which are supported in a rack. The rack is composed of 10 mold assemblies, each made up of two cores sandwiched between two steel molds. The metal is poured into each rack which is provided with a pouring basin, at a temperature range of 2700 to 2800°F. Pouring time is 1.5 minutes per rack. After pouring each rack, the pouring basin is removed and dumped into an oscillating conveyor. About 5 to 7 minutes after the pouring shake-out commences. The ball clusters are allowed to drop into the oscillating conveyor which transports them to the batching pits. Segregation of the sand from the metal occurs at the end of the oscillating conveyor where a screen is installed.

From the pits, the ball clusters are tumbled in a breaking barrel for the removal of pouring gates, metal fins and risers. These returns as well as the defective balls are sent back to the melting section as part of the succeeding charges. The good balls are further tumbled in a cleaning barrel to remove silica sand that has adhered to the ball. After cleaning, the balls are stored in batch pits ready for heat treatment.

Heat treatment of the balls consists of three steps: austenitizing, quenching and tempering. One tray of balls weighing about four tons, is heated in oil-fired furnaces to a temperature of 1659°F and soaked for three hours. The tray of balls is then drawn out and undergoes an interrupted water quench. The quenched balls are immediately tempered to relieve stresses in another furnace at 400°F for three hours. These balls are then tumbled to remove scales in a polishing barrel, in preparation for final inspection.

In-process inspection of the cast balls is done at each phase of the process fròm shake-out up to final treatment. Final segregation of reject balls is done before weighing. The good balls are finally weighed and turned over to the Warehouse Department for storage and subsequent shipment to the concentrators.

Significance of the Process

The ball casting process adopted at the ACMDC Foundry is a relatively simple process, making use of materials which are mostly available locally such as steel scrap, silica sand, flour and others, although certain importations of ferro-alloys and steel scrap may become necessary.

The Atlas Foundry produces steel balls of comparative quality at a production cost of at least ₱750 per metric ton lower than the landed cost of imported balls, thus, company savings on steel balls alone total over ₱12.5 million per year. In addition, huge dollar expenses are avoided and ball inventories minimized.

At the present milling rates of both DAS and Biga Concentrators, Atlas consumes almost 1,400 metric tons of steel balls per month. With the expected capacity of the ball plant, ACMDC will no longer be dependent on imported balls.

STEEL CASTING PRODUCTION

The Atlas Foundry produces many types of castings, which include liners for ball mills and crushers, shovel dipper teeth, grizzly and breaker bars, hammers, and several others of unimaginable sizes and shapes. By producing these castings necessary for the mining and milling operations of the vastly expanded Atlas mines complex, ACMDC saves an estimated ₱2.4 million annually in costs of these equipment replacement parts.

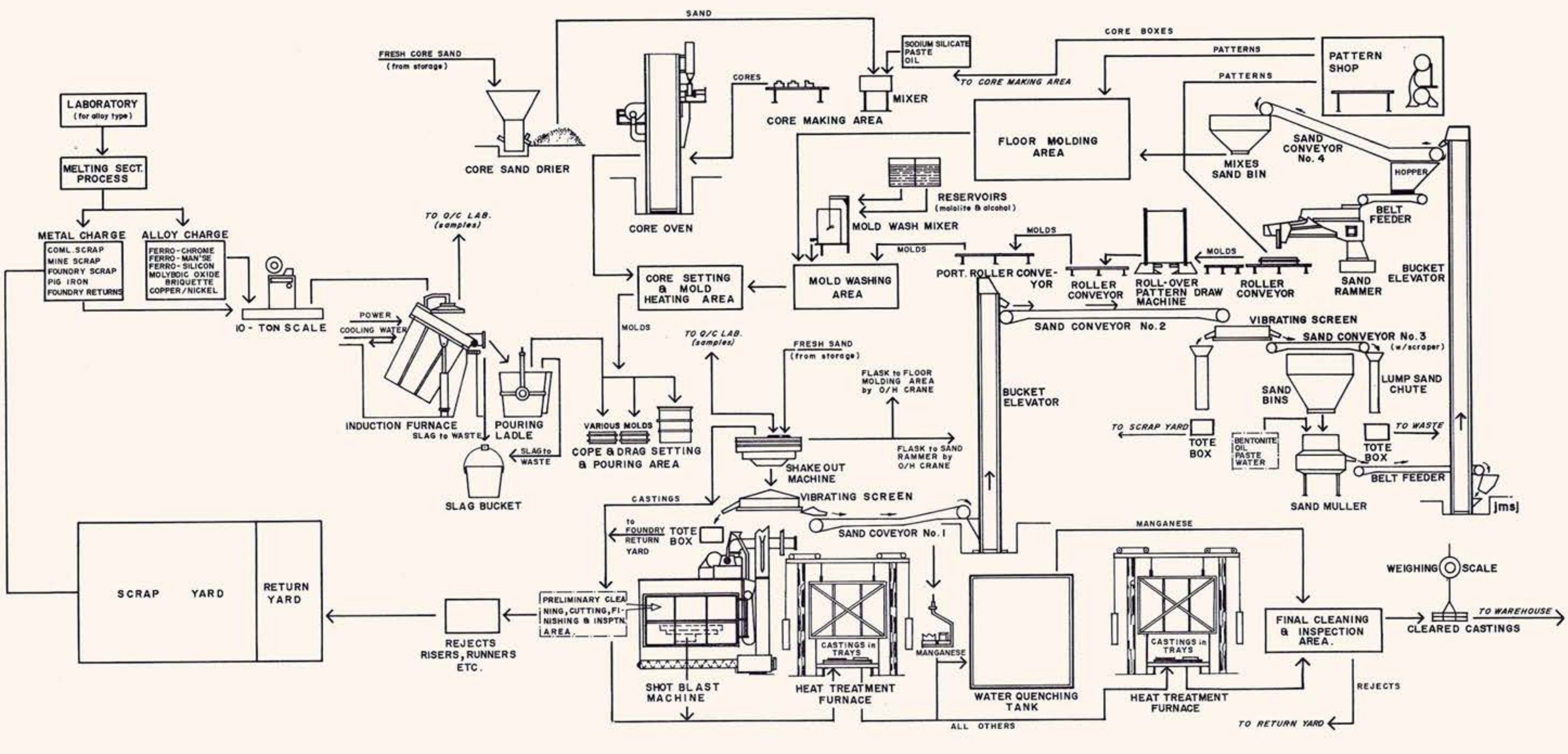
Steel casting production consists principally of melting steel scrap, alloying and adjustment of metal composition, pouring of the molten metal into sand or permanent molds, heat treating and cleaning of the castings. These phases of operations at the Steel Foundry Shop are briefly described as follows:

Melting

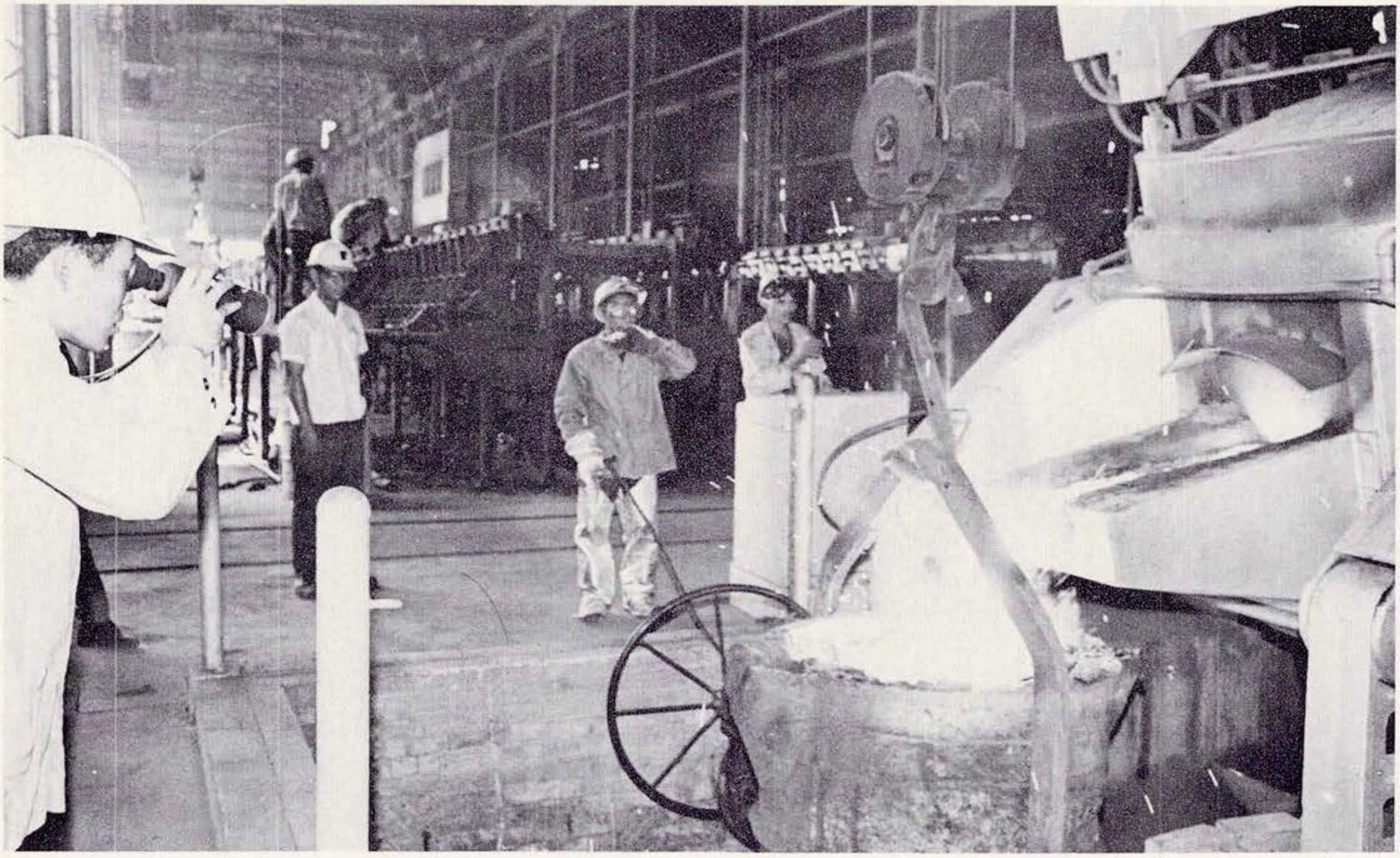
This phase utilizes three melting furnaces, a six-ton BBC main-frequency induction furnace, a three-ton Inductotherm 180-cycle furnace, and a 2-1/2-ton arc furnace. The initial charge to the furnace is mainly steel scrap, foundry returns and pig iron.

Alloying

After meltdown, a preliminary sample is taken for analysis. The desired composition is attained by add-



FLOWSHEET FOR STEEL CASTING PRODUCTION



A quality control man takes the metal temperature during tapping as part of process control procedure.

Ball mill liners are stacked in storage yard adjacent to the steel foundry building.

ing the necessary alloying elements to get the desired ranges. The alloying elements usually controlled in this phase are carbon, manganese, silicon, chromium and molybdenum. These elements are added in the form of coke, ferromanganese, ferrosilicon, ferròchromium and molybdic oxide briquettes.

Typical types of steel compositions being produced are medium and high carbon chromemoly steels, plain manganese steel, manganese molybdenum steel, chrome-moly-copper iron, and high carbon low chrome compositions.

Pouring

After the desired composition is attained, the molten metal is poured into molds. Here the desired shape and thickness is set by the form of the molds. The molds are either sand molds or permanent metal molds. In sand casting, generously-sized sprues and risers are provided since low pouring temperatures are recommended. The molds are faced with chromite sand, washed with an olivine flour-based wash and dried thoroughly before pouring. Permanent molds require less elaborate preparations which consist only of attaching the combined pouring basin and riser, mold pre-heating and assembly.

Pouring temperature of the alloy varies with casting section thickness and type of mold used. The temperature is held as low as possible to promote rapid directional sòlidification and produce a fine grain structure. The pouring is done as fast as possible, usually not less than 180 Kg/minute.

Cleaning And Heat Treatment

After the pouring, the molten metal in the molds is allowed to solidify to almost room temperature. Then, the resultant castings are cleaned by the removal of the sticking sand and any protruding metal fins.

To attain the desired metallurgical properties, the castings are heat-treated in an oil-fired furnace under close supervision of the Quality Control Group, which also conducts final inspection of the casting to insure full conformity with required specifications.

THE IRON FOUNDRY

The present operations at the Iron Foundry has become semi-mechanized, with the completion of the expansion project. The major production facilities currently in use include the following:

1. A water-cooled cupola with a melting rate of two metric tons per hour.
2. Four molding machines, with sufficient molding output to cope with the melting rate of the cupola
3. Complete sand reclaiming circuit
4. Roller conveyors for mold handling
5. Complete shake-out and ball tumbling equipment
6. Pouring ladles stationed in a looped monorail system

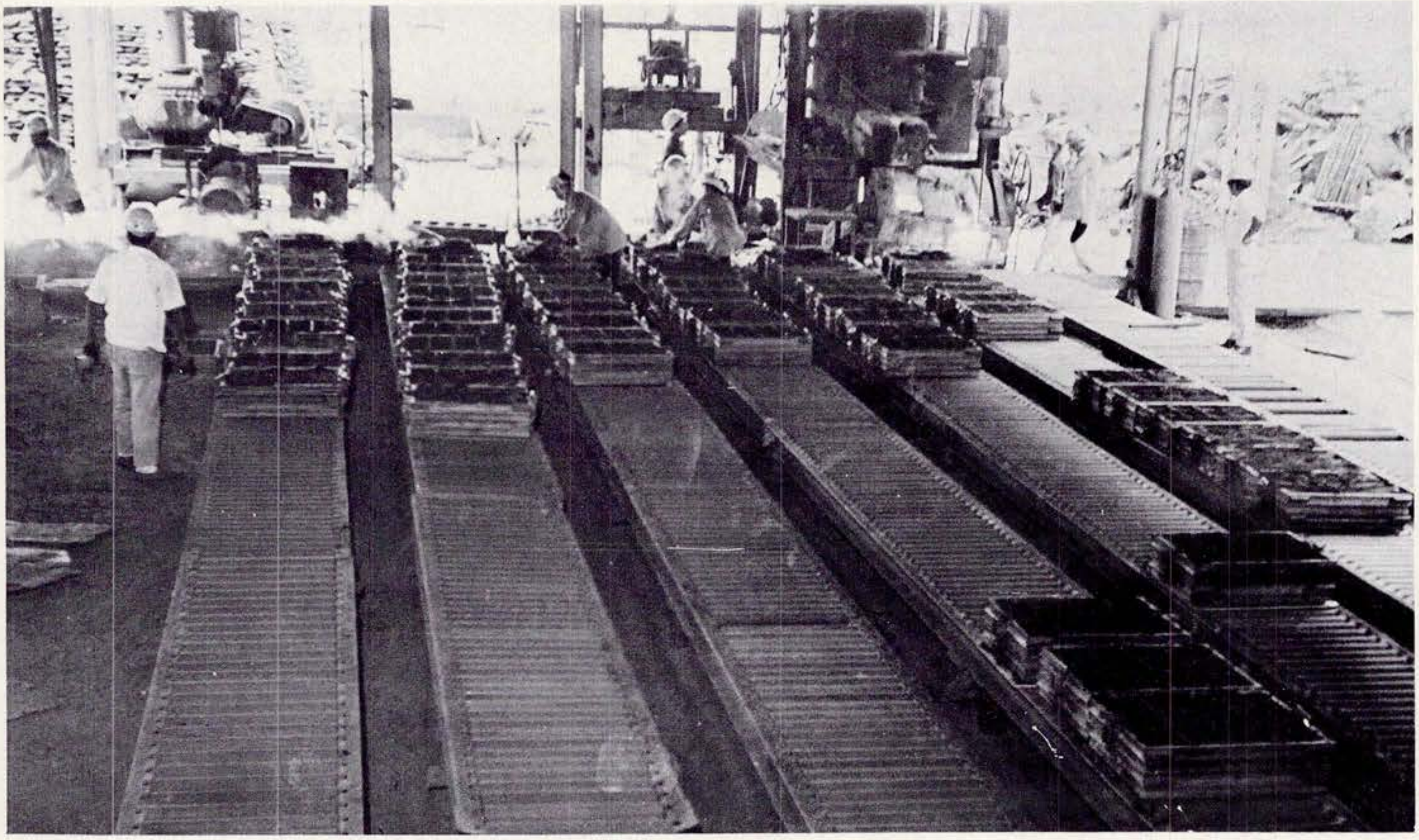
Green sand molds are prepared in pneumatic molding machines and assembled on roller conveyors while the cupola is being prepared. Cupola daily preparations include brickwork, scrap and ferro-alloy charge formulations and kindling of the coke bed.

With the first tap of the cupola, the cycle of the Iron Foundry operations starts. A continuous stream of molten metal gòes into the holding ladle while pouring of molds is in progress. Poured iron ball molds are immediately passed into a vibrating shakeout machine, with red-hot balls going into an air-quenched Mayfran steel conveyor system and the hot sand is conveyed directly to a complete sand reclamation circuit.

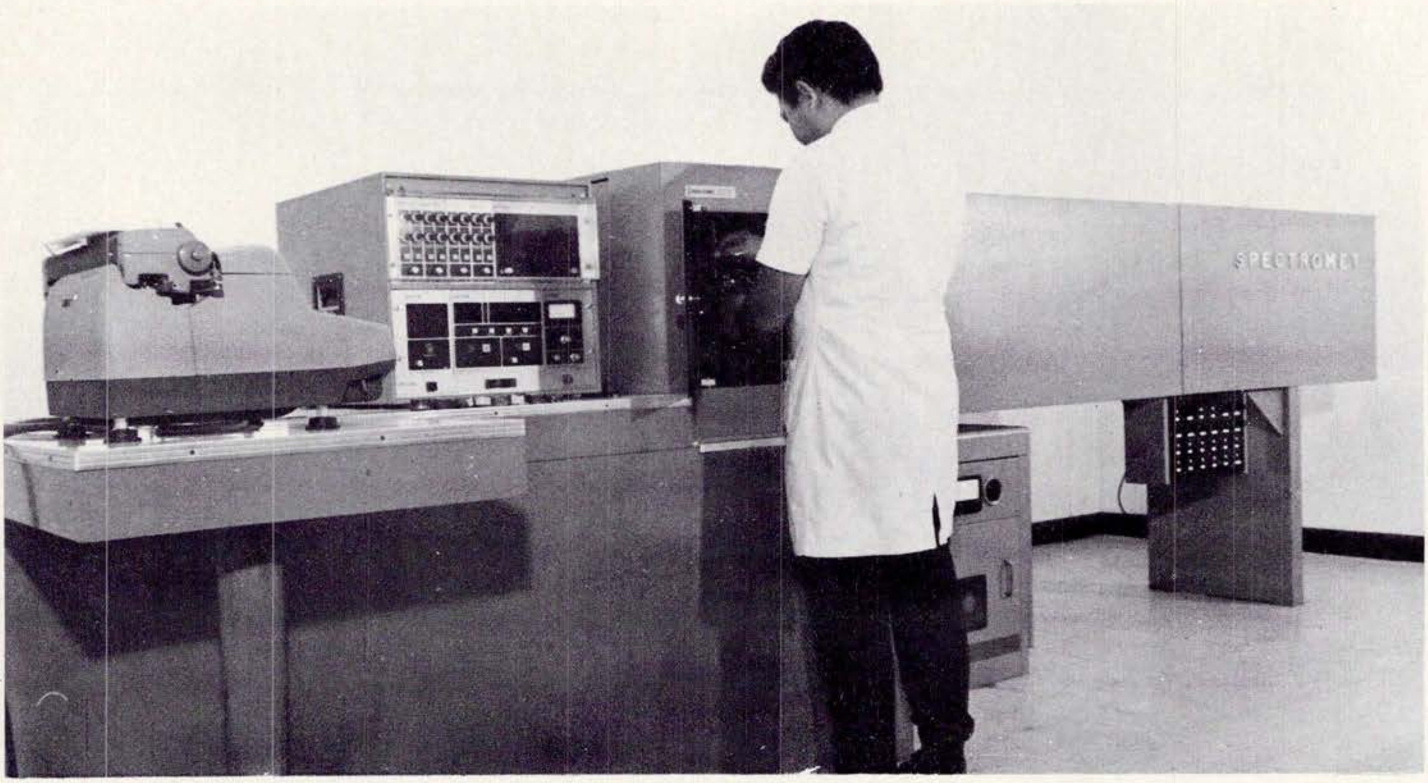
Molding continues as the melting and pouring operations are in progress. Several bins for the prepared sand are located above the molding machines and are fed by another 24" belt conveyor from the sand mixers.

Hot balls from the shake-out machines are conveyed into a bucket and are dumped into a tumbling machine by means of an air hoist. The tumbling process is carried out until the balls are completely cleaned. Sorting is handled by the Quality Control group, and the good balls run freely from an inclined chute into drums placed in a pit at the end of the system, ready for turn-over to the warehouse.

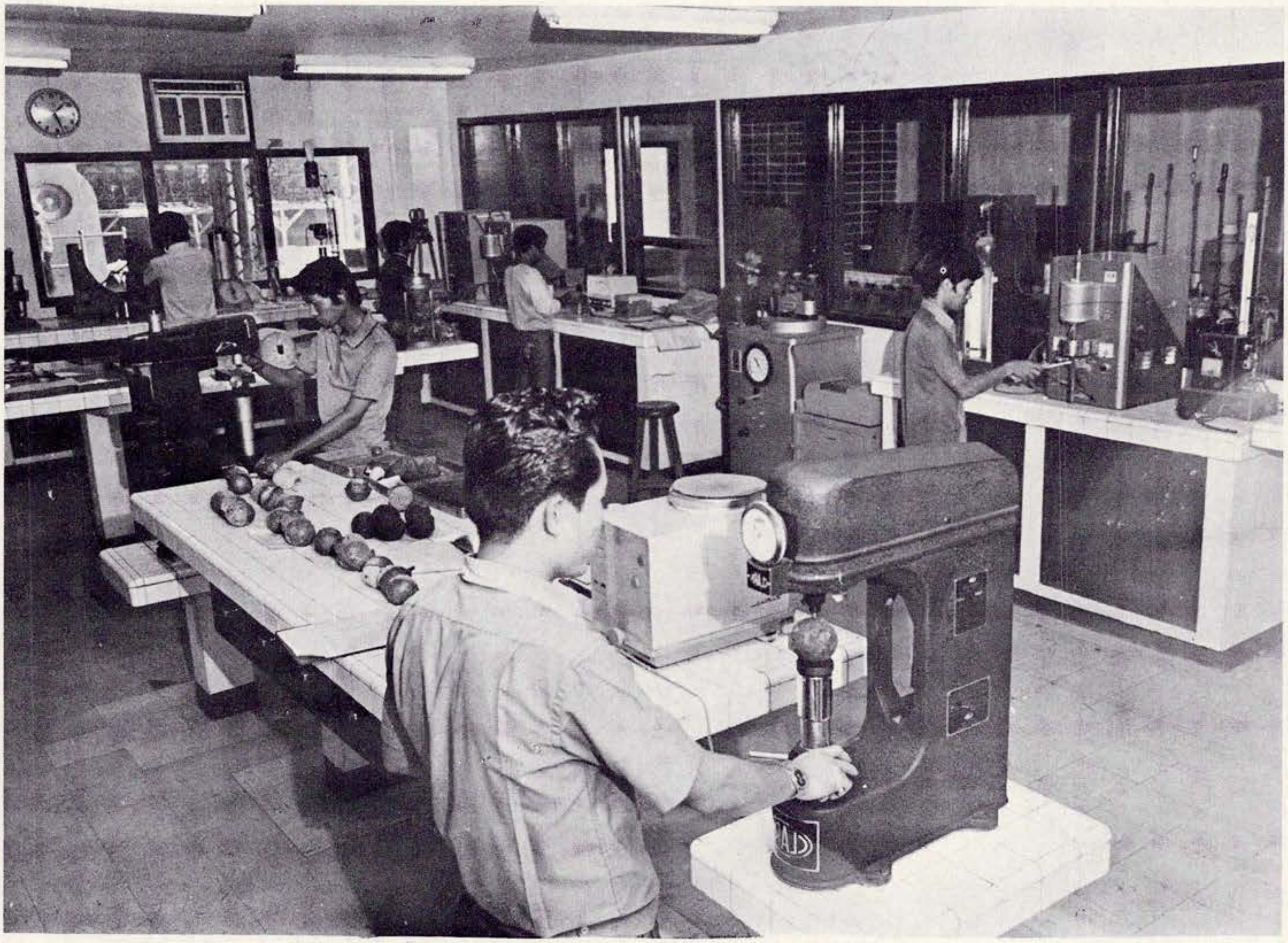
The Iron Foundry produces white iron balls in 1-inch and 1.5 inch diameter sizes for regrind mills at a total rate of about 300 metric tons per month, sufficient to meet the full requirements of both concentrators. Plans for producing Ni-hard balls as an alternative composition is being undertaken. Local production of grind balls results in considerable savings to Atlas estimated at more than ₱3 million annually.



Molding in the iron foundry is done simultaneously with the melting operation (shown at background). The molds are distributed on six rows of roller conveyors for pouring.



Shown above is the computerized direct-reading spectrometer in the foundry laboratory which can analyze metal composition within a few seconds.



Quality Control testing of balls produced in the foundry is done in every phase of production through the use of modern laboratory equipment.

QUALITY AND PROCESS CONTROL

Close control of all casting processes at the Atlas Foundry Shops as well as control of the quality of the finished castings is accomplished in every phase of production. Process control procedures implemented during core preparation, melting and pouring, and heat treatment is a direct function of the Quality Control Group.

To achieve its functions, the laboratory has acquired equipment like the direct-reading emission spectrometer, automatic carbon determinator, metallographic apparata, electric lab furnaces and sand testing equipment.

Mixing of the core sand is closely checked and each batch of core mix is sampled and tested for moisture, permeability and strength. The cores baked in the oven are also tested for dry hardness.

In melting steel, the composition is controlled by taking several samples for each heat. The samples are analyzed for carbon using a LECO SR-12 Carbon Determinator. The other important elements are analyzed by a Baird-Atomic Spectromet unit. Pouring temperatures are taken and recorded for each rack poured to correlate ball properties related to temperature variations. During the pouring operation, a Jominy bar sample is also taken and evaluated for determination of appropriate heat treatment procedure.

The critical temperature control in the heat treatment process is handled by the Product Inspection Section. Proper quenching sequence and procedures are closely supervised to have the desired ball properties. Inspection of the cast balls are made after quenching, and again after tempering.

FOREIGN EXPORT PRICES

Table I
CONTINENTAL STEEL EXPORT
Monthly Price Averages February to April 1972
(In US $ Per Metric Ton)

	February	March	April
Billets	—	—	—
Reinforcing rounds (a)	100+	99.5+	100+
Merchant bars	110.7+	110.08+	110+
Joists, channels (Brit)	—	—	—
Channels (US)	124+	124+	124+
W.F. (Univ. beams)	132.7+	132.8+	134+
Wire rods	121.5+	124.2+	120
Hot rolled strip: 1 in.	—	119.9+	121+
Tube strip	119.4+	120.3+	121+
Heavy plates (c)	127+	125+	—
Medium plates (d)	117+	117.8+	—
Universal plates	—	—	—
Chequer plates	120+	122+	125+
HR sheets: 16g. and up	—	—	—
HR coil (dry)	—	—	—
CR sheets: 17-20g.	130.1+	137+	—
Galv. coils: 17-20g. (b)	179.1+(e)	180+(e)	180+(e)
Bright wire	—	—	—
Black annealed wire	—	—	—
Galv. wire: 5-16 1/2g.	—	—	—
Barbed Wire	—	—	—

Source: Metal Bulletin

*+2 1/2% exporter's commission incl. *less $5; corrugated extra $2; flat sheets $3.*

(a) Usual deformed bar premiums; structural $2; intermediate $3

(b) 4-ton coil

(c) over 8 mm.

(d) 3-8 mm.

(e) Some markets quoted on cost and freight basis

MB's appraisal Continental (ECSC) mills' basis (net unless stated)

FOB export prices, ordinary Thomas Commercial quality. Markets, sizes, quantities, delivery, etc. can affect prices shown.

Table 2
JAPAN MONTHLY AVERAGE DOMESTIC PRICE
(In US $ Per MT unless otherwise indicated)
February-April 1972

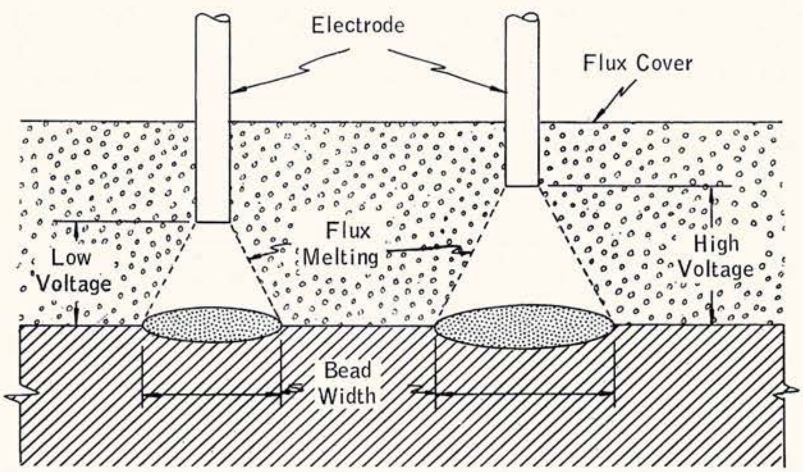
Iron Steel Products	February	March	April
Round Bar 9mm	88.92	85.37	89.67
16-25 mm	89.49	88.79	94.01
Flat Bar 6 × 50 mm	102.65	102.78	108.07
Equal Angle 6 × 50 mm	94.67	94.44	97.74
10 × 90 mm	98.23	97.92	102.95
Channel 6 × 65 × 125 mm	112.50	113.54	123.52
H-Shape 9/14 × 250 × 250 mm	131.31	131.60	132.20
Hot Rolled Sheet (3 × 6) 1.6 mm	113.32	114.68	126.13
Cold Rolled Sheet (3 × 6) 1.2 mm	131.72	133.43	138.89
Medium Plate 3.2 × 3 × 6	109.82	112.05	123.78
Plate 6 × 4 × 8	108.93	111.46	123.09
9 × 4 × 8	108.93	111.71	123.78
Gas Pipe (Black) 15A (1/2 inch) (per kg.)	0.13	0.13	0.13
Water Pipe (White) 15A (1/2 inch) (per kg.)	0.21	0.21	0.21
Galvanized Sheet			
(plain) 0.30 mm	159.03	159.02	160.07
(corrugated), 0.25 (per sheet)	0.52	0.52	0.53
Colored Sheet			
(lone side, plain) 0.30 mm	225.69	225.69	226.39
(one side, corru.) 0.25 (per sheet)	0.66	0.66	0.67
Wire Rod, 5.5 mm	98.96	100.05	111.55
Round Nail, 100 mm (4 inches)	149.24	150.79	156.86
Iron Wire, No. 8	123.20	124.26	136.54
Annealed Iron Wire, No. 8	132.39	132.04	143.92
Galv. Iron Wire, No. 8	150.03	150.69	159.63
Barbed Wire, No. 14	211.90	212.85	213.28
Tinplate, 90 L (0.257) mm	276.20	276.20	276.20
Wire Netting, 20 × 15 mm (one roll)	5.31	5.31	5.28
Welded Steel Netting, (1 sq. meter)			
No. 4 (6 × 150 mm)	0.66	0.66	0.66
No. 8 (4 × 100 mm)	0.50	0.50	0.50
Special Steel			
Constructural Carbon Steel (SC)	125.25	123.15	125.00
Stainless Steel, (per kg.)			
SUS 24 (18 CR)			
Sheet (2-6 mm)	0.48	0.51	0.40
SUS 27 (18-8)			
Sheet 0.3 mm	1.10	1.13	1.15

Non Ferrous Metals	February	March	April
Electric Copper	998.36	1022.33	1051.04
Electric Zinc	358.33	355.75	354.86
Electric Lead	262.31	277.58	303.47
Tin	3374.37	3368.55	3434.03
Antimony	1390.15	1391.87	1381.94
Nickel	3457.71	3486.11	3486.11
Selenium	20902.78	20902.78	20902.78
Bismuth	8125.00	8244.06	8263.89
Cadmium	3901.52	4554.56	5520.83
Mercury	9807.45	9722.22	5416.67
Aluminum	552.08	545.14	545.14
Rolled Copper & Brass			
Copper Sheet, 2.0 mm	1292.08	1339.29	1384.26
Copper Tube, 50 × 5 mm	1420.03	1468.92	1500.00
Copper Rod, 25 mm	1344.28	1361.11	1379.63
Copper Wire, 0.9 mm	1284.09	1321.43	1356.48
Brass Sheet, 2.0 mm	1001.26	1048.28	1111.11
Brass Tube, 50 × 5 mm	1165.83	1199.07	1217.59
Brass Rod, 25 mm	870.37	972.22	967.59
Brass Wire, 6 mm	1016.84	1044.31	1078.70
Rolled Aluminum			
Sheet (99%), 1.0 mm (400 × 1,200)	805.56	805.56	798.61
Circle 1.0 mm	881.94	881.94	881.94
Steel Scraps			
Special for Electric Furnace	31.94	32.85	33.68
Pig Iron Scrap	50.00	49.65	49.65
Copper Scrap			
No. 1 Copper Wire (Berry)	934.28	991.87	991.67
No. 2 Copper Wire (Birch)	905.68	953.17	958.33

Source: Japan Metal Bulletin

ENGINEERING & TECHNOLOGICAL DEVELOPMENTS

technical abstracts



Sketch illustrating relationship between voltage and flux melting.

CAUSES AND PREVENTION OF HARD WELDS

Hard submerged arc welds that have caused fairlures on carbon and low alloy steel equipment like pressure vessels can be prevented in the future by better defining flux differences and by stopping the unlimited flux interchangeability presently permitted by specifications. Several basic mechanisms which can cause hard welds are rapid cooling which is due to lack or inadequate pre-heating, inadequate post weld heat treatment, and over-alloyed weld metal. The submerged arc welding process is quite unique in that it permits the fabricator and his welder to mix two welding consummables thereby influencing the chemical and mechanical properties of the weldment by the independent selection of electrode, flux and electrical variables.

To prevent hard welds, Esso Research and Engineering Co. has added the following requirements to job specifications: a) welding procedures shall be requalified whenever submerged arc welding flux is charged from one manufacturer to another or from one manufacturer's grade to another, b) consumable materials designated for single pass welding as the primary application shall not be used for multipass joints, and c) when using active fluxes, voltage ranges must be established and equipment must be available to monitor these limits. **Welding Journal, September 1971.**

THE SKF MR PROCESS FOR STEEL MAKING

A new method of making steel in an electric arc furnace was demonstrated recently at the SKF Steel Works in Hallefors, Sweden. The method called the SKF MR process, is divided into two stages: one for melting (M) in the newly invented SKF twin shell furnace and the other for steel refining (R) in an also newly developed ladle furnace. The furnace differs from a conventional electric arc furnace in that it has two shells fitted with swinging roofs. Only one of the roofs is equiped with electrodes. While smelting takes place in one furnace shell, all other operations like phosphorous refining, decarburization, tapping, fettling, charging and heating are carried out in the other furnace shell. When smelting is completed and the molten metal has reached the correct temperature, the roofs are changed and smelting of the pre-heated material in the other furnace shell can be started immediately. Removal of phosphorous is accomplished by blowing a mixture of oxygen and lime into the melt and blowing techniques are also employed to adjust the carbon content.

The twin shell furnace is also quite flexible in that it is also possible to treat two types of steel at the same time like carbon steel and stainless steel. One furnace shell can also be used for ordinary melting when it is necessary to reline or repair the other. **Asian Manufacturing, January 1972.**

CASE DEPTHS MEASURED NONDESTRUCTIVELY

Two special electronic devices, working through eddy current and coercive force measurements, were developed to determine case depths of carburized and induction hardened parts routinely. One is a magnetic comparator (an eddy current unit) which predicts metallurgical or chemical properties by comparing magnetic properties of one piece to another. Capable of measuring cases up to 0.200 inch deep, this unit can determine the case depth of track pins to within ± 0.003 inch of the actual induction-hardened depth.

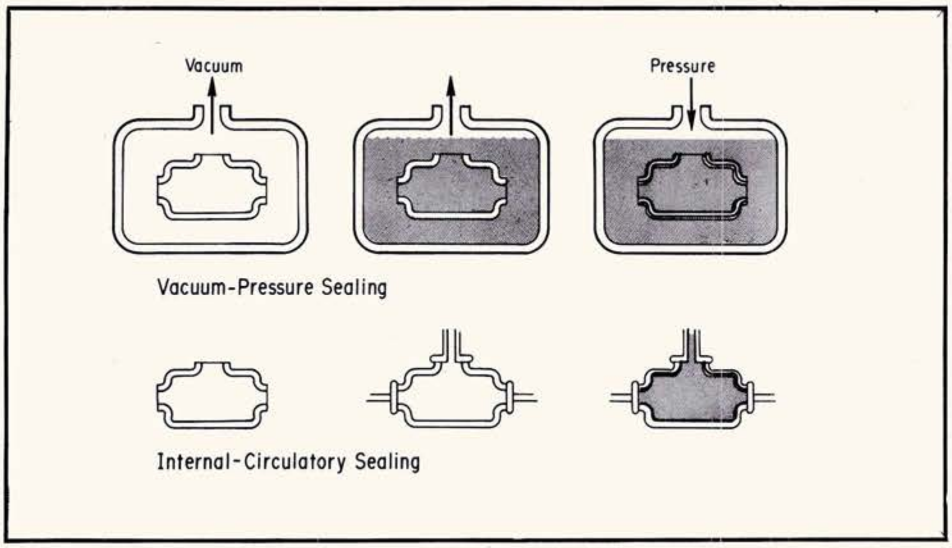
In the case depth meter, a probe is place on the piece and the coercive force value is taken in 30 seconds. The case depth is determined from a calibration curve previously prepared by destructive checks of samples with shallow and deep cases. Primarily carbon steel parts are tested with this equipment. It is extremely sensitive to core variations accompanying abnormal quenches. Compared with the comparator, the case depth meter can handle deeper cases up to 0.800 inch. It is not affected by minor composition changes. **Metal Progress, August 1971.**

QUALITY OF NODULAR IRON DETERMINED BEFORE POURING

A new test, called Thermo Qual, now makes it possible to predict microstructure of nodular iron prior to pouring. Samples are taken after magnesium treatment and postinoculation with ferrosilicon. The method is based on the qualitative relationship between cooling curves and microstructure. Analysis of cooling curves by comparison with a visual rating chart provides a reading on graphite nodularity and per cent carbide within 2-min. after withdrawal of the sample.

The sampling device used to develop cooling curve data consisted of a low carbon steel cup and a chromel-alumel thermocouple. Specimens were taken by immersing the sampler in molten iron which flowed through the side holes in the cup and surrounded the thermocouple located in the thermal center of the sample. The sample was then removed and air-cooled through the eutectic reaction. Metallographic examination was performed at the midradius of a sample on a transverse section through the thermocouple tip corresponding to a 1/2 inch section cast in sand. The sensitivity of the test to variations requires that a constant sampling procedure be established to optimize reliability. **Metal Progress, August 1971.**

SEALING POROUS PARTS



At present, a large number of castings and powdered metal parts are sealed against porosity by a process called impregnation to avoid fluid leaks through them. Impregnation is a process in which components that might be porous are immersed in a sealing agent so that the metal structure becomes impervious to liquids or gases. The automotive industry uses impregnation extensively to seal engine blocks, intake manifolds, oil pans, water pump housings, carburetor bodies, and air-conditioning components. Sealing is employed in chain saws, industrial pumps, outboard motors, and hydraulic components. In aircraft, impregnation is common in braking and control systems. The various types of sealants in use are sodium silicate or waterglass, polyester (a resin-based system cured by heat) and anaerobic materials.

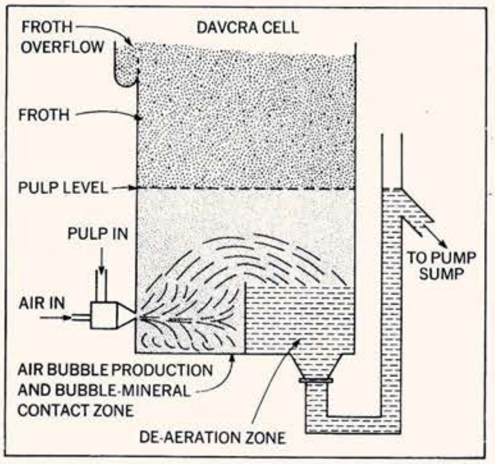
There are two approaches to impregnation. Most processing is done by vacuum-pressure sealing where a tray of parts (or individual large parts) are placed in a tank which is then evacuated. After enough time has elapsed to allow outgassing, sealant is admitted to cover all parts completely. The tank is then pressurized so that sealant is driven into the pores of the metal. Parts that are too large to be contained in an impregnation chamber are sealed by an internal circulatory method. Here, all orifices of the part are sealed and impregnant under pressure is pumped into the part. This method of sealing is sometimes incorporated into leak testing machines for mass production impregnation of parts in all size ranges. **Machine Design, August 1971**

INNOVATIVE DESIGN REVAMPS FLOTATION CELLS

The Zinc Corporation Ltd. (ZC) has created a new type of flotation cell which eliminates the impellers, using instead an injection nozzle and which is about five times more efficient than a cell of conventional design. The ZC machine, called Davcra, is also adaptable to more positive control, particularly of pulp level and air addition, and permits better control of the grade-recovery relationship.

The essential features of the Davcra machine are its injection nozzle and cell tank. The injection nozzle directs swirling concentric jets of pressurized pulp and compressed air into the cell tank. The air jet upon passing through the orifice as a central air core is force into a swirl by the surrounding pulp. The interaction of air and pulp within the nozzle cause the thorough mixing and contact between bubbles and mineral particles. The two fluid jets then impinge on a plain baffle which dissipates the jet energy and where secondary pulp flows around the primary mixing zone back towards the nozzle orifice. Pulp depth in the cell is controlled by resistance to pulp flow in the tailing discharge line.

Pilot test has been conducted with satisfactory result on coal flotation at Coal Cliff Collieries Ltd., N.S.W. and on copper flotation in the grinding circuit of the Cobar Mines Ltd. concentrator, also in Australia. Operation and testwork have also shown that on zinc roughing, one Davcra cell is equivalent to approximately five 66-cu. ft. conventional



New flotation cell performs without the usual impellers and motors.

cells. This efficiency is achieved without moving parts since the Davcra cell is simply a tank with a single pumping installation, which replace the five impellers and flotation assemblies and motors of conventional cells. Another advantage is Davcra's high tonnage capacity per unit of floor area which leads to savings in building, flooring and lighting costs. Power consumption seems about equivalent to that for conventional machines. **E/MJ, July, 1971**

THERMODYNAMICS OF IRON-OXIDES REDUCTION BY METHANE

The equilibrium gas-phase composition at various stages of reduction of ferric oxide by methane was recently investigated using a new design variant of the circulation method. It is known that the reaction of hydrocarbons with metal oxides increases the volume of the gas phase and produces a high-vapor content. The apparatus has the following automated features: maintenance of constant pressure, recording of changes in gas volume and determination of its water content and thermostating of the whole system to avoid water-vapor condensation.

The investigation showed that there is a high degree of methane conversion in the iron-oxide reduction process. The equilibrium gas phase contains large amount of water vapor and carbon dioxide. From the thermodynamic point of view, methane is a very effective reducing agent. **Steel In The USSR, March 1971**

GROUP TECHNOLOGY IN FORGING AND STAMPING

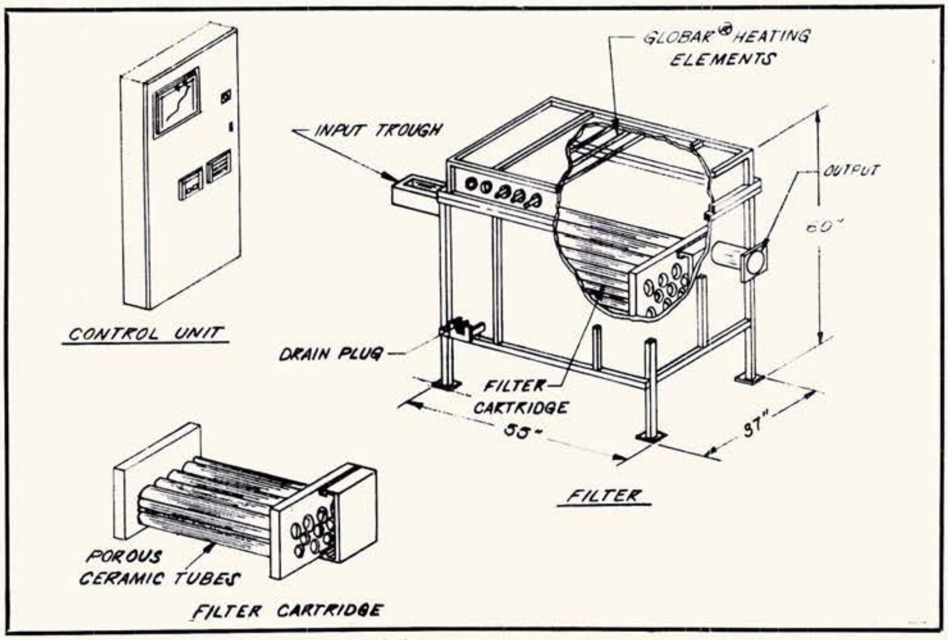
Considerable interests has been given recently to the technique of Group Technology (GT) to forging and stamping as a means of improving the manufacturing efficiency of the batch production industries. The principle of this approach is that families of similar or related components are chosen and then processed together on suitable machine tools. These machines are situated adjacent to one another, thereby reducing the between process transportation of batches of components to a low level. The arrangements of machine tools is thus changed from the conventionally used functional layout (like machines together) to a group layout with a number of machine tool groups each dealing with a specific family of components.

The major savings result from reduced die costs through the design of group die sets employing interchangeable adaptors and inserts, thereby allowing a family of parts to be produced on the same die assembly with only minor and a resultant rapid alterations between each batch of individual parts. Additional savings may also be realized through the use of the same pre-form die for multi-stage operations. The process of sorting parts into families is facilitated by the use of component classification systems, which allow code numbers to be assigned to each part. Suitable tooling can then be devised and machines selected to fit the production requirements of the family of parts as closely as possible. Rationalization of the tooling arrangements will then be possible through consideration of the parts as a group rather than individually. **Metallurgia and Metal Forming, September 1971.**

MOLTEN ALUMINUM FILTERING SYSTEM OF NEW DESIGN WITH CERAMIC TUBES

The need for filtering has long been known in the aluminum industry. Non-metallics should be removed from aluminum used in automobile trim stock; aircraft sheet, place, and forgings; fine drawn wire; or other critical applications. In this connection, a new filter system for molten aluminum was developed to provide quality products by stripping out all impurities that are eight microns or larger in size. By increasing metal recovery the filter also upgrade overall efficiency in processing. In this system a replaceable cartridge of porous and rigid ceramic tubes provides positive, high-efficiency, micro-filtration economically. The ceramic material of which the filter tubes are made is immune to attack by molten aluminum and contains a special bonding agent.

The filter cartridge, effective over long production runs, is easily replaceable. The flitration device employs a Globar electric resistance heating system with accurate and sensitive, automatic SCR temperature controls. The effectiveness of this filtering system was proven dramatically in controlled tests at a major aluminum producing plant. **Industrial Heating, September 1971.**



The major components of the aluminum filter system.

TRITON KAOWOOL — THE VERSATILE CERAMIC FIBRE

Triton Kaowool (45% alumina and 52% silica), being resilient, flexible, resistant to vibration, and four times lighter than the lightest conventional refractory, is one of the best insulators yet discovered. Its properties have made possible many new design techniques for containing heat for industrial furnaces. The basic bulk wool may be packed to densities from 3 to 121 lb./ft^3 into cavities requiring insulation. Though the temperature limit for the continuous use of Triton Kaowool Ceramic Fibre (TKCF) is 1260°C, it can be used at considerably higher temperature if a reduction in resilience and flexibility and life can be accepted. It has low thermal conductivity, approximately 35% better than insulating brick. This means low heat losses and when used as furnace lining, rapid heating and cooling at lower cost.

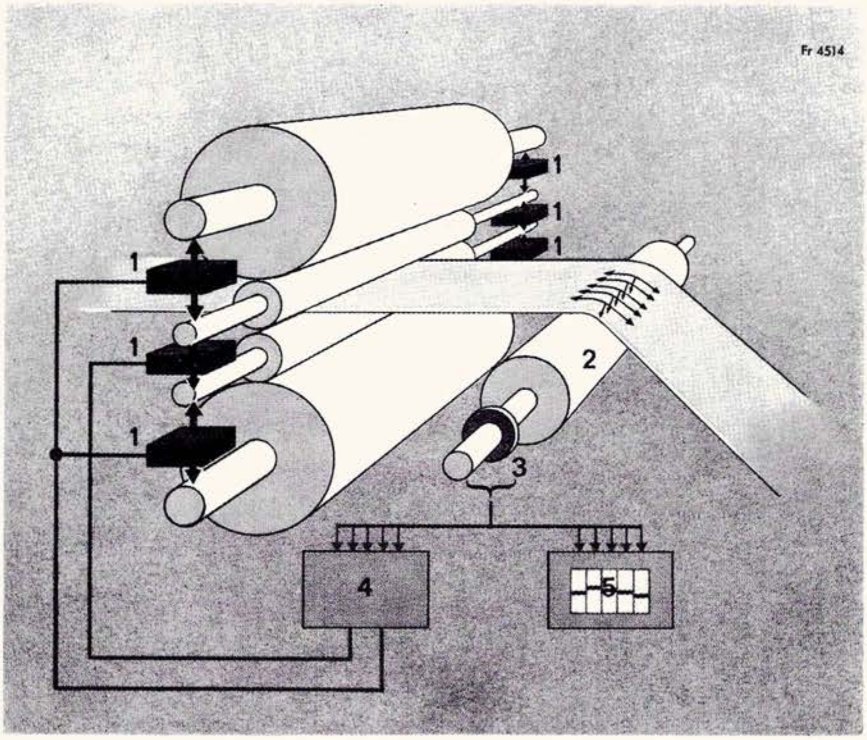
The most ubiquitous application of TKCF is in expansion joints in furnace structures. As a lining it is used in furnaces of coil-annealing, billet-preheat, heat treatment types, and in process heaters. In many steel mills, TKCF is gradually replacing the conventional sand seal in soaking pits. In non-ferrous foundries TKCF wet felt, vacuum formed shapes are used as lining for launders, spouts, and tundishes.

TKCF is made by blowing compressed air on to molten China clay. The clay used, which is pure Kaolin, is calcined and crushed, and melted in an electric furnace from which a thin molten stream falls into a high velocity blast of air. The resulting "bulk wool" contains fibers of various lengths and orientation. **Asian Manufacturing, January 1972.**

NEW NICKEL-BASE ALLOY SOLVES WELD-ZONE CORROSION PROBLEMS

A new corrosion-resistant alloy, Hastelloy alloy C-276 containing 16Cr, 16Mo, 4W, and 5 Fe, resists the formation of grain boundary precipitates which makes it suitable for most applications in the as-welded condition as in the chemical process industry. The new alloy has excellent ductility favoring various hot and cold forming techniques. Because of good formability, the alloy can be made into fluted heat exchanger plates.

The new alloy was developed to eliminate intergranular attack in the weld-heat affected zone by controlling the carbon and silicon contents (normally 0.02% and 0.05%, max.). It exhibits good corrosion resistance to many oxidizing, reducing and neutral environments, and has excellent resistance to stress-corrosion cracking. Alloy C-276 can be hot formed in the 1800 to 2100°F range. It can be joined by standard welding techniques. However, any operation that requires normalizing (1 or 2 hours at 1600 to 1700°F) is not recommended. **Metal Progress, March 1971**



Schematic diagram of a four-high mill, where the deflector roll has been replaced by a Stressometer measuring roll.

1 — Actuator
2 — Stressometer measuring roll
3 — Signal transmission
4 — Control equipment
5 — Display unit for strip shape

STRESSOMETER FLATNESS TRANSDUCER FOR COLD STRIP MILLS

The increasing quality requirements on finished products have led to the growing automation in rolling mills. One step towards improving quality is the ability to roll strip with good shape. The problem of measuring the shape of a strip has led to the development by ASEA of a mill-duty flatness tranducer, called Stressometer. The Stressometer measuring roll is mounted in place of the normal deflector roll. It can also be used for measuring the strip tension and is then supplemented by another deflector roll, which satisfies the requirement of constant wrap angle for the strip. To obtain full benefit from the equipment, it must be combined with some system capable of changing the shape during rolling such as the crown adjustments in Sendzimir mills, a roll deflection and a zone cooling system.

The principle of measurement of this device is a follows: if the shape of the strip is not ideal, the specific tension across the strip is not constant. When the strip runs over a deflector roll, it will be influenced by a radially directed force. The distribution of this force across the strip has the same appearances as the distribution of the specific strip tension and can be used for measuring the shape of the strip. **Asea Journal, 1970**

CASTING UNDER HIGH PRESSURE IN METAL DIES

A new technique in die casting was revealed recently involving the imparting of a very high pressure to a metered amount of liquid metal as it solidified in a die. Unlike pressure die casting, where the pressure is transmitted by the plunger via the gate, here the metal is pressurized by high forces exerted through an upper or male die. The solidification takes place in only a second or two and the pressure on the metal altered the solidification pattern and the heat transfer characteristics. The high piston-pressures acting on the semi-plastic metal also eliminate shrinkage cavities and gas porosity. Other advantages include: high yield as gating and feeding are virtually eliminated, excellent surface finish, superior mechanical properties, less wear and tear on dies and the process is more suitable for castings with thicker sections. Apparently, there is no limit to the range of metals which could be cast and success was mentioned with Stellite, yellow brass, stainless steel and superalloys at a pressure of about 15,000 psi. The technique was also considered as an answer to the problem of incorporating fibre reinforcements such as silicon carbide and tungsten carbide whiskers in castings. The process is now being used in Russia for the manufacture of components for the automobile and electrical industries. **Metallurgia and Metal Forming, September 1971.**

PPG DEVELOPS NEW ELECTROCOATING SYSTEM

A cationic electrodeposition coating system that deposits a highly corrosion-resistant organic finish at the cathode, rather than at the anode (evidenced in commercial electrocoating systems now in use) has been developed by the Coatings and Resins Division of PPG Industries, Pittsburg, Pa, U.S.A.

The cationic system eliminates the presence of anodic dissolution products, such as iron, in the deposited film. **Industrial Heating, June, 1971**

GAS TO PARTIALLY REPLACE COKE IN A COLD BLAST CUPOLA

Motivated by reports regarding the successful utilization of natural gas to partially replace coke in cold blast cupolas with the additional benefit of increases in output, John Vickers and Sons Ltd. installed a new cupola which was modified to incorporate gas burners. To ascertain the best blowing rate, the company installed an airflow recorder and had an orifice plate fitted in the blast main. The gas and air rates were set at the limiting orifices to give injection rate equivalent of 25 per cent of the normal coke charge.

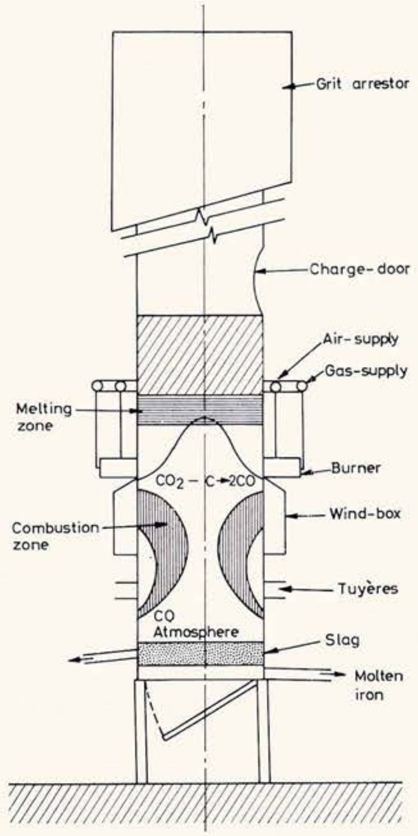
The cupola charges were composed of:

260 lb. of iron scrap	74.5%
90 lb. of pig iron	25.5%
7 lb. of lime	
45 lb. of coke representing	12.9%

coke/metal ratio.

The metal temperatures were 50-80°C higher than normal and the carbon equivalent was satisfactory. Further runs were made with further reduction of the coke charge. In a similar manner, the gas injection rate was gradually raised until the coke charged is 25 lb/charge, i.e. approximately 45 per cent coke replacement. The replacement of 45 per cent of the coke charge is regarded as the maximum for this cupola because of the increased waste gas temperature leaving the cupola.

No increased wear of refractory has occurred. Therefore, as the throughput of the cupola has been increased, there is an effective reduction refractory wear per ton of metal melted. **Iron and Steel, February 1971.**



Sketch of the cupola modified to incorporate gas burners and showing the flow pattern of the furnace gases.

HEAT TREATMENT OF HIGH SPEED STEELS

Several methods of heat treatment for high-speed steel is available. One is nitriding, a surface treatment designed to introduce nitrogen into the peripheral layer of the steel to a depth of 0.0005 – 0.001 inch, producing a skin with a hardness of up to 1100 HV. Nitriding imparts a very high wear resistance at the expense of some ductility. It is accomplished in molten cyanide salt baths which normally contain from 7-15% sodium cyanate, 15% sodium cyanide, and certain percentage of sodium carbonate and alkaline chloride. The amount of nitrogen introduced depends upon the temperature (450-560°C), immersion time, cyanate content and the steel used. Molybdenum based high-speed steel normally nitrides more easily than does the tungsten type.

Carburization is the introduction of carbon into the metallic surface. It is carried out intentionally to impart exceptional wear resistance or accidentally due to a high carbon potential in a heat treatment furnace. Normal thermal distortion may occur due to incorrect handling and/or positioning of components whose length is large compared to their thickness or diameter, or due to uneven heating. Such work is best suspended vertically, or possibly held in a jig. Distortion may also occur due to the lack of stress relief after heavy machining, but the majority occurs as a result of the martensite reaction which is accompanied by an increase in volume. **Metallurgia and Metal Forming, September 1971**

EFFECT OF CALCIUM FLUORIDE ON THE DESULPHURIZATION OF PIG IRON BY HIGH-MAGNESIA SLAGS

When calcium fluoride (CaF_2) is added to different metallurgical slags, the extent to which the metal is desulphurized increases. This is associated with an improvement in the conditions of diffusion of sulphur in the slag because of a reduction in slag viscosity. On account of the above, the effect of additions of CaF_2 (at about 1-4%) on the desulphurizing capacity of synthetic high-magnesia (20-30% MgO) slags having a basicity of 0.6 was examined. It was found that the maximum desulphurization factors are possessed by a slag containing 25% MgO and 2% CaF_2 with a basicity of between 0.6 and 0.8. Chemical analysis of slags gives evidence of an increase in the basicity and in the volatilization of fluorine, particularly marked in the acid slag with a high CaF_2 content. This justifies the assumption that, during the melting process with acid slags and concentrations of CaF_2 of not less than 3%, there is not only the possibility of a physical action of calcium fluoride on the course of desulphurization but also a chemical action which is manifested in the enrichment of the melts by calcium oxide as a result of the volatilization of fluoride in the form of silicon fluoride. **Steel In The USSR, February 1971**

CORROSION PROTECTION OF ALUMINUM ALLOYS IN CONTACT WITH OTHER METALS

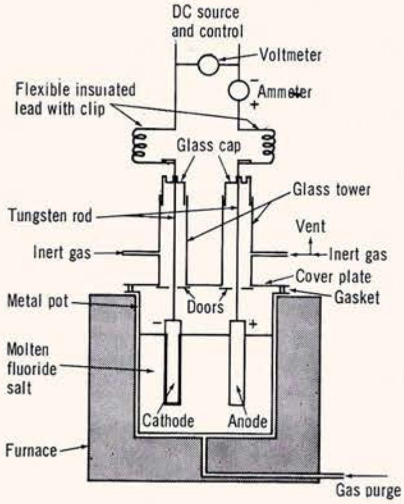
Aluminum alloys used in equipment exposed to corrosive environments are commonly protected by various coatings. The more protective coatings are effected by anodizing (chromic or sulfuric acid treatment) or alodizing (chromate treatment) of the aluminum. In instances where anodized or alodized aluminum alloys are used in contact with 347-CRES (corrosion-resistant stainless steel) or 6 Al-4V titanium alloy, galvanic corrosion oftentimes results. Investigations of the quality of chemical and galvanic protection given by anodized or alodized coatings applied to test panels of various aluminum alloys, revealed that sulfuric acid – anodized coatings provided the best protection. All pairs of panels were subjected to the standard ASTM salt-spray test for various periods. Alodized coatings, although capable of protecting aluminum alloys not in contact with more-anodic metals, did not prevent galvanic attack of the coated aluminum coupled with either of the two metals. When anodized or alodized coatings broke down under the salt spray, the degree of galvanic corrosion varied with the difference in electrochemical potential between the aluminum and the paired metal.
Light Metal Age, October 1971.

DETOXIFYING FREE CYANIDE IN WASTE WATER

Calgon Corporation has offered an inexpensive and speedy system for detoxifying free cyanide in waste water as a package unit. The process is based on catalytic oxidation. In the process a catalyst solution containing cupric ions is mixed with the waste water, and the mixture is allowed to get in contact with air or oxygen (depending upon the cyanide concentration). The mixture is then pumped through a bed of granular activated carbon, where the cyanide is oxidized to carbonates and nitrogen compounds.

It is claimed that operating and maintenance costs is \$0.92 per pound of cyanide destroyed which is less than half the cost of conventional alkaline-chlorination techniques. Calgon also said that its system destroys cyanide within 25 minutes compared to one to two hours for alkaline chlorination.
Chemical Engineering, October 1971.

BORIDING STEELS FOR WEAR RESISTANCE



Drawing shows the essential features of a typical cell.

Boriding, as done by the metalliding process, involves the electrodeposition of boron atoms onto the metal from a bath of molten salt containing fluorides of lithium, sodium, potassium and boron, producing hard, wear-resistant coatings. In this process, the part to be alloyed on the surface acts as the cathode while pieces of elemental boron in a copper basket constitute the anode. The bath is covered with argon or a mixture of nitrogen and hydrogen to minimize contamination. An electrolysis circuit controls the boron deposition with cell voltage being used to monitor development of the coating.

Parts can be borided at temperatures as low as 1100°F although the convenient range is 1470 to 1650°F. Coatings preferred range from 0.5 to 2.0 mils in thickness containing about 0.7 to 3.0 mg. of boron per sq. cm. of surface. Treatments last from 14 min. to 5 hrs. with current density at the cathode ranging from 0.5 to 2.5 amp. per sq. dm. As a rule a high current density produces a thin coating on a low-alloy steel in a short time. As borided steel has a dull gray color, a consequence of its rough surface. Smoother coatings can be deposited, either by lowering the metalliding temperature or raising the current density or both. To prevent porosity boriding should be limited to alloys which do not require further high temperature treatment. At present, boride coatings can be applied to tool steels, mandrels, dies and many others.
Metal Progress, February 1971

BATCH FURNACE LINE HANDLES VARIETY OF MINING EQUIPMENT

Joy Manufacturing Co., Claremont, N.H., a major manufacturer of rock drilling machinery, tungsten carbide bits, mobile loaders, and other equipment for mining has added a new gas-fired heat treating facility to attain a greater degree of control over carburizing and hardening processes, and to increase production capacity. This line of batch-type furnaces handles a variety of parts which differ widely in size, shape, and steel composition. Components include light rotchet, pawls, plungers, pins and others up to large shafts and bull gears.

Since carburizing furnaces have integral quenching tanks, parts can be quenched directly after carburizing, eliminating the need for reheating for hardening. Many of the parts are carburized at 1700°C, cooled to the appropriate hardening temperature for the material, and then quenched. Distortion is substantially reduced by this practice so that grinding allowances can be minimized or even eliminated. Most of the parts are either hardened (by quenching and tempering) or carburized. For example, bull gears (AISI 4320) are carburized for

9 hrs. at 1700°F to a 0.050 to 0.060 inch case, cooled to 1500° F, held for 2½ hrs. quenched in oil, and then tempered at 350°F for 2½ hrs. to RC 60.

The system designed and built by Sunbeam Equipment Corp., Meadville, Pa., consists of three batch-type furnaces with integrated quenching baths, protected by atmospheres; three box-type recirculating tempering furnaces; two 1,500 cu. ft. per hour generators of endothermic atmospheres; one batch-type combination washing-rinsing unit; one sixpoint infrared CO_2 recorder-controller; and motorized transfer cart. **Metal Progress, July 1971.**

WHEELS FOR HIGHER SPEED GRINDING

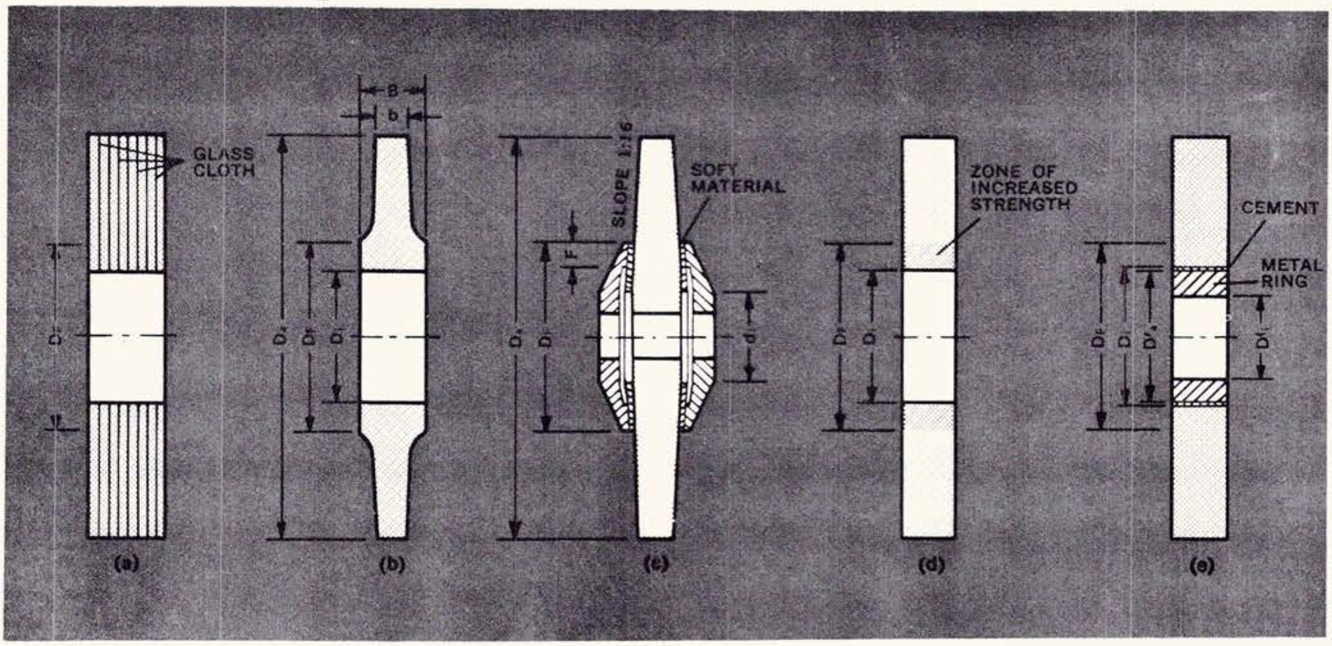
A new approach to high-speed wheel design has been made at Carnegie-Mellon University. It is well-known that grinding wheels tend to fail by radial tensile cracks running from the bore to the periphery of the wheel as a result of the circumferential stresses induced by centrifugal action. To prevent these circumferential tensile stresses from developing, the wheel was divided into sector-shaped segments. The main feature of this design is that the wheel is now held together by compressive, instead of by tensile, stresses. Since grinding wheels are about six times as strong in compression as in tension, this arrangement enables very much higher wheel speeds.

Machines for high-speed grinding (HSG) operate at a much higher removal rate, and this calls for higher horsepower. Since one of the limitations in HSG is increased grinding temperatures several means are provided to avoid this like increasing work speeds, increasing fluid penetration to wheel face (preferably an active grinding oil), using softer wheel grades and internal cooling by interrupted grinding. Use of softer wheels runs counter to providing wheels of greater strength and safety at high speed. The new segmented wheel design makes it possible to use softer grade, larger-grain-size segments since the new design provides a greater factor of safety against wheel breakage. **Mechanical Engineering, August 1971.**

HIGH TEMPERATURE PROPERTIES OF CAST IRONS

For many years, the use of cast irons in specified high temperature applications has been restricted to temperatures below 232°C. This temperature limitation has applied particularly in steam engineering applications to grey and malleable iron flanges, valves and fittings but for nodular iron the temperature has recently been raised to 343°C. The data presented on the growth and scaling properties, tensile properties and creep and stress – to – rupture properties of commercially available cast irons demonstrate the stability and strength of cast irons at high temperatures and show that iron castings have useful load bearing properties at temperatures above 232°C.

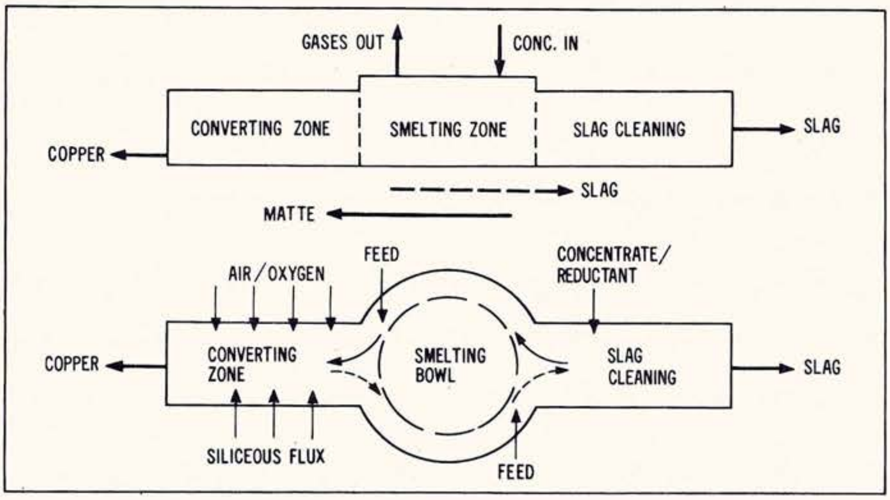
The maximum working temperature for unalloyed grey irons is 350°C where very close dimensional stability is required. This temperature may be raised to 400°C or even 450°C by adjust-



Methods of increasing maximum operating speed of a grinding wheel includes: a) Glass-cloth reinforcement, b) wheel of constant stress, c) conical gringing wheel, d) impregnated bore, and e) metal ring cemented to bore.

ments of chemical composition and alloying; alternatively nodular and malleable irons may be used.

When cast irons are exposed to high temperatures they will grow in size and some oxidation of the surface may occur even when the temperatures are below the critical temperature, i.e. below 700°C. In most engineering applications interests are normally focused in the growth and scaling properties below 650°C. For higher temperature applications, special highly-alloyed cast irons will generally be required. **Iron and Steel, February 1971.**



Evaluation and plan of a straight-line WORCRA smelter-converter.

THE USE OF SILICON-CELL PYROMETERS ON CONTINUOUS ANNEALING LINES

The U.S. Steel Corporation research program showed that silicon-cell pyrometers would constitute excellent instruments for the measurement of surface temperature in the range 900-1400°F, provided the silicon cell was protected from reflections from higher temperature sources. One such application was the measurement of temperature at the end of the heat zone in continuous annealing lines.

The steel strip leaving a continuous annealing heating zone emits infrared radiation which can be readily measured in a wavelength range of about 0.8 to 20 microns. There are advantages, however, in using the shorter wavelength radiation, 0.8 to 1.0 microns, to determine the temperature of the strip. The measurements, therefore, are more affected by the strip temperature and less by other factors such as strip emittance. Trial runs at Edgar Thomson-Irvin works showed that the silicon-cell pyrometer, used with an emittance valve of 0.60 can measure strip temperature with an accuracy of about ± 25°F. The reason for its relative independence of emittance effects is that the radiation from the heated object at about 0.90 micron wavelength increases steeply with increasing temperature which also makes it difficult to use on targets where radiation from higher temperature sources may be present. **Iron and Steel Engineer, February 1971.**

WORCRA DIRECT REDUCTION OF COPPER CONCENTRATE

The WORCRA process for continuous direct smelting-converting of copper concentrates looks promising as indicated by the results of both large and small scale pilot operations. In this process, continuous smelting, converting and slag-cleaning by conditioning and settling are all combined in a single furnace. It is characterized by the following features: a) it produces metal rather than matte, directly from concentrates, b) most of the exothermic oxidation reactions are generated and continued within the liquid bath, hence the description "bath smelting", c) the bath smelting and converting zones is turbulent (due to injection of oxygen containing gas) and continuously flowing, d) in the converting zone, slag moves (under gravity) countercurrent to matte and metal, e) copper-in-slag is reduced to small levels as the slag flows through the smelting zone and slag clening zone; there is no "revert" slag, nor the necessity for separate copper recovery treatments, and f) the SO_2 bearing gases generated in the smelting and converting stages combine and leave the single furnace continuously at a rich tenor via one gas offtake.

The WORCRA process inrects particulate solids and gases into the bath to maintain within the smelting and converting zones the maximum surface area for liquid-phase reactions. In pilot plant trials in Crackle Creek, New South Wales, it was possible to produce copper within the range of 98.2-99.5% metal. Gold and silver recovery and slag compositions were generally similar to that in conventional practice. **E/MJ, August 1971.**

USE OF COAGULATORS IN ALUMINUM DEOXIDATION OF STEEL

If aluminum shot is introduced into the ingot mould while it is being filled, the total amount of iron-metallic inclusions and aluminum oxide in the metal increases greatly. The high affinity of aluminum for oxygen and the supersaturation developing cause extremely dispersed inclusions of aluminum oxide to form such that the diffusion flow against them is small. Introducing large foreign particles as coagulators into this flow would therefore be advisable. Theoretically, coagulation of particles in a turbulent flow of steel consists of collisions between and the absorption of small particles by large particles, accompanied by sintering and surface melting and the possible formation of liquid phases and distribution of products of deoxidation in them.

In this connection, tests have been made on introducing a mixture of ground lime, fluorspar, and aluminum into the runner during deoxidation while steel ingots were being bottom poured. Semi-finished rolled products from the experimental ingots were investigated, and this confirmed that the amount of stable non-metallic inclusions in the steel can be reduced by introducing both coagulators and deoxidizing agents into the runner. **Steel In The USSR, February 1971**

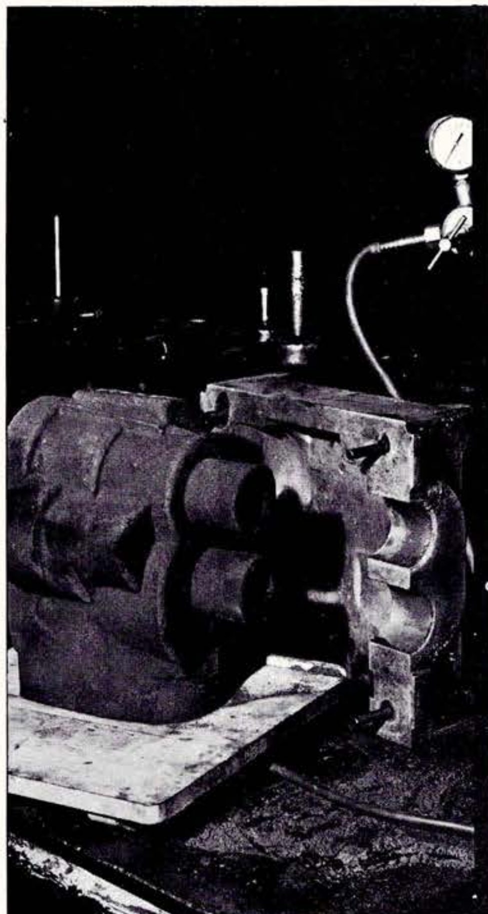
TENDENCY TO HOT CRACK REVEALED IN SIMPLE TEST

A new device, called Tig-a-ma-jig developed by Cabot Corp's Stellite Div., Kokomo, Ind., can now check the comparative susceptibility of sheet alloys to hot cracking during welding by introducing strain into a test specimen independent of welding parameters. In this test, a 6 by 1 inch specimen of desired thickness is placed in the device by mechanically fastening both ends over a die block of known radius of curvature. A stationary gas tungsten-arc weld is made in the center of the specimen. After an almost steady-state thermal conditions are attained, augmented strain is applied suddenly by loading the specimen in bending as a fixed end beam-a movable ram traverses upward to force the mid-portion of the sheet to conform to the die block radius. The radius of die block curvature determines the magnitude of strain introduced to the outer fibers of the specimen.

Hot cracks to be evaluated lie in or intersect the circumferential heat-affected zone immediately surrounding the stationary weld puddle. In checking test results, the length of each crack in or intersecting the heat-affected zone is measured and recorded. Data are then presented as a plot of the total crack length versus the percentage of augmented strain. **Metal Progress, August 1971.**

DESIGN OF COLD FORGING TOOLS

Optimum design of the forming tools is one of the essential factors for the successful development of a cold forging process. Applications of cold forging are limited by the forming properties of the material to be forged which is determined by the mechanical properties required and loading capacity of the tooling which in turn is dependent on the flow stress. The "boron steels" developed in the U.S.A. offer a new possibility for cold forming parts of very high strength from steels with a relatively low flow stress. Despite their low carbon content of 0.15-0.23%, it is possible to heat treat these steels, by adding 0.002% boron and increasing slightly the manganese content, to give tensile strengths of up to 200,000 psi. To further reduce the flow stress of these steels and therefore, the forces required to form them, the silicon content could be reduced to less than 0.05%. Induced by this American experience, a German producer of difficult cold forged part in 16MnCr5 steel (SAE 5120) went over to a special analysis of only about 0.07% silicon with the resulting increase in tool life and machine utilization. It is also well known, however, that the limits for cold forging set by the loading capacity of the tools or by the critical deformation of the material can be considerably widened by preheating the material. **Metal Forming, April 1971.**



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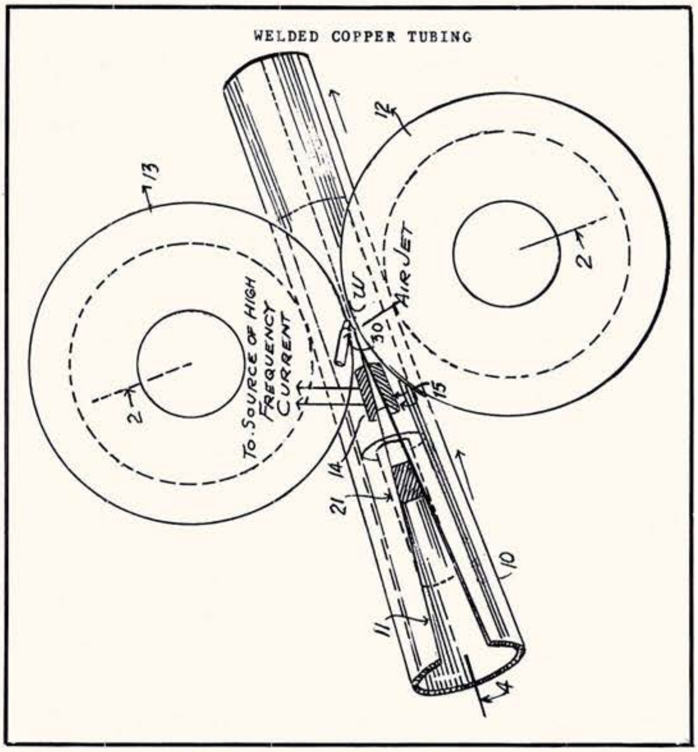


WELDED COPPER TUBING

Robert James Stanton and Wallace Collins Rudd, both of New York, assignors by mesne assignments to American Machine & Foundry Co. of New York, a Corporation of New Jersey, USA
Applications filed on Feb. 12, 1960

This invention relates to welded copper tubing and more particularly to tubing which has been formed by shaping a strip of copper of about 97% purity or higher into tubular form and by welding together the meeting edges of the strip. The tubing is constituted of copper of the type or types variously referred to as tough, tough pitched electrolytic, standard or chile bars, all of which contain not less than about 95% copper (usually over 99%) and having approximately 100% electrical conductivity.

It is claimed that metal tubing formed of copper having an electrical conductivity of approximately 100% and formed with a welded seam, characterized in that the weld is uniform at successive points throughout the effective length of the line of the weld in cross-sections of the welded regions, after etching to reveal grain contrasts, including no discernible fused or cast metal in the weld, the ductility at the zone of the weld and tensile strength across the length of the weld, after annealing of the copper, being as high as the unwelded zones therein, and the line of the weld in cross-sections of the welded region after annealing and etching to reveal grain contrasts being normally substantially unobservable under 30× magnification.

METHOD FOR REPAIRING APPARATUS SUCH AS CHILL MOLDS

Gerhard Hammerle, Eschen Furstentrem, Liechtentein

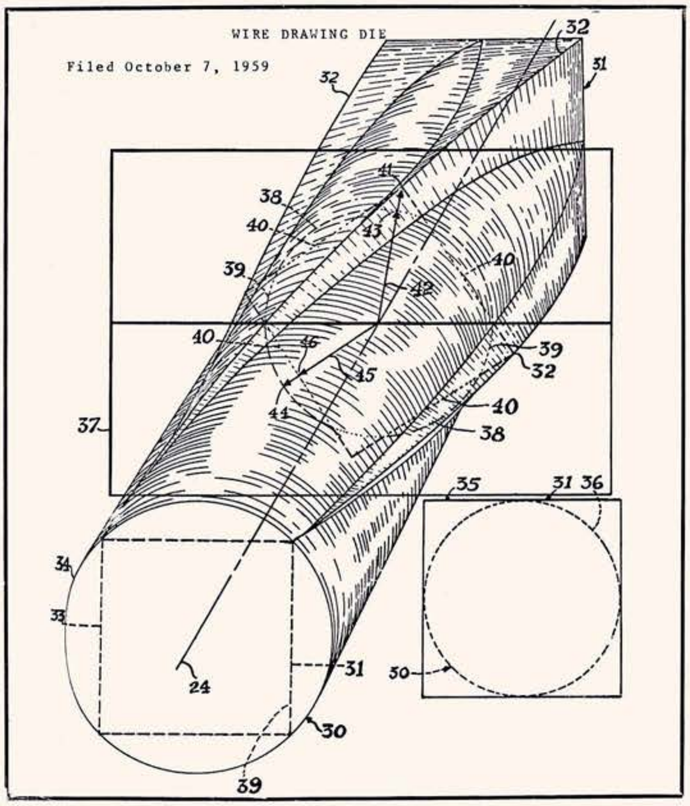
This invention relates in general to a method for repairing an apparatus such as a cast chill mold and to a new and useful method for repairing chill molds wherein a groove is provided along the tear or rupture at the inner wall of the mold, and a plurality of securing elements, such as nails, are driven into the wall and secured within the groove below the surface of the wall and the groove is filled with a welding material; and to an improved repaired chill mold construction.

WIRE DRAWING DIE

Roy Mackenzie Kelday and Frederick Lanceley Hayden, both of Ontario, Canada
Applications filed on Oct. 7, 1959

This invention relates to wire drawing dies adapted for the drawing of wire having a general cross-sectional shape which is non-circular and of which the orientation varies helically along the length of the wire. The new die permits easier drawing of wire and has longer life wherein all dimensional reduction of the wire drawn through it is effected on arcuate surfaces and the portion of the periphery of the wire subject to drawing action is progressively and substantially decreased in each succeeding increment proceeding through the shaping portion of the die passage.

It was claimed that the die has a passage which



extends from the entry face to the exit face along a straight longitudinal axis and which includes a shaping zone of substantial length, said shaping zone being of continuously decreasing cross-sectional area toward its exit and over its entire length and of a cross-sectional shape such that the distance between said axis and any point on the periphery of said zone, when measured along a line in the transverse plane which includes said point and is perpendicular to said axis is the greater of:

a) the distance which would be measured along the same line between said axis and the periphery of a first figure of the same length as said shaping zone and of continuously decreasing circular cross-sectional area over its entire length and constructed so as to be concentric with said axis and to have the entry end of said shaping zone as its base;

b) the distance which would be measured along the same line between said axis and the periphery of a second figure of the same length as said shaping zone end of uniform non-circular cross-sectional shape and substantially uniform cross-sectional area throughout its length and constructed so as to have the entry end of said shaping zone as a base and being helically twisted about said axis with a uniform lead; and

c) said second figure having a maximum radial dimension equal to the radius of said first figure at the exit end of said shaping zone, substantially the minimum cross-sectional area of said passage being at the exit end of said shaping zone, whereby substantially all dimensional reduction of wire drawn through the die is effected on surfaces which are arcuate in planes perpendicular to said longitudinal axis of said passage.

Figure 13 is a schematic view illustrating in principle the formation of the shaping zone of the passage.

MACHINE FOR MOLDING HOT METAL

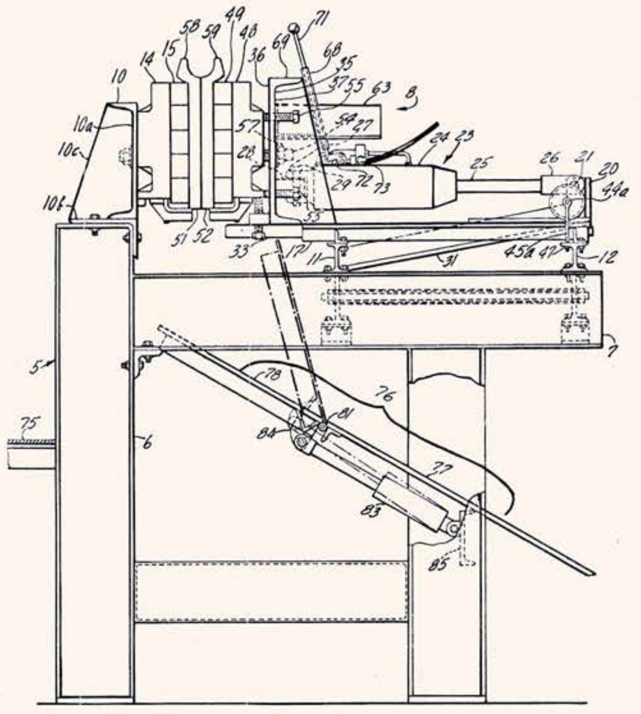
Paul O. Hartman, Scottsdale & Roland B. Peck, Jr. Phoenix, Arizona, assignors, by mesne assignments, to Midland — Rose Corporation, Cleveland, Ohio, Applications filed Sept. 23, 1963

The machine, in its normally intended use, will include permanent mold-halves and one or more disposable cores supported between the mold-halves by urging one mold-half toward the other. Machines of this general type are particularly suitable for casting objects which may be cast in clusters, such as steel balls used in the grinding mills of the ore processing industry.

An important object of the present invention is to provide a molding machine suitable for hot metal casting in which parts of the machine are arranged to fully expose pouring spouts, runners, or other positions of a mold that receives hot metal from a ladle. Incidental to this object is having all portions of the machine, except, the top areas of the mold, concealed or removed from the hot metal pouring region. A further object is to provide a molding machine which may be incorporated in a battery of such machines in side-by-side relationship with the mold portions thereof in end-to-end relationship to align mold and core portions of the entire battery into a single molding unit capable of receiving metal during a single pouring operation.

Figure 1 is a fragmentary longitudinal elevation of the molding machine.

MACHINE FOR MOLDING HOT METAL



This invention claimed a molding machine adapted for receiving hot metal pouring equipment overhead comprising:

a. a base of generally vertically open construction above and below the casting region thereof;

b. mold means, such as a fixed plate and a permanent mold half is fixed, generally upwardly extending relation with the base having a molding face facing in a generally horizontal direction toward the front end of the machine;

c. a horizontal guideway disposed in downward offset relation with said face and its length extending in a frontward direction relative to said face in generally parallel relation to said horizontal direction;

d. a reciprocal mold member in guide relation with said guideway and sharing guide means therewith restricting relative movement to a path lengthwise of the guideway, said guide means including means establishing fixed angular but slidable relation of the member with the guideway, said member having a molding face in opposed relation with said face of the mold means;

e. a support member projecting upwardly from the base in fixed relation therewith adjacent the end of the path further from said mold means being disposed in horizontally opposed relationship in generally cantilever relation with said base;

f. expansible and contractible means disposed between, and connected to said members along an axis above, and generally parallel to, said guideway for traversing the mold member lengthwise of said path; and

g. any portion of said guideway and said guide means extending immediately rearward of said support and rearwardly thereof lengthwise of the guideway being disposed below a level adjacent the lower extremities of said molding faces, said expansible and contractible means being thus disposed above said guideway and guide means portions, and the space above, and coextensive with, such portions being clear of any mechanism for guiding said member relative to said molding means.

MULTIPLE CHILL MOLD DEVICE

Forgny Eric Charles Fransson, Karlshoga, Sweden
Assignor to Aktrebologet Bofors, Bofors, Sweden
Filed May 18, 1967

The invention relates to a multiple chill mold device for simultaneously casting several ingots according to the so-called bottom casting process. The multiple chill molds device in which ingots formed in the molds are made externally accessible for withdrawal from the molds by removing hot taps from the molds. The casting burr are also made externally accessible by removing the upper part of a pouring tube or gate and can be detached as a unit from the device by turning the same upside down and applying a sharp impact to a burn part protruding from the pouring tube.

It is known that knocking of the mold upon completion of each casting operation severely limits the useful life of the molds. It is the object of this invention to provide a multiple chill mold device which does not require the rough handling of the molds of remove the ingots and permits the convenient and rapid removal of all burrs formed in the feed channels or ducts of the device.

What is claimed is a multiple chill mold device for simultaneously casting a plurality of ingots comprising:

(a) a plurality of molds each provided with a cavity having a substantially conical volume with the largest diameter at its upper end and each open at its upper end and close at its lower end by a bottom wall having a feed hole which communicates in flow series with its related cavity therethrough;

(b) a base plate having a center bore therethrough and on which the bottom walls are fixedly secured to arrange the molds circumferentially about the center bore, the base plate further provided with a mold hole for each mold communicating in flow series with the feed hole of that mold, the base plate in its side remote from the molds provided with a stepped opening communicating in flow series with the center bore and one radially extending groove for each mold communicating in flow series between the stepped opening and the feed hole of the mold;

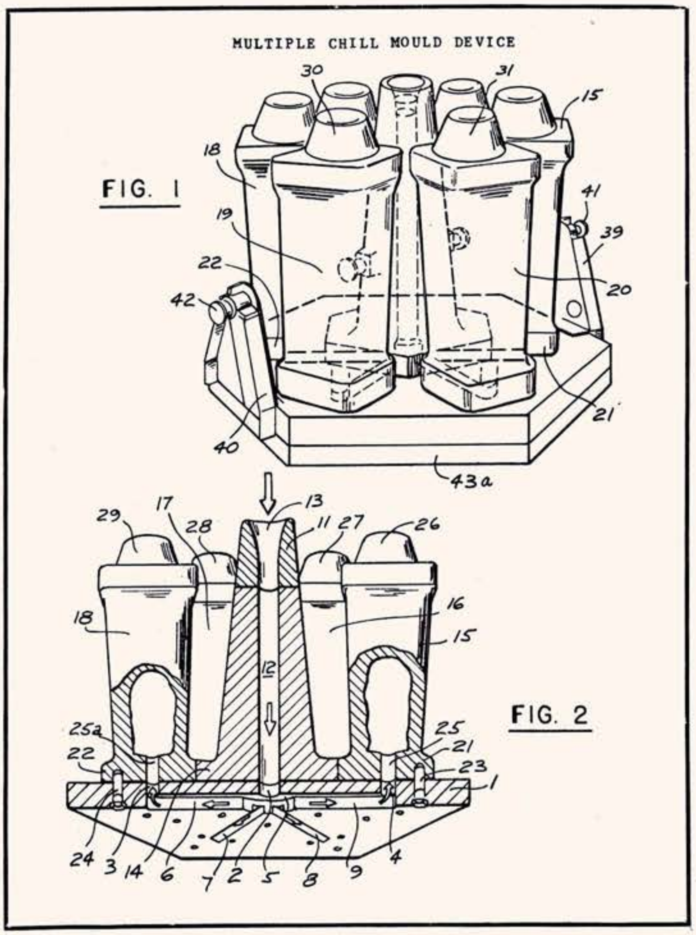
(c) a pouring tube fixedly secured to the base plate on the same side as the molds and axially arranged about the center bore to deliver molten metal thereto;

(d) a top removably placed upon the upper end of each of the molds, each top enclosing a portion of the cavity of its mold whereby the upper part of a hardened ingot can be exposed upon removal of said top so that said ingot can be jerked loose and free from metal in its mold hole;

(e) means for turning the multiple chill mold device upside down as a unit;

(f) the pouring tube, the stepped opening, the radial extending grooves and the feed holes all provided with refractory linings.

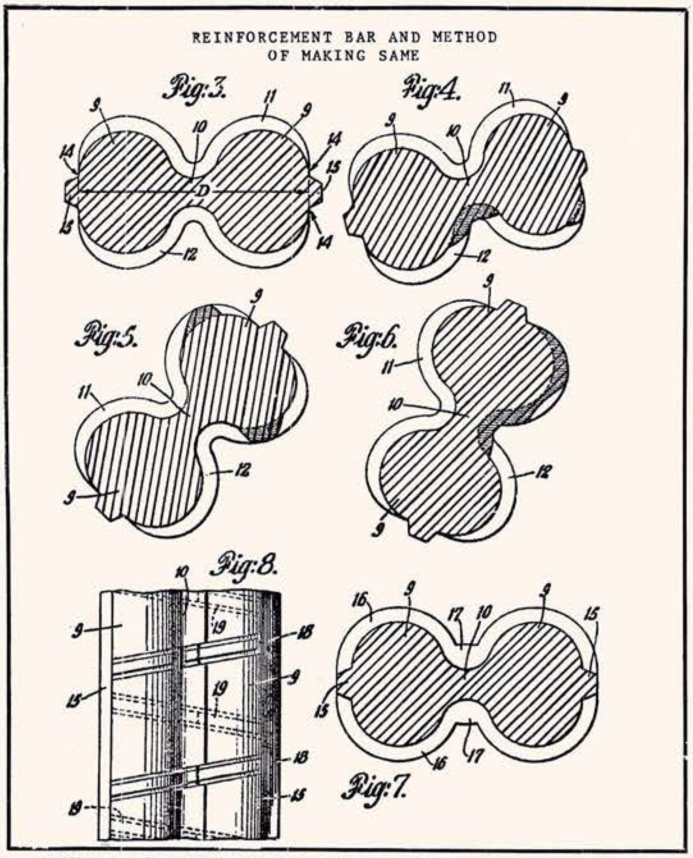
Fig. 1 is an elevational perspective view of an assembled multiple mold device for casting.



ROLLING MILL APPARATUS AND METHODS OF ROLLING METAL

Alexander Ian Wilson, Sheffield England,
Assignor to the Hill Eng'g. Co. Ltd., Sheffield, England

The invention relates to a method of and apparatus for rolling metal wherein the metal is passed to and fro between the rolls of at least one pair of rolls and is gripped alternately by gripping members mounted at opposite sides of the roll pass. The metal is first gripped in a first gripping member mounted for reciprocating movement towards and away from one side of the rolls and is thus entered into the pass by movement of the said gripping member towards the rolls. The metal is then received at the other side of the pass in a second gripping member mounted on that side of the pass for reciprocating movement towards or away from the rolls, the metal moves lengthwise in the direction of rolling relative to the second gripping member until free of the rolls. The metal is thereupon gripped in said second gripping member and is then reentered between the rolls (into the same or another pass) by movement of the second gripping member back towards the rolls and is again received at the first mentioned side of the rolls in the first gripping member.



REINFORCEMENT BAR AND METHOD OF MAKING SAME

Joseph Durbin Stites, Oakland, New Jersey, USA
Assignor to Webrib Steel Corp., New York, USA
Application filed Feb. 28, 1948

The invention relates to reinforcement bars for concrete structures and the like, and to methods of manufacturing such bars to give them improved physical properties. It relates, in particular, to improvements in the type of twisted reinforcement bar. This invention provides an improved form and arrangement of transverse ribs in such twisted bar which will increase the bond value and eliminate, or greatly reduce the manufacturing problems encountered with spiral ribs and other rib forms. This twisted bars possess recognized advantages over other types from the standpoint of tensile and bending strength, as well as bond value. The twisting process was found to give to the transverse ribs a configuration which is peculiarly adapted to increase bond values.

Fig. 3 is a section of the untwisted bar. If desired, the transverse ribs may join the longitudinal ribs in the manner shown in Fig. 7. In Fig. 8, another modification of the invention in which the transverse ribs are given a slight initial pitch in the rolling operation.

This method of manufacturing a reinforcement bar comprises the steps of forming a bar having two parallel rodlike sections joined by an integral web and forming thereon a series of parallel transverse ribs extending across said web and around one side of said rod-like sections, and a second series of parallel transverse ribs extending across said web and around the other side of said rod-like sections, said two series of ribs being arranged in staggered relationship, and thereafter twisting and stretching the bar so formed to produce a helical structure, the parallel ribs being spaced closely together so that, in the helical structure produced by the twisting and stretching operation, all planes normal to the axis of the helius will intersect at least a portion of a transverse rib.

BAND SAW FOR METAL CUTTING

Isamu Amada of Tokyo, Japan
Application field on Aug. 13, 1965

The invention relates to a band saw for cutting off metallic material and has for its object to provide a band saw having a sharp cutting property thus increasing cutting off efficiency and a long durability. This invention provides a band wherein the hardness is different at the working portion and guide portion of a band saw which is achieved by heat treatment and longitudinal or transverse deformation, is suitably provided on the lower portion of the blades by additional machining. Since the edge of the guide portion is not as hard as the working portion, the width of the blade is subjected to quicker abrasion just after the beginning of cutting and the thickness thereof decreases so that the edge of the working portion can penetrate into the workpiece sufficiently for effecting a quicker cutting of the work.

The invention claimed a band saw for metal cutting, comprising a band saw body including a series of teeth along the edge, said band saw body including alternating guide portions and working portions, said guide portions and said working portions each constituting a portion of said band saw body and each including a plurality of said series of teeth, and said working portions are formed harder than said guide portions.

SHEET METAL WORKING MACHINE

Hermann Weil, Bruchasal/Baden, Germany
Assignor to Scharringhausen Maschinenbare Gesellschaft

A sheet metal working machine for cutting and edge trimming of metal sheets and plates comprises the combination of a conventional seesaw shear having shear blades extending in parallel to one another and also having a pressure pad for holding the plates down with means for subsequent cutting-shaping of the plate edges to form V-, double V-, Y-, and U; formed butt joints for welding purposes.

The means consists of a guide way for a carriage, the guide way extending in parallel to the shear blades and being spaced from the shear blades so as not to obstruct the handling of the plates. A slide is supported on the carriage which slide is laterally displaceable thereon, and cutting tubes are mounted on the slide.

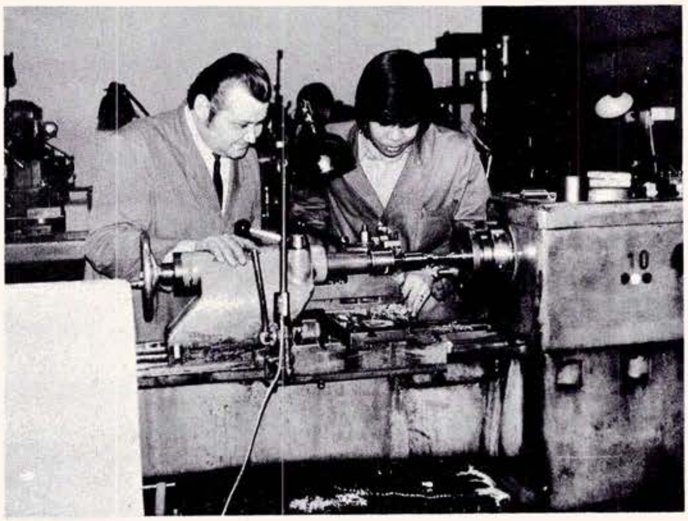
During the cutting process the carriage idles on one side of the metal plate from where it is moved after cutting in parallel to the plate edges to the desired form by driving means.

MIDC corner

news coverage of important MIDC, NSDB, PISI & SEAISI happenings.

MIDC Trainees Abroad

A supervisor in the workshop is shown explaining to Rolando Viloria how to operate a milling machine.



Rolando Viloria is shown operating a lathe machine, machining an eccentric shaft, under the supervision of a German instructor.

Rolando T. Viloria, a junior mechanical engineer of MIDC's Industrial Technology Department is currently undergoing an 18-month training course on Tool and Die-Making and Design Techniques in West Germany. After spending some time in Saarbrucken for the language course, he is now undergoing a familiarization course in machine shop equipment and techniques geared towards tool making at Gewerbeforderungsanstalt, a technical institute in Frankfurt/Main. His training includes layouting of stock material prior to machining operations and actual operation of machine shop equipment such as lathes, milling machines, shapers, planers, drilling and grinding machines.

After this, he will undergo actual in-plant training on tool and die-making techniques including production and heat treatment process, tool and die design and construction, tool and die economics and materials technology and tool and die maintenance and repairing techniques.

The other MIDC trainees in Germany are Marcelo Villanueva, Pedro Maniego and Solito Sandoval. Another MIDC trainee, Antonio Lazo, is now in Japan.

PHILIPPINE FOUNDRY SOCIETY TO PUT UP FOUNDRY RAW MATERIALS COOPERATIVE

The Philippine Foundry Society will put up a cooperative for the bulk buying of foundry raw materials, it was agreed upon in the organization's first official meeting for 1972-73 at the Architectural Center held last April 14.

The Philippine Foundry Society, organized in March 17, 1972, has for its aim the development and promotion of the metal casting industry. On its front-burner, a project it aims to accomplish in the near

Demosthenes D. Dar

Jose D. Girado, Jr.

Toribio J. Jamolin

Emmanuel V. Nolasco

future is that of working "for the technical requirements of the industry's foundry sector by upgrading skilled labor especially in the fields of sand testing, tool and die-making, quality control and inspection, non-destructive testing, and calibration of foundry equipment."

This year's officers of the society are: Ernesto Patenia, Prospero Salvacion, L. S. Valdez, Abraham Averilla, Servillano Lim, Hermes Bautista, Clarito Ilustre and Antonio Abastillas.

MIDC SENDS TECHNICAL PERSONNEL ABROAD

MIDC through the United Nations Industrial Development Organization (UNIDO) is sending the following personnel to train in different technical fields at MIDC Singapore for four months:

1. Demosthenes D. Dar, who finished mechanical technology at the Philippine College of Arts and Trades will be trained on tool and die-making.

2. Jose D. Girado, Jr., a mechanical technology graduate of the Philippine College of Arts and Trades will also train on tool and die-making.

3. Toribio J. Jamolin, who is a holder of a Bachelor of Science in Mechanical Engineering Degree from the University of the Philippines will specialize in metrology, inspection and quality control.

4. Emmanuel V. Nolasco, who used to be with Lepanto Consolidated Mining Co., and is now assistant engineer at the Industrial Technology Department of MIDC, will train on mechanical design in Montreal Canada, after a four-month preliminary training course at MIDC Singapore. Mr. Nolasco is a mechanical engineering graduate from the University of the Philippines.

5. Romualdo Publico, holds a degree in Bachelor of Science in Mechanical Engineering from the Mapua Institute of Technology. He will specialize in tool and die design.

6. Marencho Rivera, a mechanical engineer from Mapua Institute of Technology, will train on mechanical workshop practice. His experiences include, being design engineer for Grace Park Engineering, Inc. and Marsteel Corporation.

7. Jose S. Sason, MIDC molding engineer, is a metallurgical engineer from the University of the Philippines. A participant in the Seventh In-Plant Group Training Programme for Technicians in the Iron and Steel Industry at Zaporozhye, USSR, he will train on foundry techniques.

8. Fernando N. Seriña, an outstanding student at the University of the Philippines where he obtained his degree in Mechanical Engineering will undergo training in cutting tool design and tool-making.

Romualdo Publico

Marencho G. Rivera

Jose S. Sason

Fernando N. Seriña

Solito P. Sandoval

T. Sakurayama

T. Shintani

M. J. Davies

MIDC ENGINEER TO GERMANY

Solito P. Sandoval, MIDC assistant engineer, enplaned for Germany last May 3 on an 18-month fellowship grant from the German Government.

In the concrete, Sandoval's technical training in Germany will revolve around metrology which includes the design, calibration and repair, and production of measuring and inspection tools; metallurgy of measuring and inspection of tool materials; metrology techniques; and dimensional quality control.

Sandoval finished his B.S.M.E. from the University of the Philippines in 1970. He joined MIDC starting as a researcher in February 1, 1971. His experience in metal work include tool and die design and metrology at Ysmael Steel.

INFORMATION SEMINARS CO-SPONSORED WITH FOSECO, ASEA

Two MIDC information seminars with private firms as co-sponsors were held April 7 and 11 from 1:30-4:30 p.m. at the BOI Training Room, 5th Floor, Ortigas Building, Ortigas Avenue, Pasig, Rizal.

The April 7 seminar, accompanied by film showings was co-sponsored by Warner Barnes. Panel discussants were Egon Gladh, UNIDO Foundry Expert; Raul P. Sulit, Assistant Department Head, MIDC Industrial Technology Department; T. Wint, General Manager, Foseco Japan Ltd., Osaka, Japan; T. Shintani, Field Service Manager, Foseco Japan Ltd.; T. Sakurayama, Field Service Manager, also of Foseco Japan; and M. J. Davies, Section Leader, Foseco International Ltd., Birmingham, England. Films shown included: Preparing the Cupola for Charging; Operating the Cupola; Inoculation and Operation CO_2.

The April 11 seminar, on electric-arc and induction furnaces, had the following as panel discussants: UNIDO's Egon Gladh; Jan Uggla, chief metallurgist, Furnace Department, ASEA Sweden; and Marino Matig-a, assistant manager, Industrial Department, ASEA Philippines. Frank Dugal, UNIDO Project Manager for MIDC delivered the opening remarks while Mr. Ake Nilsson gave a brief introduction about ASEA industries. Jan Uggla lectured on the topics "Electric Induction Furnace" and "Presspour Furnace." Films shown were on the ASEA Industry and Presspour Furnace.

Moderator and over-all coordinator for both information seminars was Estefanio M. Gacad, MIDC Training Supervisor.

metals NEWS & RELATED EVENTS

Maria Cristina Chemical Industries, Inc. signed a contract with Engineering Geoscience, Inc. which will provide technical and professional services to MCCI on geological, mining, and metallurgical projects. Shown signing the contract are Ricardo P. Guevara (right), MCCI president; Jose Rolando R. Santos, Engineering Geoscience president. Also shown in the photo is Romano F. Brigoli, Jr. project consultant of MCCI (left).

HOOVEN ALUMINUM, A BOON TO METALS INDUSTRY

Hooven Aluminum is now using the patented Kalkolor anodizing process of KAISER Aluminum and Chemical Corporation of the U.S. The Kalcolor process produces light-fast and abrasion-resistant colors through the conversion of alloying elements within the metal rather than the use of organic dyes. It not only gives aluminum products beauty but also protects the metals from corrosive effects of the atmosphere.

Starting initially with general purpose fabrication tools in 1954, Hooven Aluminum, in 1962, purchased a 1500-ton hydraulic extrusion press with the necessary auxiliary equipment to produce aluminum sections from basic six-inch diameter billets. Its most recent acquisition is a new 3,500-ton LINDEMAN extrusion press, which was installed last year in its Cainta plant in Rizal. It has a mold diameter of nine inches to 13 inches.

Hooven aluminum's industrial applications include: irrigation pipes, bus and truck sections, TV aerial antennas, refrigerator freezer compartments, flourescent bulb casings, and others. Its market penetration has gone beyond the domestic market to foreign marts in Asia, Europe, and Africa.

PHILACOR SEMINARS EMPHASIZE QUALITY IN INDUSTRY

The first of a series of seminars this year focusing on quality was held by PHILACOR, manufacturers of Westinghouse home appliances.

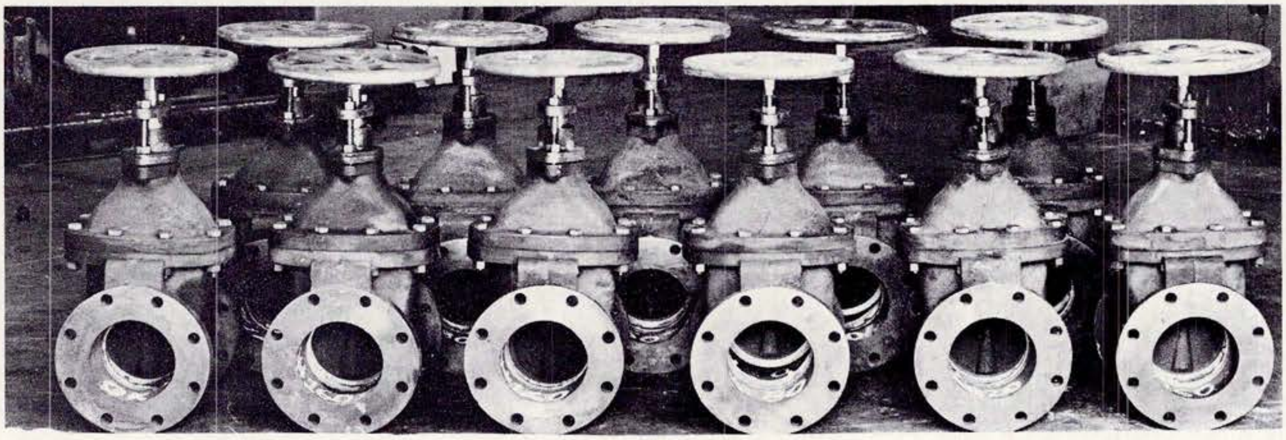
Participated in by PHILACOR management — headed by Dante G. Santos, president — and employees, the first weeklong workshop had "Industry Leadership Through Quality" as theme.

Papers taken up included: "Quality and the Consumer", "Appliance Industry Standards and the Philippine Market", "Product Quality and Engineering", "Quality in Manufacturing", "Plant Engineering and the Manufacturer of Quality Products", and "Product Quality and Field Service".

The opening and plenary sessions started March 4 at the Elk's Club in Makati. The other meetings were conducted at the Manufacturing Conference Room of PHILACOR at its Parañaque plant and offices.

MARSTEEL MANUFACTURES INDUSTRIAL VALVES

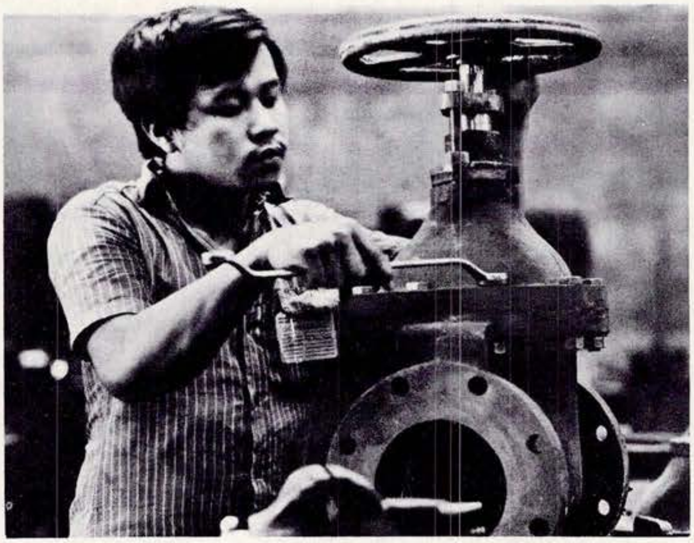
Globe and gate valves — mechanical hardware items used to regulate and control the flow of water, oil, and gases — are now being manufactured by MARSTEEL as the company's project enters its commercial production stage. Trial production has ended with valve prototypes passing quality control tests in the hydrostatic testing facilities of the company.



Gate Valves of 150 psi, cast iron body, bronze mounted, with non-rising stems. The parts are cast by MARSTEEL's Foundry Division, and machined and assembled by the Manufacturing Division.

Consumption of valves have been considerable in the past years and it is expected to increase substantially in the future considering the number of new factories and industrial plants being put up.

Valve production of MARSTEEL is registered with the Board of Investments with a capacity of 550 MT per annum. MARSTEEL valves are available on a wide range of pressure rating from 125 psi and above, on sizes from 2" to 10", cast iron body, bronze mounted and non-rising stems. On the planning stage are similar products such as check valves, air cocks, and valves for gas cylinders.



Six-inch gate valves undergoing final assembly checking.

ELISCO ENGINEERS BACK FROM RUSSIA

Messrs. Panfilo M. Tejada and Renato Sta. Ana Bartolome of Elizalde Iron and Steel Corporation (ELISCO) have just arrived from Russia after attending the Seventh In-Plant Group Training Program for Technicians in the Iron and Steel Industry for six months at Zaporozhye, Ukraine including observation tours of major cities of USSR.

Recently promoted to the managership of the Planning and Control Division of ELISCO, Mr. Tejada is one of the pioneers of the company's electrolytic line. In 1968, he underwent training on the operations of cold rolling mills at the Tobata Plant of the Yawata Iron and Steel Corporation of Japan.

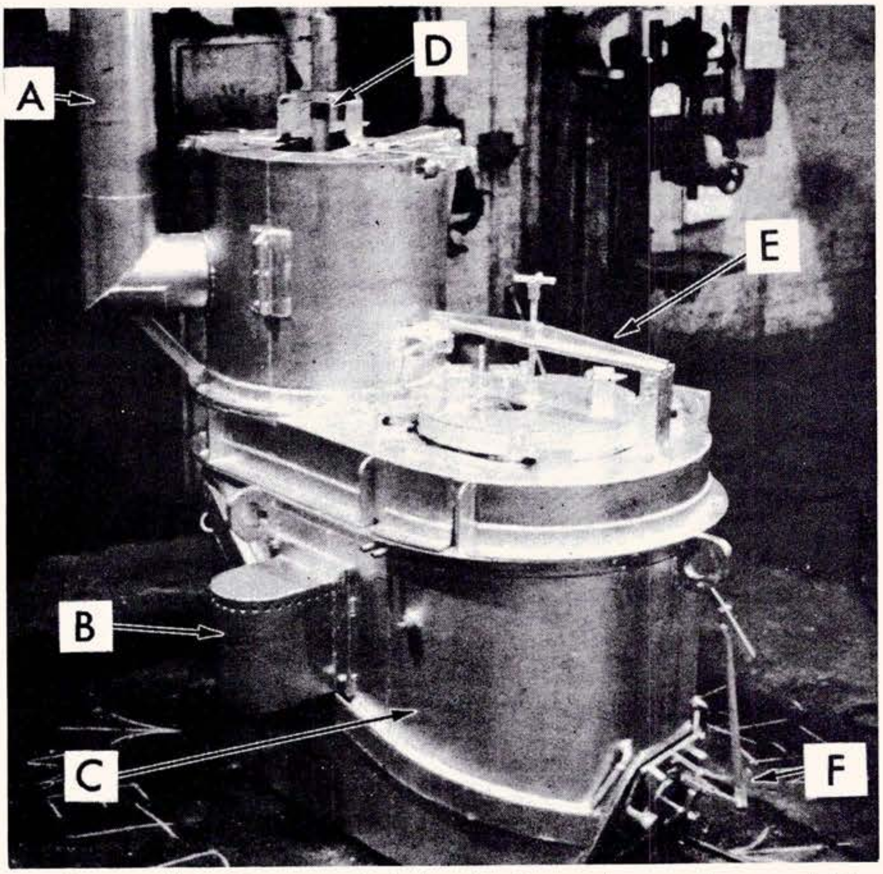
At Zaporozhye, he underwent training on the rolling of slab, small and big sections including angular steel bars as well as hot and cold rolling. At Krivoi Rog, he observed steel ball production, at Donetsk, continuous steel casting techniques and at Zdanov, iron mining to iron ore beneficiation.

Mr. Bartolome, Manager of the Maintenance and Services Division, is an electrical engineer from the Mapua Institute of technology. In the USSR, he observed electrical maintenance techniques in cold rolling mill operations. Prior to this, he underwent electrical construction training at the Tobata Plant of the Yawata Iron and Steel Corporation of Japan.

Renato S. Bartolome

Panfilo M. Tejada

Foreign news



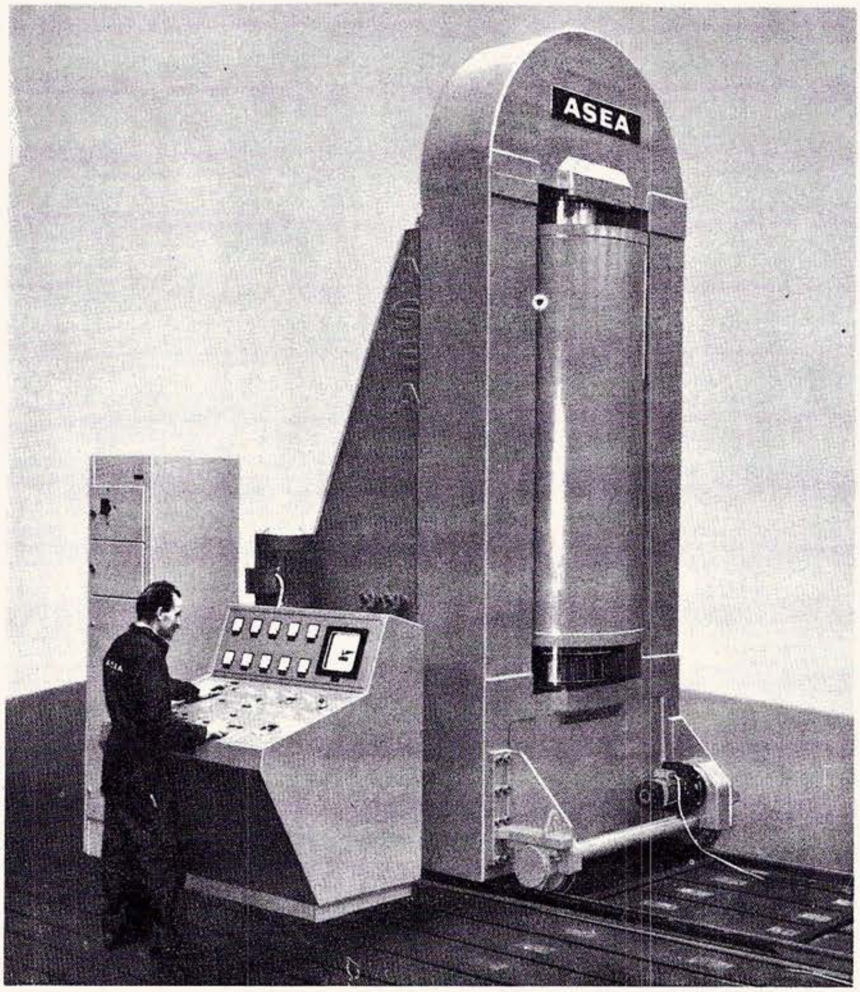
Key elements of the filter system include: a) a furnace burner exhaust stack, b) a protective cover of the ultra-violet flame safety device, c) furnace shell, d) metal flow control valve, e) filter cartridge hold-down assembly, and f) drain-out mechanism.

NEW ALUMINUM INGOT CLEANING PROCESS

A rigid media filter system for removing impurities from aluminum ingot was developed by Kaiser Aluminum and Chemical Corp. The process, which controls non-metallic inclusion in aluminum, is used where extremely high quality metal is required for critical production applications. The principal components of the system are ceramic tubes which are assembled to form a disposable cartridge that is the filter medium. The rigid media filter cartridge is made with an aluminum oxide grain that is bonded with low silica glass. The filter has the ability to selectively remove inclusions in sizes ranging from 0.005 to 0.012 inch. The filter cartridges used in the system can process up to 90,000 pounds of aluminum charges, the throughput depending upon the flow rate in the system. Aluminum filtered through the rigid media filter is used for high quality, premium products, such as aircraft plate, extrusions and forgings, automotive trim stock, and computer memory discs.

NEW ELECTRODE FOR CONDUCTIVITY MEASUREMENTS OF MINERAL SUSPENSION

The conductivity of a solution is often used industrially to control the salt concentrations of reacting systems. The electrodes used are normally made of glass, fitted with platenized platinum electrodes. During leaching, there is a build-up of soluble and/or insoluble salts which often leads to deposition of solids on the platinum electrode and on the glass, causing erratic measurements of the conductivity. To overcome these difficulties, a new electrode was designed. The assembly consists of an electrode casing, two measuring tubes and an electrode stem. The measuring tubes and



QUINTUS equipment for cold isostatic compaction.

the electrode stem are screwed to the electrode casing which in turn has two separate chambers containing an electrolyte, for example HCL, H_2SO_4, HNO_3 or any salt solution conducting electricity. One significant advantage of the new electrode design is that the range of conductivity measurement can be adjusted by changing the concentration of the electrolyte in the electrode. The principle applied in this design is also suitable for the design of indicators for automatic control of the levels of mineral suspensions.

MEASUREMENT OF OXYGEN ACTIVITY

ASEA, a Swedish company, has developed the first commercial system for the simultaneous measuremnt of the oxygen activity and temperature of liquid steel. The equipment, called "OXYPAC", comprises a lance fitted with a probe at one end to be inserted into the steel bath, and a separate electronic unit. Sensing elements in the probe are an electrochemical cell and thermocouple. The electronic unit of the equipment converts the electromotive force from the thermocouple of the probe in the steel bath into oxygen activity and temperature. The valves are plotted on a recorder which make possible the adjustment of the various process variables and additions. When being used, the probe itself is destroyed in the steel melt at a temperature of about 1700°C in a matter of 15 seconds.

DEVELOPMENT OF RIVETING PROCESS

A new riveting process, called electromagnetic riveting (EMR), has been developed by the Boeing Co. which is hoped to revolutionize the fastening industry. The new process can form a rivet in 1/2000th of a second and it has been found to cut both costs and rejections, increase production output substantially and reduce factory noise by a large margin. The reveting system consists of two guns, one used on each side of the work piece drawing on electromagnetic energy to form a rivet with a single impact. Each gun contains an electrical coil which transmits energy to a riveting ram, driving it forward with up to 30,000 pounds of force. One brief impact does the job, forming a shape at each end of a straight, headless rivet. One big advantage of the process over machine riveting installations is that it can reach places where the big riveters cannot. EMR installations are being used on wing panels that cannot be riveted on the million-dollar, automatic riveters.

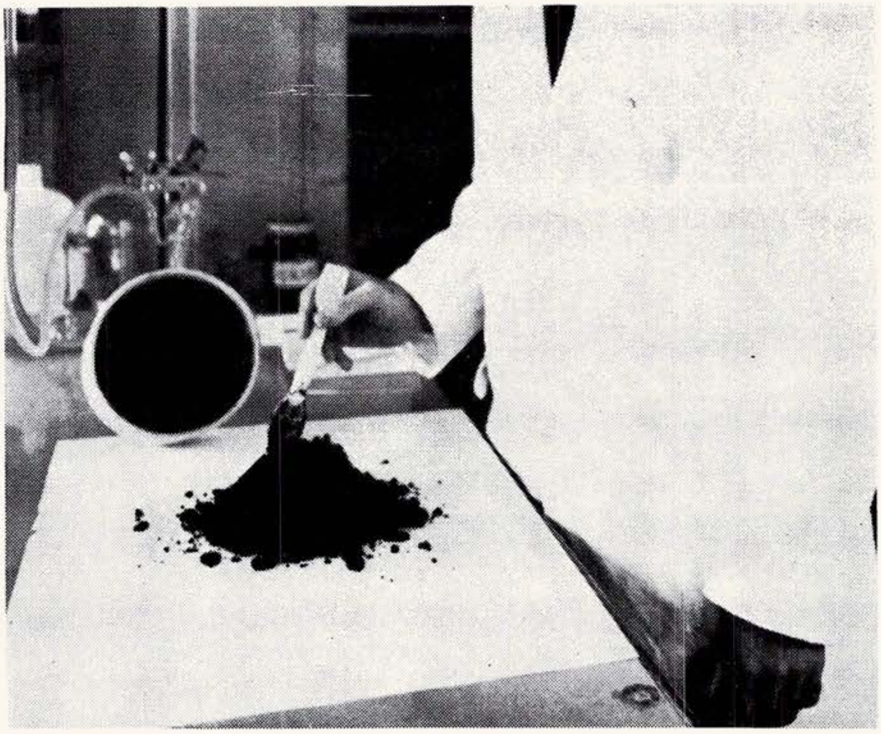
EXTRA STRONG, EXTRA SOFT GRADES OF 1010 AVAILABLE

ARMCO Steel Corp. has come out with two alternatives for AISI 1010; one is stronger and one is softer. Gainux, the stronger grade has yield strengths of 50,000 psi (20,000 psi higher than that of 1010) and 45,000 psi. It can be further strengthened by forming and aging at up to 450°F for 45 min. In switches from 1010, equal strength with a thinner gage or higher strength without charging gage can be obtained. Gages run from 0.0740 to 0.150 inch with standard sheet lengths and coils up to 72 inch wide.

The Super Soft grade has a yield strength of 12,000 psi; a tensile strength of 35,000 psi; an elongation of 40%; and a hardness of Rb O-10. Its softness makes it attractive in energy absorbing applications, such as parts for passenger compartments in autos. It also forms almost as easily as soft copper, replacing copper and lead in such applications as gaskets. This material has large grains (larger than ASTM 1)which give it a spangled effect particularly when it is pickled.

PHYSICAL CHEMISTRY OF ONE-STEP COPPER PRODUCTION FROM A CHALCOPYRITE CONCENTRATE

The traditional methods of processing sulphide copper concentrates to blister copper consist of three steps, namely: roasting, smelting and converting. Interest is now being shown in the possibility of compressing these stages into a single process in which case the physical chemistry underlying these processes, must be examined. An example of such attempts is the one-stage operations of El Teniente in Chile where a favourable factor is the very high grade of concentrate (95% chalcopyrite on dry solids) and where an all-in-converter operations has been installed. A problem to be overcome is that combined roasting and smelting requires precise control of the oxygen potential at all points for a suitable degree of sulfur removal without high local oxygen contents, which produce magnetite. From the analysis of the process, it appears that (a) on thermal grounds the process is possible with a dry, high-grade chalcopyrite concentrate, if oxygen enrichment to about 30% is used, and (b) that copper losses in the slag will be serious and will require a secondary recovery operation.



The nickel-loaded brown coal ready for burning.

AUSTRALIAN BREAKTHROUGH IN METALS EXTRACTION

Australian research scientists at the University of Melbourne's Institute of Materials Research have discovered two methods of extracting metals from or using brown coal. The discoveries could lead to extensive new market for brown coal. In the first method powdered brown coal was added to ammoniacal solutions of the metals and after a few minutes the metals were absorbed onto the surfaces of the porous coal. Metals such as nickel, lead and copper can be recovered by burning away the coal. The more volatile metals such as zinc or cadmium can be recovered by heating the impregnated coal to vaporize the metals and then cooling the vapor to the solid form. After contact with the different metal solutions, the brown coal contained up to 15% of its own weight in copper or nickel, 36% in silver, and 46% in lead with zinc and cadmium also extracted equally well.

In the second extraction process, gold was recovered from solutions by modifying the process of cementation. Instead of adding zinc powder, brown coal char carrying previously absorbed zinc or copper was added to gold solutions. The zinc and copper dissolved while the gold is deposited onto the char. The char was then burnt to recover the gold. Up to 100% of the gold in a solution can be deposited in a few minutes and the char containing about 25% gold is obtained.

DESULPHURIZING OF STEEL BY THE BOFORS METHOD

AB Bofors have developed a method for rapid and effective desulphurization in the ASEA-AKF ladlefurnace. In this methd, the ladle furnace is provided with electrodes for arc heating and with a stirrer coil. With arc heating, the highly basic slag can be held in the molten state, while stirring brings about not only the essential intimate contact between the desulphurizing slag and the steel bath but also increases the rate of separation for sulphide inclusions. In desulphurization trials carried out in a 50-ton ASEA-SKF plant at Bofor where Misch metal (contains about 50% cerium and other rare earths) was used as desulphurizing agent and lime as the main slag former, extreme desulphurization can be carried out resulting in a sulphur content of less than 0.001 per cent for carbon steels and less than 0.003 per cent for chromium steels. In addition, a good desulphurization is achieved without the addition of Misch metal as a result of the low oxygen content in the steel and high slag basicity. Compared to other degassing processes without the possibility of heating, this process allows the transfer of the oxygen refining and alloying, without limitations concerning temperature losses, from the melting to the ladle furnace.

NEW HARDENABILITY TEST FOR HIGH-SPEED STEELS

With Jominy (end quench) test bars, modified to cool more slowly, it was possible to determine the cooling rates necessary to suppress the high temperature reaction occurring in high-speed steel during cooling between 2000 and 1500°F. After selecting M7 as the test material, a slightly longer Jominy bar was designed, then surrounded with a heavy steel shield. Bar and shield were heated in a salt bath and end-quenched to room temperature, quenching the end of the bar only, not the shield. Cooling rates varied such that differences in tempered hardnesses could be observed along the length of the bar. To correlate these differences, cooling rates were determined in the bar. The test shows that the reaction precipitates MoC and Mo_2C, lowering the tempered hardness of the steels significantly. The data obtained indicate that the high temperature reaction and its attendant lowering of tempered hardness may be avoided if (1) the cooling rate between 1800 and 1700°F exceeds 20°F per second, or (2) the time to cool from 2000 to 1500°F is 30 seconds or less. To heat treaters, the most practiced method will be to cool from hardening temperature to 1500°F in 30 seconds or less.

IMPROVEMENT OF BELL-TYPE ANNEALING FURNACES FOR THE BRIGHT ANNEALING OF COILS

At the Cherepovets metallurgical works single-stage gas bell furnaces of the Stal proekt design are used for the annealing of coils of cold-rolled low-carbon steel. The 2100 mm. diameter coils are placed in single piles on the stage at a height of 4700 mm. The thermal stresses in the precombustion chambers of the burners and the temperatures (up to 1600°C) were extremely high, and this resulted in a low service life for the burners (3-4 months) and deformation of the lower part of the muffle. It was established that the location of the fume-exhaust fans adjacent to the burners and the absence of gas circulation in the working zone reduced the efficient use of heat in the furnace; over-heating of the outer parts of the lower coils was observed, forcing the works to redevelop certain design features of the furnace.

The new air-injection type burners were installed with a supply of natural gas under pressure which ensures the inflow of a large quantity of atmospheric air (over 60% of the theoretical requirement). The burners are fixed tangentially in two rows (eight in the lower and four in the upper). The reconstruction was found to make the heating more uniform and improve all indices.

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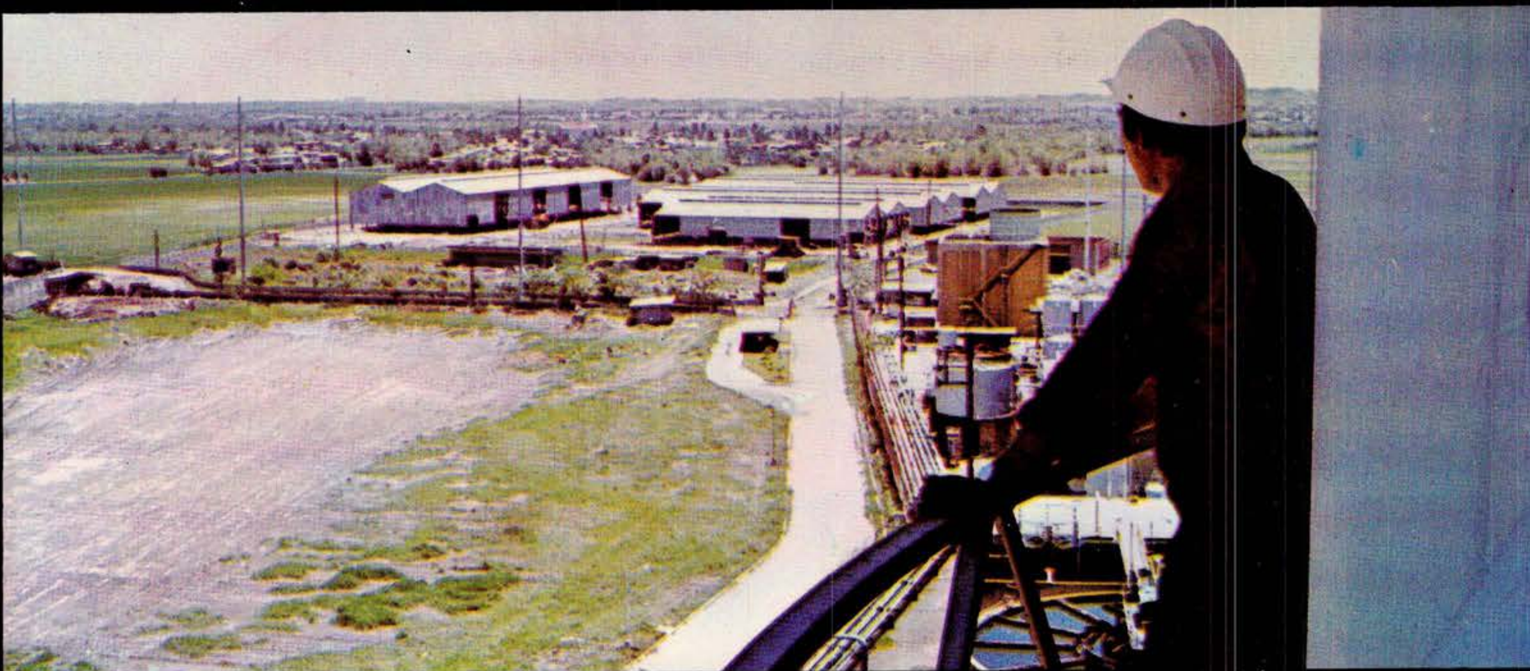

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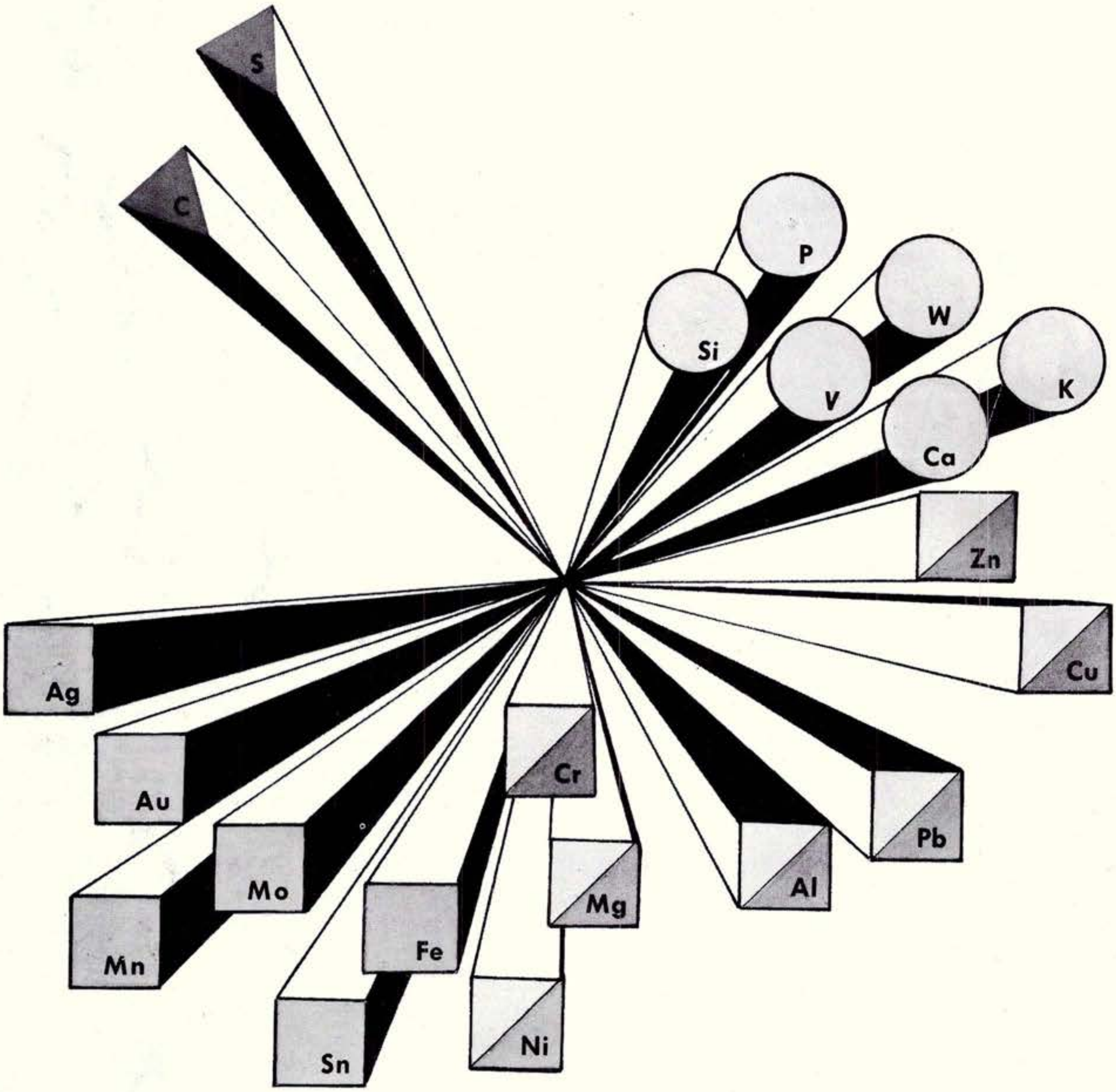

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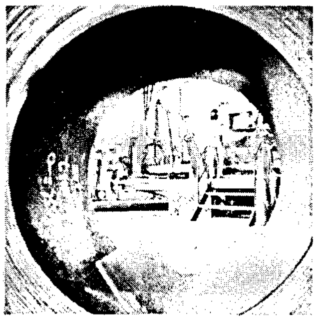

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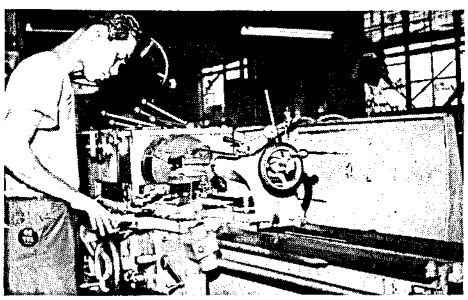

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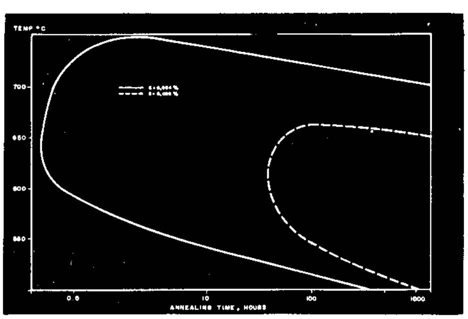

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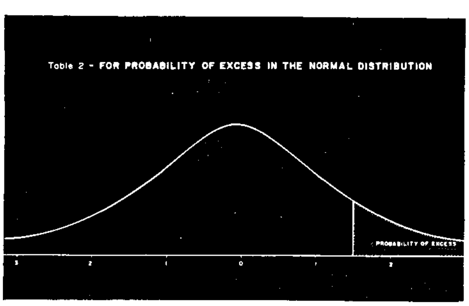

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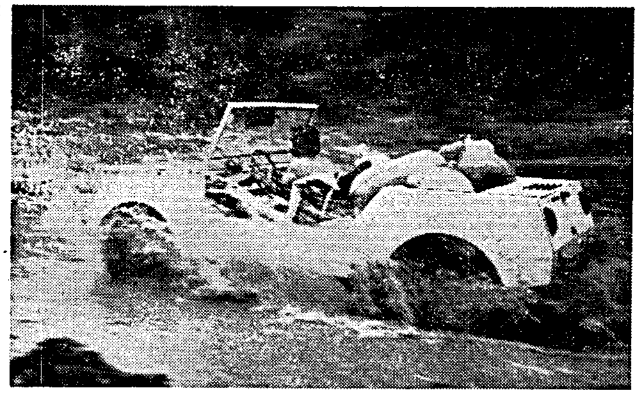

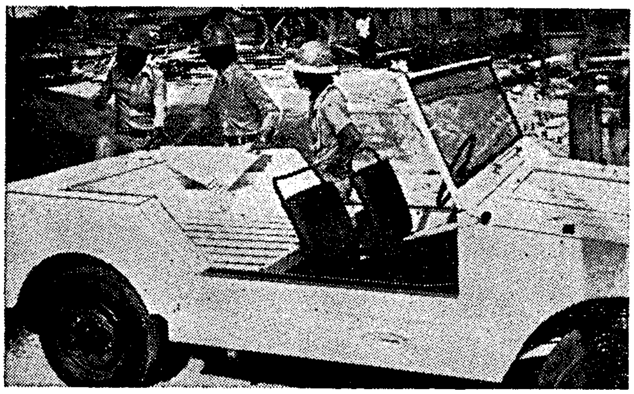

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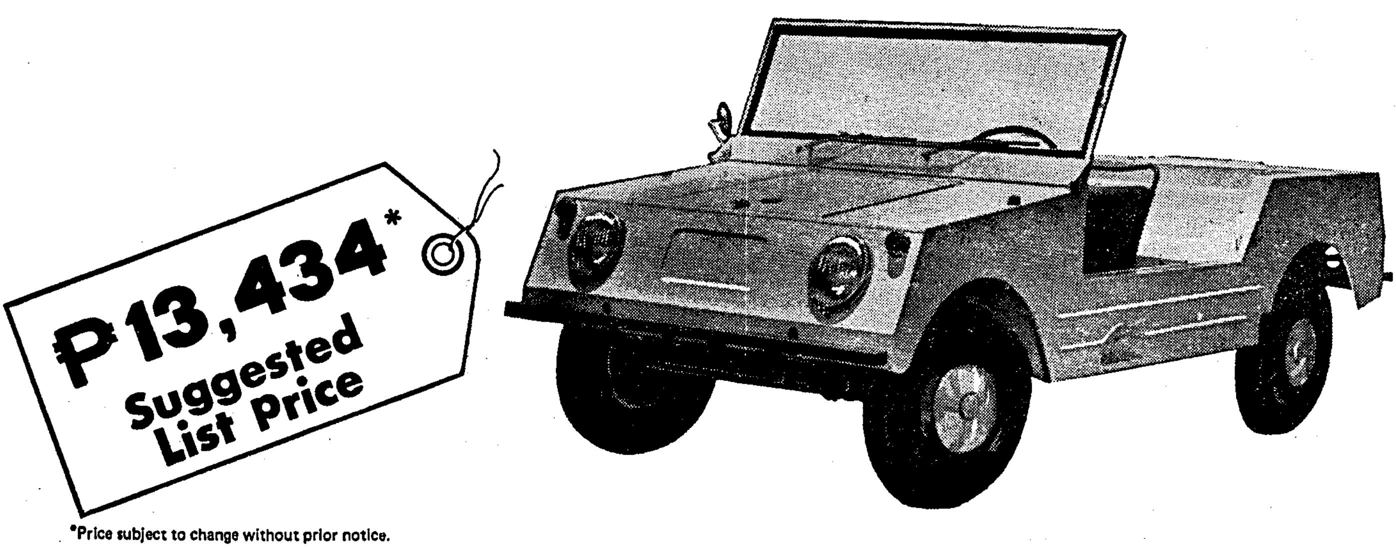

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MIRDC WIELDS STRONG ROLE IN REHABILITATION EFFORT

In the wake of the most disastrous floods of memory, all hands have to pitch in to assist the victims, to replant in the face of a food crisis and to rebuild knocked down industrial establishments so that they could be productive again.

For its part, the Government is considering deferment of the implementation of capital-intensive projects to concentrate primarily on the rehabilitation of damaged industries and maximize the utilization of existing plants to increase production with a minimum of additional financing.

Production would thereby move to high gear within a short period of time while the work of rehabilitating the damage continues. The task of rebuilding over, the government can again continue its thrust on new capital-intensive projects as originally planned before the catastrophe came.

With this emergency policy on industrial rehabilitation laid down by the government, the emphasis of the Metals Industry Research and Development Center on training and technological upgrading to assist the secondary metals industry should fit in very well. MIRDC's role also ties in appropriately with the results of a recent study made by the firms who prepared proposals for participation in the Progressive Car Manufacturing Program. These firms have assessed that at least $100,000,000 worth of unutilized equipment in the metal forming industry could be mobilized for the manufacture of components of cars, other transport vehicles and equipment in general.

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LOW SHAFT FURNACE SMELTING OF FERRUGINOUS MATERIALS

CONCLUSION

by ESTEFANIO M. GACAD

D. CHARGING PRACTICE – TYPE OF CHARGE

Due to the short stack height of low-shaft furnaces and short residence time of the charge in the stack, the iron ore, sinter or pellets to be used must have high reducibility characteristics. Magnetite is not a good material for the low-shaft furnace because of its poor reduction characteristics.

The charging method used depends upon the permeability of the burden stock and on the type of gas distribution desired. Low-shaft furnaces are charged either by bed (layer charging) or by batch (mixed charging) except the Koln-Kalk low-shaft furnace in which composite briquettes were charged.

Layer or bed charging is done by putting alternate skiploads of fuel and ore plus flux in required proportions in the furnace. In mixed charging the required proportions of fuel ore and flux are placed in one skip and dumped in the furnace.

Aside from the charging method used, the shapes of the furnace and its charging mechanism influences the charge distribution in its stack and also the charge stock permeability to a certain extent.

E. CASTING PRACTICE

The casting practice and facilities of low-shaft furnaces is similar to that of a blast furnace. The tapping frequency is determined primarily by the effective capacity of the hearth which is a function of coke granulometry (and shape of coke in the case of briquettes) as previously stated. When the hot metal in the hearth has reached its maximum safe level slightly below the slag tuyere, the furnace is tapped. A secondary factor which determines tapping frequency is the production rate. The higher the production rate, the more frequent is the tapping. The number of slag flushings between tappings depends also on the effective hearth capacity and the slag yield (quantity of slag per ton of pig iron). The lower the iron content of the charge the higher is the slag yield. If the slag yield is high, more slag flushings between tappings are required.

III. PHYSICO-CHEMICAL AND METALLURGICAL PROCESSES IN LOW-SHAFT FURNACES AS COMPARED TO BLAST FURNACES

A. CHARGE AND GAS RETENTION TIME

The retention times of the charge and gas in the low-shaft furnace, on the average, are 1/3 and 1/2 respectively, relative to the retention times in blast furnaces when both furnaces are operating at normal driving rates. Although the charge granulometry in the low-shaft furnace is smaller than that in the blast furnace, the gas retention time is short relative to the rate of gas-solid reaction so that the optimum conditions for reaction kinetics are not satisfied. Thus the reduction potential of the reducing gas is not efficiently utilized. This is evident from the relatively high carbon monoxide (CO) content of the top gas (24 to 51 per cent) of low-shaft furnaces operating under normal pressure with no enrichment of the blast as compared to those of blast furnace top gas (18 to 30 per cent CO) and consequently the higher coke consumption per ton of molten metal of low-shaft furnaces compared to blast furnaces.

Effect of Pressure – Under normal operating conditions, the average pressure in the blast furnace is about three (3) times that in the low-shaft furnace. Consequently, the relative rate of overall reduction of iron oxides is faster in the blast furnace since overall reduction is favored in the direction of higher pressure.

Operation of the low-shaft furnace under high pressure results in the decrease of effective gas velocity (at constant blowing rate) hence there is longer gas residence time in the charge stock, and faster rate of reduction bringing about more efficient utilization of the reduction potential of the reducing gases. These are evident from the lower coke rate and CO content of the top gas and also the presence of the chemical reserve zone. The operating characteristics of the low-shaft furnace under this condition is therefore similar to those of the blast furnace. These are further discussed below.

B. HEAT EXCHANGE AND TEMPERATURE DISTRIBUTION

When the granulometry of the charge in the low-shaft furnace is adapted to the height of the charge stock or shaft, the heat exchange processes and vertical temperature profile are similar to those in blast furnaces (whether the low-shaft furnace is operating under normal or high pressure), provided both are operating at normal driving rates.

There are two zones of active heat exchange between the hot ascending gases and cold descending charge called the upper and lower heat exchange zones, respectively, which are separated by a middle zone, called thermal reserve zone, marked by inactivity from the point of view of heat exchange. It is further characterized by a temperature difference of 20 to 50 degrees Centigrade between the gas and the charge. The temperature at this zone varies from 750 to 1100°C and is a function of the coke reactivity and burden reducibility. (15) The existence of this zone attests to the very high efficiency of blast and low-shaft furnaces as heat exchangers. Its presence has been verified by probes in the shaft of blast furnaces and in the Ougree low-shaft furnace.

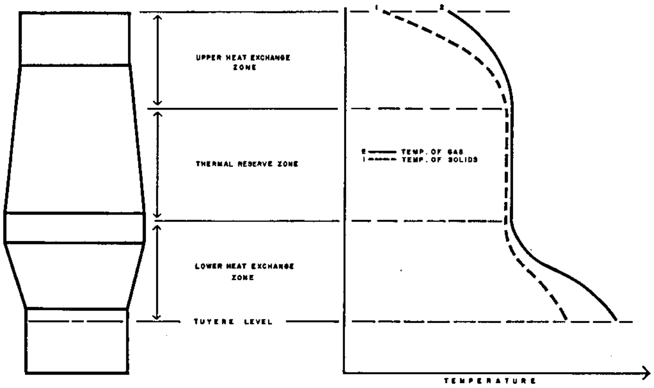

Figure 8

HEAT EXCHANGE ZONES AND SCHEMATIC TEMPERATURE PROFILES IN BLAST AND LOW-SHAFT FURNACES.

In all these zones the temperature of the gasphase is always higher than that of the condensed phases (solids and liquids). Comparing the heat capacities of the gases and charge in the different zones, the heat capacity of the gas phase is higher in the upper heat exchange zone, almost equal in the thermal reserve zone lower in the lower heat exchange zone than that of the charge. The general form of the temperature and heat exchange zones are shown in Figure 8. The positions of these zones and temperature profile are not fixed but vary from time to time depending on burden characteristics and gas flow through the burden.

Effect of Some Variables on Heat Exchange – At increased blowing rates the thermal reserve zone decreases while the lower heat exchange zone increases. The temperature of the top gas also increases. At constant blowing rate, the effect of oxygen enrichment of the blast is to decrease the lower heat exchange zone, increase the thermal reserve zone and decrease the top gas temperature. Similar results are obtained when the temperature of the blast is increased while opposite results are obtained with fuel oil or steam injections in the tuyeres. To maintain a stable thermal regime in the furnace, the practice is always to combine variables with compensating effects such as either increase in blast temperature or oxygen enrichment of the blast with oil or steam injection.

C. CHEMICAL EXCHANGE

The basic chemical process in the shaft of blast furnaces and low-shaft furnaces is the exchange of oxygen between the burden and reducing gases which are formed principally by the reaction of carbon in the coke with oxygen and moisture of the hot blast. The chemical or oxygen exchange in the blast furnace and in the low-shaft furnace when under high pressure, is graphically represented in Figure 9. As in

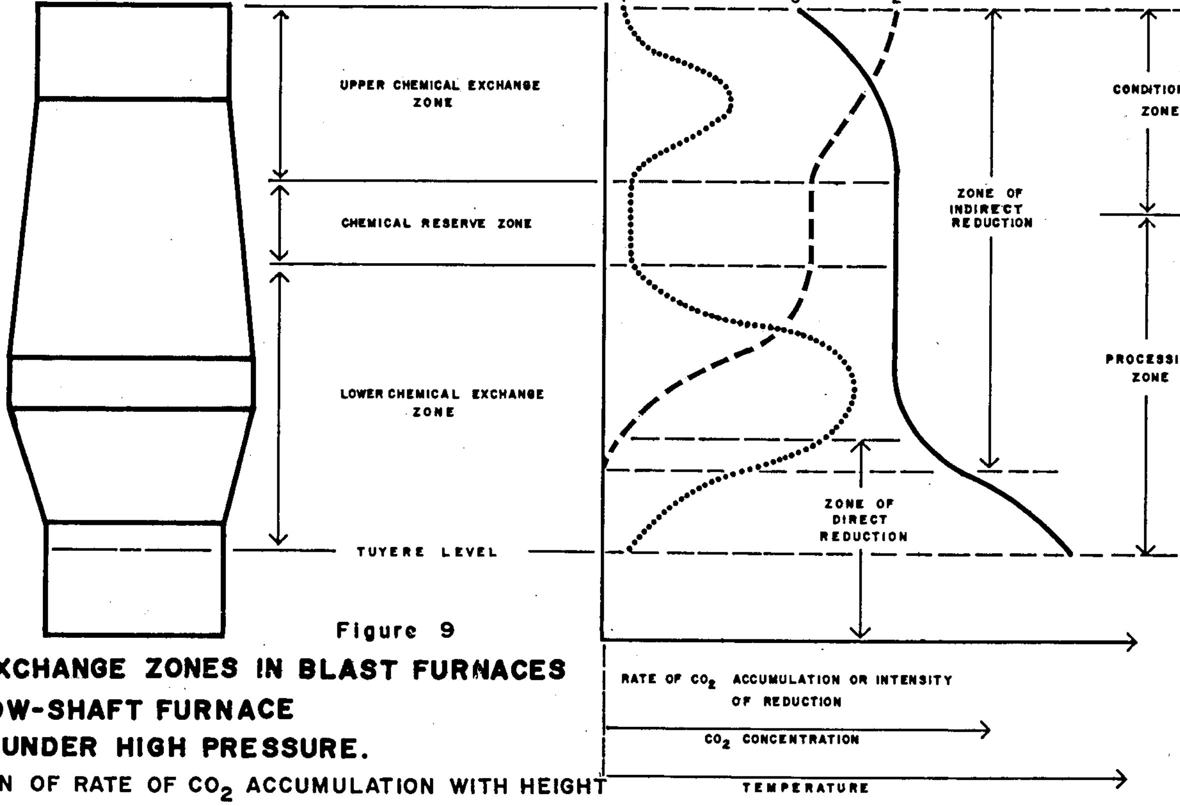

Figure 9

CHEMICAL EXCHANGE ZONES IN BLAST FURNACES AND IN A LOW-SHAFT FURNACE OPERATING UNDER HIGH PRESSURE.

1 – VARIATION OF RATE OF CO_2 ACCUMULATION WITH HEIGHT
2 – VARIATION OF CO_2 CONCENTRATION WITH HEIGHT
3 – TEMPERATURE OF THE GAS

heat exchange there are also two zones of active chemical exchange which are separated by a chemically-inactive zone known as the chemical reserve zone. This zone lies within the thermal reserve zone.[16] The presence and extent of this zone depends upon the reducibility of the burden and blowing rate.

The chemical reserve zone is sometimes called the idle zone and its existence in blast furnaces has been cited as a valid reason for the use of low-shaft furnaces. This zone corresponds to a state of pseudo-equilibrium between wustite (Fex0) and gas. Its presence in a blast furnace (and high pressure low-shaft furnace) is an indication of very efficient oxygen exchange or maximum utilization of reducing gas potential. It also indicates a "reserve" of productive capacity. This means that production can be increased, without increasing the coke rate, by increasing the blowing rate until the chemical reserve zone has disappeared beyond which any further increase in blowing rate will result in increased coke rate. Most low-shaft furnaces, however, are operating under normal pressure without a chemical reserve zone.

Zone of Direct and Indirect Reduction – The chemical reserve zone conceptually divides the furnace into the upper "conditioning" zone, where the burden is preheated and reduced to wustite by indirect reduction, and the lower "processing" or smelting zone. In this lower zone, wustite is reduced to iron by indirect and direct method, silicon, phosphorous, etc. are reduced by direct method and carbon is burned at the tuyeres. The heat balance of this zone determines the coke rate of the whole furnace. The quantities of gases and heat from the processing zone which goes to the conditioning zone are more than sufficient for the heat and chemical exchange requirements of this (conditioning) zone.

As shown in Figure 9, the upper chemical exchange zones, chemical reserve zone and part of the lower chemical exchange zones are zones of indirect reduction. The rest of the lower chemical exchange zone and the hearth are zones of direct reduction. For a particular operation and assuming uniform distribution of the gas throughout the charge stock, the minimum coke rate is attained when a well-defined chemical reserve zone is present in use the same type furnace stack. This condition corresponds to an optimum proportion of indirect and direct reduction zones.

Effect of Some Variables on Chemical Exchange – From the point of coke rate, any change in operating variable which increases the zone of direct reduction and correspondingly decreases the zone of indirect reduction will result in an increased coke rate. These variables are: 1) blowing rate; 2) distribution of gas flow through the charge stock; 3) pressure; 4) reducibility of the burden; and 5) temperature profile of the furnace. The specific effects of these variables, individually or in combination, on coke rate and furnace performance were thoroughly discussed in the paper of Rist and Meysson.[17]

The operation of most low-shaft furnaces under normal pressure, as stated above, is characterized by the absence of a chemical reserve zone so that the proportion of direct reduction zone is greater. The results of this are: 1) inefficient utilization of the reduction potential of the gas as manifested by the high CO content of the top gas; 2) high coke rate; 3) high FeO content (or oxygen potential) of the slag with a very low desulfurization potential which, if not properly controlled, could result in poor metal quality.

When the proportion of direct reduction zone is greater, most of the reduction is shifted to the lower chemical exchange and hearth zones. Under this condition, reduction takes place mostly by direct processes so that the burden is not sufficiently reduced upon reaching the heart. This is due to the fact that direct reduction processes are mainly liquid-solid reactions with very slow reaction rates in contrast to the fast reaction rates of the gas-solid indirect reduction reactions. These account for the high FeO content of the slag.

With irregular charge descent, this condition is compounded because the insufficiently reduced and relatively cold material that falls in the hearth further increase the FeO content of the slag and also increases the risks of blockade and chilling of the hearth. It is a common observation in low-shaft furnace operation that after a serious slip of the charge stock, the effective hearth capacity is decreased, the slag has very high FeO content and the pig iron is relatively cold with high sulfur and low silicon contents.

The operating results of the Ougree low-shaft furnace under normal and high pressure both under normal driving rate is shown in Table VI. With the same iron ore (test periods 43 and 47), the operation under a top pressure of 1.42 kg./sq. cm. resulted in a 10 per cent decrease in coke rate, 9.7 per cent increase in production rate, 11.4 per cent increase in indirect reduction and 16.7 per cent increase in top gas CO_2/CO ratio. With the same sinter burden (test periods 52 and 53), the operation under a top pressure of 1.37 kg./sq. cm. resulted in a 13 per cent decrease in coke rate, 7.8. per cent increase in production rate, 13.4 per cent increase in indirect reduction and 43.7 per cent increase in top gas CO_2/CO ratio.

D. SLAG COMPOSITION AND CHARACTERISTICS

Compositions and Melting Temperature — For low-shaft furnaces operating with limited and low temperature of the blast, the composition of the slag must be confined to a limited range the particular temperature imposed by the type of fuel and blast temperature used can maintain it molten and slightly superheated to be fairly fluid. Slag composition beyond such specified range can cause operational difficulties because the prevailing temperature may not be able to maintain the slag molten or fluid enough. These compositions ranges are defined by the liquidus temperature surface diagrams of the particular components of the slag. Such diagrams were prepared

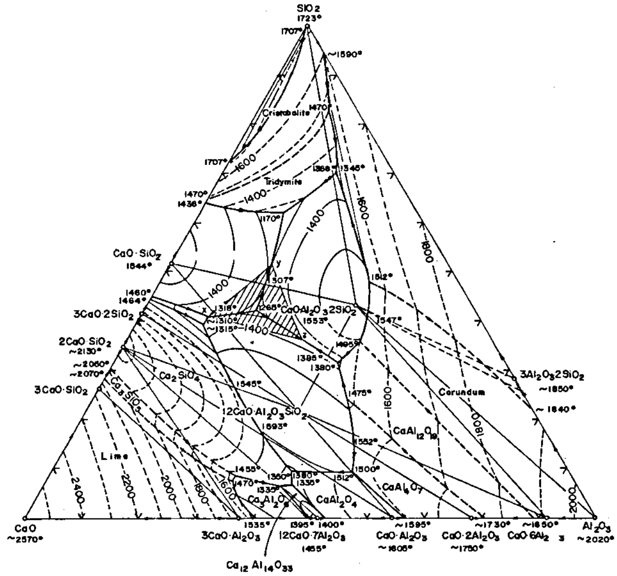

Figure 10
LIQUIDUS SURFACE TEMPERATURES OF THE SYSTEM $CaO-Al_2O_3-SiO_2$

and discussed in the article of Osborn et.al.([18]). These diagrams are for the systems $CaO-SiO_2-Al_2O_3-MgO$ which are the major components of blast, and low-shaft furnaces slag. These four oxides account for about 98 per cent of the total slag composition.

An example of such diagram for a ternary system composed of $CaO-SaO_2-Al_2O_3$ is shown in Fig. 10([18]). The hatched portion represented by triangle x-y-z represents the range of slag composition with a melting temperature of about 130°C down to 1265°C. This range is recommended for low-shaft furnaces with low blast temperatures in order to obtain optimum slag fluidity and desulfurization characteristics. It will be noted that the lowest melting temperature in Fig. 10 is 1175°C. However, slags in this region have very low desulfurization capacity.

The alumina content of slags is given important consideration in the operation of blast and low-shaft furnaces. Ores with high alumina to silica ratio are troublesome because when the slag contains more than 18 per cent Al_2O_3, the melting temperature is very high.([19]) Under such conditions magnesium oxide (MgO) must be introduced in the burden in the form of dolomite or dolomitic limestone in order to decrease the slag melting temperature. Under worst conditions the use of fluorspar (CaFl) for short periods is recommended. Fluorspar, however, is expensive.

Oxides of alkalies such as potassium oxide (K_2O) and sodium oxides (Na_2O) decrease the melting temperature of slags. These are, however, detrimental to furnace operations since they cause deterioration of refractories and formation of accretions and scabs which adhere to the furnace walls.

Table VII

EFFECT OF TEMPERATURE AND COMPOSITION ON THE VISCOSITY OF BLAST-FURNACE SLAGS

Viscosity, poises, at Indicated Temperatures and Al_2O_3 Contents in per cent

MgO, %	2732F (1500°C)							2550F (1398.9°C)							2460F (1348.9°C)			
	5	10	15	20	25	30	35	5	10	15	20	25	30	35	5	10	15	20
0.82 Basicity**																		
20	3.9	3.9	3.8					8.1	8.4	8.3					12.1			
15	4.2	4.1	3.7	3.9				8.3	8.8	8.0	8.9				12.6	13.4	12.7	13.5*
10	4.4	4.6	4.3	4.1	4.1	4.1	4.1	9.1	10.2	10.0	8.2				14.2	16.0	16.3	13.7
5	4.8	4.8	5.0	4.8	4.7	5.0	5.0*	9.7	10.6	11.9	11.4					16.9	19.6	
0	4.8	5.1	5.2	5.0	5.5	5.6			11.6	13.2	13.6						22.2	
0.90 Basicity (Interpolated From Data for 0.82 and 1.00 Basicity)																		
20	3.4	3.4	3.4					7.0	7.0	7.0					10.6	10.2		
15	3.5	3.4	3.2	3.3				7.0	7.1	6.7	7.1*				10.8	10.8	10.5	
10	3.7	3.8	3.5	3.6	3.6	3.6	3.6	7.9	8.3	8.0					12.3	12.9		
5	4.3	4.1	4.0	4.1	4.1	4.3	4.4	8.5	8.7	9.5	9.1*					13.7		
0	4.1	4.6	4.6					10.0										
1.0 Basicity																		
20	2.8	2.8	2.8*					5.9	5.5	5.5*					9.0	8.8		
15	2.8	2.6	2.6					5.7	5.7	5.3					9.0	8.3	8.3	
10	3.0	3.0	2.7	3.1	3.0	3.1	3.1	6.6	6.4	6.0	7.0	7.1	7.0	7.1	10.3	9.7		
5	3.8	3.3	3.0	3.3*	3.4*	3.6	3.9*	7.5	6.7						10.3	10.3		
0	3.4	4.0				4.2	4.1*		8.3							12.0*		
1.10 Basicity (Interpolated From Data for 1.00 and 1.22 Basicity)																		
20	2.4	2.4	2.4												5.0*	4.5*		
15	2.4	2.4	2.4												5.0*	4.5*	4.5*	
10	2.6	2.7	2.7	2.7	2.7	2.7	2.7								5.5*	5.5*		
5	3.0	2.8	2.6			2.8	3.2											
0																		
1.22 Basicity																		
20	1.9																	
15	2.0	2.1																
10	2.2	2.3	2.3*	2.3	2.3*	2.3	3.0*											
5						2.0	2.5											
0							3.0											

*Extrapolated data. **Basicity = (% CaO + %)/(%SiO_2 + %Al_2O_3), where %CaO + %MgO + SiO_2 + %Al_2O_3 = 100%

Viscosity and Composition — Viscosity, the inverse of fluidity, is a very important physical property of the slag. It is a function both of composition and temperature. Generally, the viscosity value of the slag must be as low as possible for the following reasons: 1) for easy percolation of the slag droplets through the coke reserve zone to the hearth; 2) to allow the droplets of molten iron to pass through and separate from the molten pool of slag; and 3) for easier tapping and flushing of the furnace.

The viscosity of slags is increased by the presence of impurities such as crystalline substances, foams or fine bubbles, finely suspended particles, and deleterious compounds like chromium oxide (Cr0) and titanium dioxide TiO_2). These compounds make the slag very viscous and it is for this reason that the maximum tolerance of Cr and TiO_2 contents of burdens for melting furnaces are 0.03 per cent and 0.10 per cent, respectively.

At temperatures above the liquidus temperature, viscosity of a slag with a specific composition decrease as the temperature is increased. For the systems CaO-SiO_2-Al_2O_3-MgO diagrams were prepared by McCaffery and his co-workers[20] showing isoviscosity lines. Dr. R. B. Snow[21] has reinterpreted and compiled into a single table (Table XVII) this information along with the results of more recent works.

Aside from causing difficulties in operation, viscous slags pose a potential danger both to furnace operation and personnel. When slag is viscous, the separation of iron from the slag is difficult. Under such condition, droplets of iron are entrained by slag during flushing which can melt the slag tuyere and may result in an explosion. Granulation of such slags by water can also result in an explosion. Operating personnel without protective apparels caught within the vicinity of such explosions can suffer from serious physical injuries.

If the slag is very viscous, the voids or spaces between the coke particles in the coke reserve zone may eventually be plugged and result into a hearth blockade. This is a very critical situation which, when not immediately corrected, can result in the burning of slag tuyeres and even iron tuyeres by molten iron which cannot percolate to the hearth bottom. Such burning of slag or air tuyeres by molten iron usually result in explosions.

Effect of Burden Descent – Regular descent of the burden is most desirable for obtaining and maintaining slags having suitable viscosity and temperature on the assumption that the chemical composition of the burden is within the optimum slag composition. On the other hand, irregular burden descent like slips poses difficulties in maintaining a good slag even if the furnace is burdened for optimum slag composition.

Slips make slag control very difficult and, depending on the severity and condition of the hearth, are potential causes of hearth blockage. Slips introduce masses of relatively cold and unprepared or unburned materials, depending on whether these materials are ore and primary slag or coke, in the hearth.

If such materials fall into the hearth after tapping, partial or total hearth blockage may result depending on the quantity of material that fell in the hearth because these materials will plug the voids of the coke reserve zone.

On the other hand, when such materials fall into the hearth when it already contains molten slag and pig iron the composition of the slag and pig iron is changed and their temperature is decreased. The slag viscosity may or may not increase depending on its temperature and the composition of the materials. Also, such materials exert a chilling effect in the hearth or worst, freeze a portion of or the whole hearth. The consequences of a frozen hearth are similar to a hearth blockage.

Control of Slag Composition and Characteristics – In the operation of smelting furnaces, control of slag composition is achieved only by proper burdening and charging. Once the raw materials are already in the furnace the corresponding slag composition is relatively fixed and hardly anything can be done in order to modify it. The slag temperature and viscosity, however, can be changed by proper modifications in blast temperature and auxiliary facilities like oxygen, steam, fuel, oil, gas, etc. injections if these facilities are available. As stated in the foregoing, an upward change in slag temperature decreases its viscosity while a downward change in temperature increased slag viscocity.

Control of slag chemical composition, therefore boils down to the control of the chemical composition of the raw materials. This is achieved by proper blending and homogenization of the different sources of iron ores, fluxes and coke in their corresponding stockyards. The purpose of this is primarily to minimize variation of the chemical components of the respective raw materials, specifically $Ca0$, $Mg0$, $Si0_2$ and Al_20_3 so that the slag to be obtained will fall within the range of optimum composition. The secondary purpose of this is to achieve physical homogeneity of the raw materials hence minimize size segregation in the furnace.

If the variation of the raw materials' components exceeds the prescribed range, control of the smelting process is difficult as a result of varying composition and viscosity of the slag. Consequently, the quality of the metal is poor. Such variation also requires frequent adjustment of the burden and other operating variables which result in unstable smelting for furnaces in which the smelting process is controlled only by burden adjustment process. In terms of product quality, such conditions result in a high percentage of off-grade iron due to the fact that if the burden is altered the change takes effect four to five hours later. As an example, if the latest tap of iron is off-grade and the burden is immediately changed the succeeding tap will still produce off-grade iron.

This was one of the major problems encountered in the operation of the J. Panganiban low-shaft furnace. There were fluctuations in iron ore chemistry, principally its $Si0_2$ content due to the varied sources which were about 10 small ore deposits and insufficient blending because of limited facilities.

IV. COMMERCIAL VIABILITY OF LOW-SHAFT FURNACES

The commercial viability of the low-shaft furnace lies in the production of foundry grades of pig iron and derived products based on the following conditions: 1) availability of fuels, either briquettes manufactured from non-coking coal or small-sized coke which are not usable in blast furnaces; 2) availability of prepared burden (ore, sinter or pellets); and 3) sufficient volume of iron foundry products.

The limited production capacity of low-shaft furnaces does not make it an alternative for the highly efficient blast furnaces but rather a complement to blast furnaces in the overall concept of a rational integrated iron and steel industry. As long as the required products is molten iron in large quantities the low-shaft and blast furnaces are the most suitable production equipment. As a complement to blast furnaces, the low-shaft furnaces are highly suited for the production of relatively lower quantity and varying grades of foundry pig iron while the blast furnaces could be limited to the high volume production of two or three grades of basic or steelmaking hot metal. This concept will allow a more rational utilization of available raw materials. The high quality fuels and coarser-sized ore, sinter or pellets should be charged to the blast furnaces while the poorer quality fuels and smaller-sized burden should be used by the low-shaft furnaces. The concept of putting up one low-shaft furnace only, complete with raw material preparation equipment and facilities at or close to the major raw material deposit, solely for pig iron production is not commercially viable. At best, pig iron production is a marginal industry. This was true in the case of the J. Panganiban low-shaft furnace.

Whether to choose direct reduction processes, electric smelting furnaces and low-shaft furnace for the production of foundry pig iron depends upon a very thorough feasibility study taking into account local economic conditions. This is beyond the scope of this article.

For a more commercially-attractive operation, the low-shaft furnace is suited for the production of large volume cast iron products. Casting the molten iron into pigs then remelting the pigs in other shops for iron foundry products is expensive and leads to inefficient utilization of energy. The rational method is to tap the molten iron into mixers, holding furnaces or ladles where final adjustments in composition could be made then casting them into prepared molds for cast iron products.

Recent developments of several processes for the production of metallurgical and foundry coke briquettes (22) from various types of non-coking coal and the very successful utilization of these briquettes for smelting purposes in the Ougree low-shaft furnace (and in cupolas) (23) has strengthened the viability of low-shaft furnaces. These processes have successfully passed the pilot plant stage of development and some are now under commercial development.

In February 1970, coke briquettes made from non-coking coals were successfully use in blast furnace no. 3 of the Rheinstahl Huttenwerke AG in Germany (24). The furnace has a 6.8 meters hearth diameter, 25.2 meters height and 764 cubic meters working volume. Two runs were performed using two types of coke briquettes. In both runs, metallurgical coke was totally replaced by coke briquettes. The first run lasted for three (3) days and 2,700 tons of briquettes were consumed. The furnace had a daily average production of 1,348 tons of iron with an average gross coke rate of 662 kg. per ton of iron and a wind temperature of 1,048°C. The second run lasted for seven (7) days and 7,000 tons of briquettes were consumed. The daily average production of the furnace was 1,265 tons of iron at an average gross coke rate of 652 kg. per ton of iron and a wind temperature of 885°C. It is worth noting that during the last quarter of 1967 and 1969 these briquettes were tested successfully in the Ougree experimental blast furnace. (14)

This breakthrough in metallurgical fuel technology is a timely solution for the efficient utilization and exploitation of the world's vast reserves of non-coking coal. It offers a highly promising solution for the full development of the Philippine iron and steel industry and the economic utilization of our barely tapped non-coking coal reserves, one of which has been proven by laboratory scale tests to be suitable for the production of briquettes for possible utilization in the J. Panganiban low-shaft furnace (25,26).

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CORROSION RESISTANCE

INTRODUCTION

This is intended to give brief guidance on the choice of stainless steel for service under various corrosion conditions. The most common forms of corrosion in stainless steel are discussed according to the environments in which they are generally encountered.

Each section concludes with accounts of some typical case of corrosion with suggested choices of material.

Acids — General Corrosion

The good corrosion resistance exhibited by the stainless steels is explained by the formation of a protective surface film of chromium oxide. Other alloying elements, such as molybdenum, silicon, copper and nickel, may also have a favorable effect on corrosion resistance. The effect of these alloying elements varies in different corrosion environments, which is why the environment must be taken into account in choosing a type of steel.

NON-OXIDIZING ACIDS, SULFURIC ACID (H_2SO_4) AND PHOSPHORIC ACID (H_3PO_4) AND ORGANIC ACIDS

An increase in the molybdenum increases corrosion resistance in these environments. In sulphuric acid, for instance, the addition of copper produces further improvement in the resistance. The iso-corrosion graphs (Figs. 1 and 2) and the table illustrate the favorable effect of molybdenum and copper.

Corrosion tests in a mixture of 82 per cent acetic acid, eight per cent formic acid, and 10 per cent water. Temperature 180°C.

Steel	Corrosion Rate (mm per year)
AISI 316	0.69
AISI 317 (3.5 Mo)	0.51
SANDVIK 2RK65	0.25

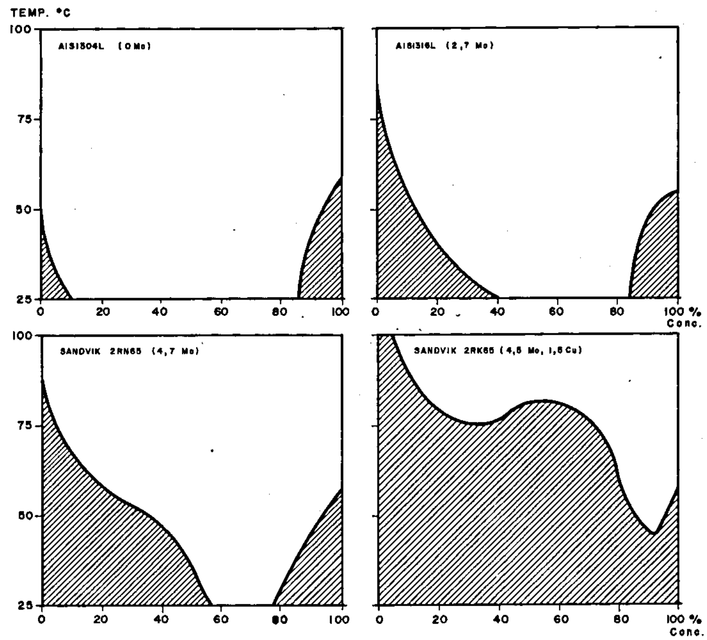


Figure 1

ISO-CORROSION DIAGRAM FOR SULPHURIC ACID (H_2SO_4). THE CORROSION RATE WITHIN THE SHADED ZONES IN LESS THAN 0.3 mm. PER YEAR.

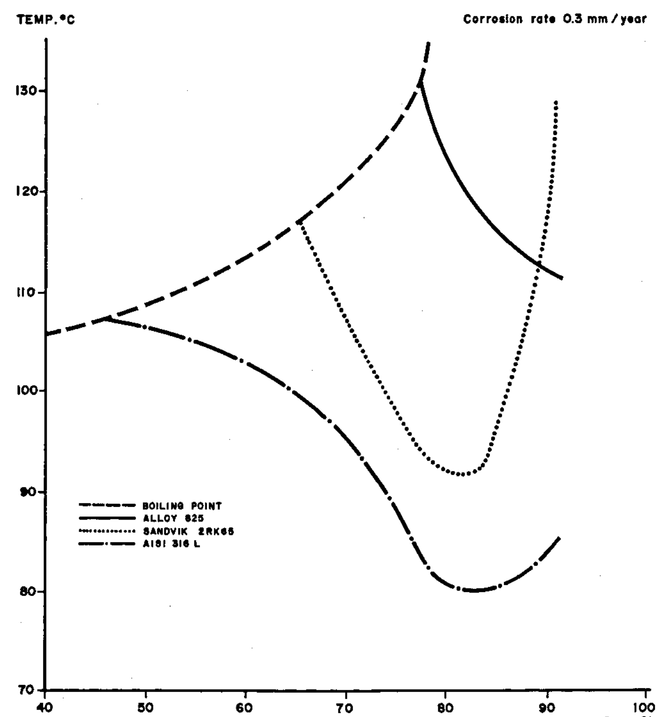


Figure 2

ISO-CORROSION DIAGRAM FOR PHOSPHORIC ACID (H_3PO_4)

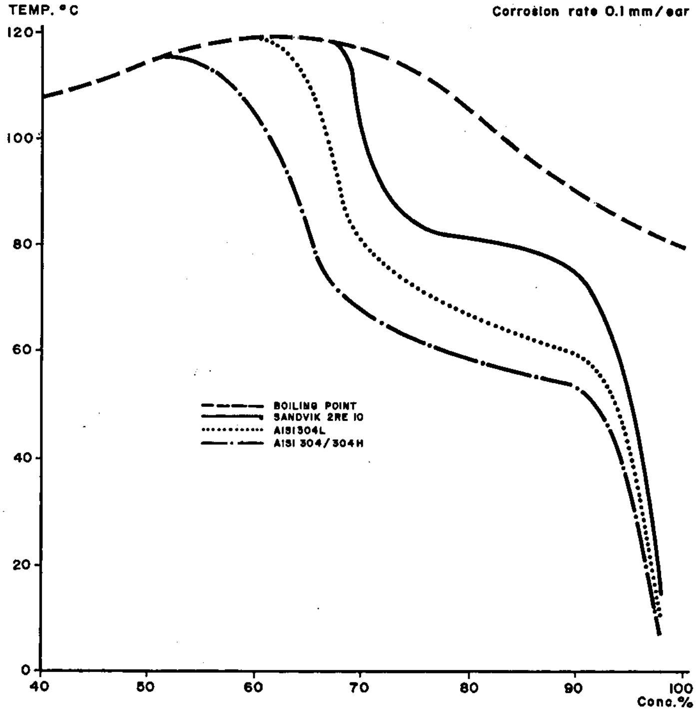


Figure 3
ISO-CORROSION DIAGRAM FOR NITRIC ACID (HNO_3)

Oxidizing acids

Austenitic 18/8 steels of the AISI 304 type are commonly used in oxidizing environments. A reduction of the carbon content gives improved resistance, as also does an increase in chromium content. The iso-corrosion graph (Fig. 3) shows the resistance to nitric acid of some different types of austenitic stainless steel.

Chloride-bearing Aqueous Solutions — Stress Corrosion

Austenitic stainless steels are susceptible to stress corrosion in chloride-bearing aqueous solutions. Even very small chloride contents — a few parts per million — may initiate this type of corrosion at temperatures above about 70°C, if the material is subjected to tensile stresses at the same time.

Ferritic stainless steels, like the rest of the ferritic steels, are generally not susceptible to chloride-induced stress corrosion and may thus present a solution to the stress-corrosion problem. These steels however, are less resistant to general corrosion and pitting than the austenitic stainless steels.

Thus, steels, with a high molybdenum content have a considerably better resistance to pitting and are therefore better suited than the latter for service in sea water.

Welding — Intergranular Corrosion

In connection with welding or other operations in which heat is applied to stainless steels there may be

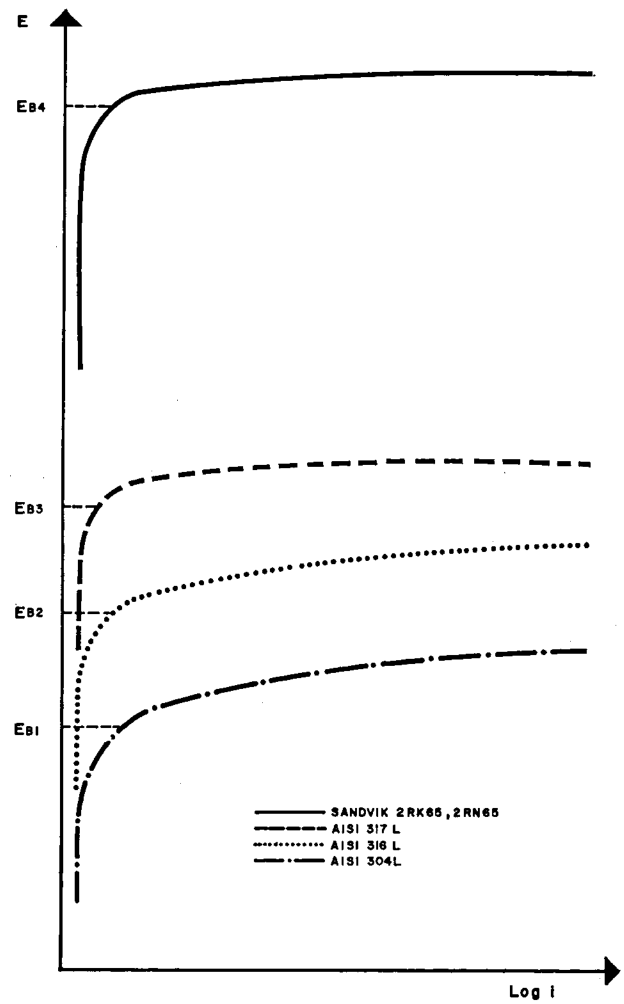


Figure 4
PITTING POTENTIALS FOR SOME DIFFERENT TYPES OF STAINLESS AUSTENITIC STEEL.

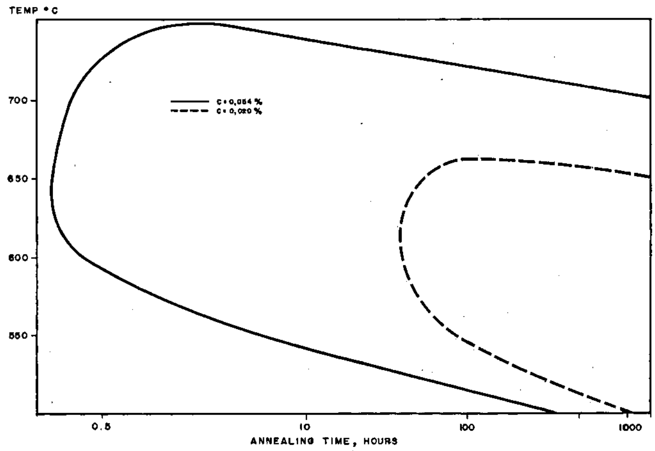


Figure 5
TTC DIAGRAM ILLUSTRATING THE EFFECT OF CARBON CONTENT ON SUSCEPTIBILITY TO INTERGRANULAR CORROSION IN AUSTENITIC STAINLESS STEELS OF THE 18/8 TYPE. AFTER HEATING AT TEMP. & FOR TIMES FALLING W / IN THE CURVE THE STEEL IN QUESTION IS SUSCEPTIBLE TO INTERGRANULAR CORROSION.

a precipitation of chromium carbides, which results in impaired corrosion resistance and a risk of intergranular corrosion. This corrosion problem can be avoided by choosing a stainless steel having a carbon content less than 0.03 per cent, or a niobium— or titanium-stabilized steel. (See Fig. 5)

Therefore, if a specification calls for resistance to general corrosion and pitting on a level with that of the austenitic steels and the environment entails a risk of stress corrosion, the new ferritic-austenitic steel SANDVIK 3RE60 may offer a good solution. Operational experience has established that it has a notably better resistance to stress corrosion than the austenitic steels.

The susceptibility of austenitic steels to stress corrosion decreases with increasing nickel content, and materials containing more than about 35 per cent nickel can be regarded as completely resistant to stress corrosion. Materials having good resistance to stress corrosion are Alloy 800 and 600 containing about 32 per cent and 73 per cent, nickel respectively.

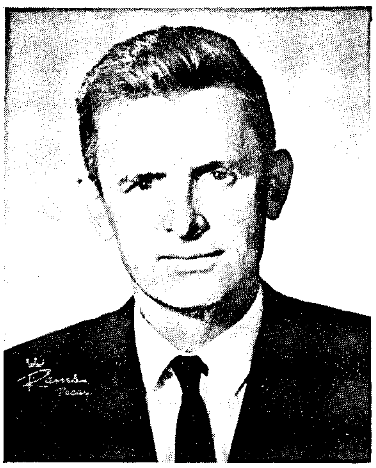
Sea Water — Pitting

In sea water and other aqueous solutions having a high content of chlorides, stainless steels suffer local corrosion attacks known as pitting. Resistance to this type of corrosion can be determined by laboratory methods such as electrochemical methods of measurement in which the pitting potential is determined. The higher the positive value which this potential assumes, the higher will the resistance be to pitting exhibited by the steel. Fig. 4 shows pitting potentials for some different types of stainless austenitic steels. The favorable effect of molybdenum is clearly apparent.

All nations attempt to industrialize. For, only if a nation can produce the basic machines and tools in her own land, will she be able to sustain herself. Only by diversified productivity can she hope to stay stable if one of her chief exports should fail. Besides, if all goes well, a healthy, well-developed industry will stimulate growth and prosperity.

In a country which does not have a machine tool industry, the formation of this industry should be undertaken in the Engineering and Trade or Vocational Schools. Since no industries exist to complain about competition from schools, there should be no obstacle here. The following is a plan for putting up a Machine Tool Industry in the Philippines.

THE DEVELOPING COUNTRY AND THE MANUFACTURING ENGINEER



Alexander Ligas, a manufacturing engineer, has worked with many industrial firms here in the last 25 years. He claims to have a positive plan for the rapid formation of the Philippine Machine Tool Industry and the training of the necessary personnel.

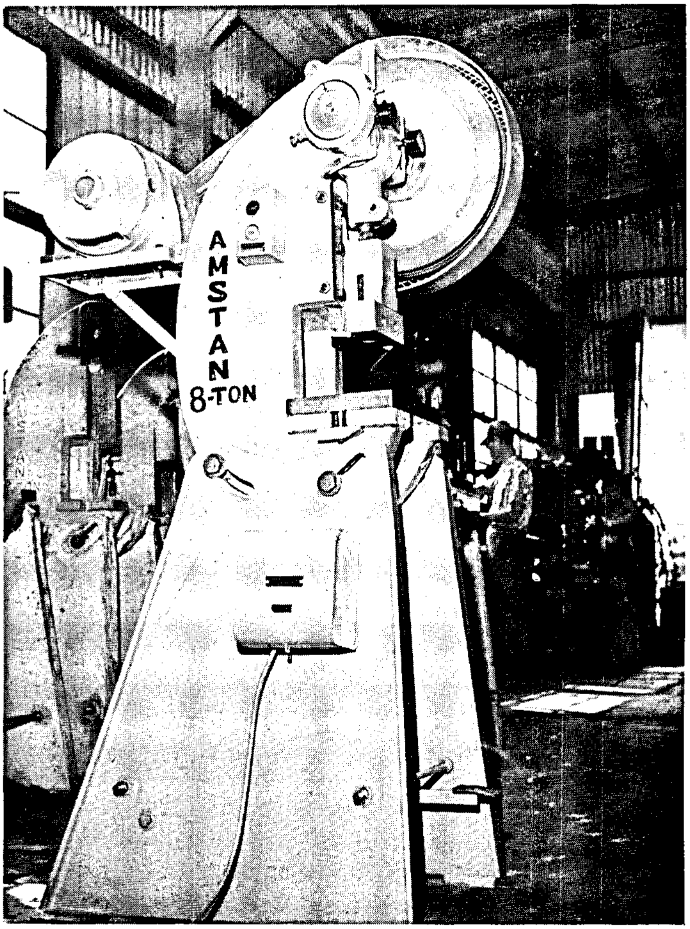
by ALEXANDER LIGAS

STARTING A MACHINE TOOL INDUSTRY

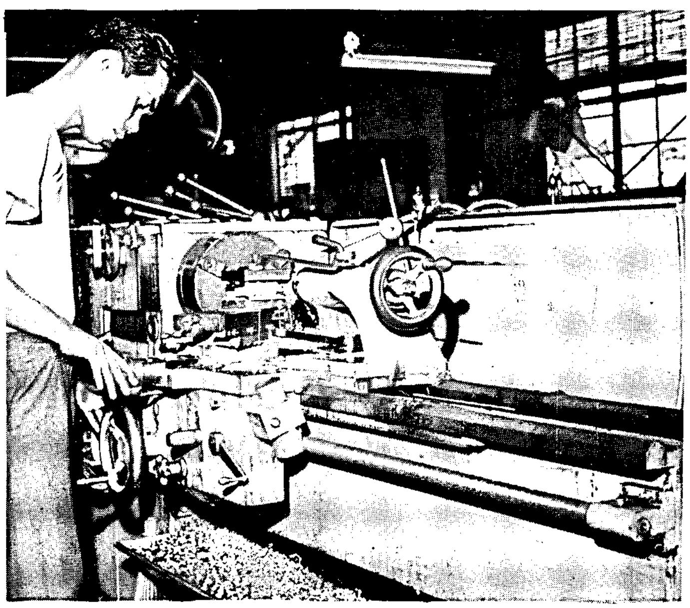
The basic tools, such as the engine lathe and the milling machine, are said to be self-reproducing. This is true if it is understood that these are only inert masses of metal until a man starts to operate them. This is predicated on the hope that the man or men have the necessary skill, experience and plans to follow them, and only in this case can these machines "reproduce themselves". To be more precise, basic machine tools can be reproduced by men who have the necessary skill, experience, and plans.

Any nation-builder knows that to industrialize he must ultimately establish a basic machine tool industry. This is the heart of all other industries. This industry is not only for producing lathes and milling machines. When his country is capable and experienced enough to produce these complicated and precise machines, he has proof that he has men who can produce the other machines and tools used by other industries.

The Machine Tool Planning Board. This consists of men in industry and government who now have the experience to build machine tools. Their function will be to provide specifications, standards of measurements, and workmanship. They will also act as a Board of Inspectors of finished prototypes, to be sure that the product will serve its purpose and is



Punch Press Assembly Line.



The First Geared Head Engine Lathe designed and made in the Philippines.

made for a reasonable price. The Society of Manufacturing Engineers can furnish the necessary standards and manuals.

The Metals Industry Research and Development Center. The program being proposed requires close coordination between the private industry as represented by the Machine Tool Planning Board and government agencies which will implement the plans of the Board. In the Philippines, the Metals Industry Research and Development Center (MIRDC) is most fitted to undertake this coordinating function. Also, the MIRDC can serve as secretariat of the Machine Tool Planning Board since it has the technical facilities, equipment and qualified personnel to prepare and undertake what the board may require. Furthermore, the Center can undertake the inspection, testing and other function as discussed in the succeeding topics.

The Department of Education. The Department of Education will accept specifications from the Planning Board and retain their consultative services to implement a machine tool engineering and manufacturing program. This program may include most engineering schools and all the trade schools in the nation.

The Engineering School. The Department of Education will assign to the engineering school a set of specifications for the various machine tools which the vocational school will be needing. Each engineering school will proceed to design one of these machines and will be supervised by the Planning Board. All the engineering schools will follow the standards of measurement and practice in drafting as specified by the Planning Board. This will guarantee that all Filipino engineers will be in line with accepted practices in the profession.

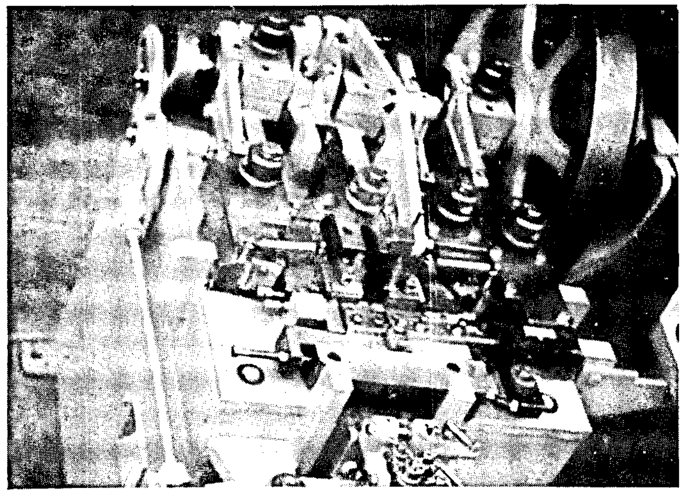
The designs will be in complete detail for each part, as to dimensions and tolerances, chemical analysis of the steel, finish, heat treatment specifications if any, and part number. Thus, it will be possible to make the part correctly without any doubt or question.

Finally, after all the drawings are made and approved for execution by the Planning Board, the experimental model will be made, if possible, in the shops of the school which designed it. If not, it can be done at the MIRDC. Inspection and testing of the model will be undertaken by the MIRDC which has all the equipment, facilities and qualified personnel to do this. After the model is made and tested on various jobs, it is modified or corrected if and where necessary, and the corresponding corrections will be made by the MIRDC on the master drawings. The dies, jigs, fixtures, gages and other special tools will also be designed by the schools. Upon final approval, sufficient sets of these drawings will be printed, and one set of drawing will be sent to each of the trade schools. The original drawings, specifications, standards and other documents will be kept by the MIRDC as secretariat of the Planning Board.

The Bureau of Vocational Education. This bureau will have a complete inventory of all the equipment in each of the trade schools throughout the country. The specialty of the schools, as to skill, equipment and instructor capability will be noted. The Planning Board will then assign to each school a part of several parts of each machine tool to be made in quantities of say, 100 units for each part. When these parts are made according to blueprint and inspected as to specifications, they are sent to the MIRDC receiving center. Upon receipt of these parts, the MIRDC will sample each batch of parts and subject the samples to Quality Control tests and inspections. At the receiving center, the various parts will be repacked (one of each part or the correct number of parts to make one complete machine); knocked down machines are then sent to each of the schools.

Upon receipt of these parts, each school will inspect all the parts and send in their evaluation to the MIRDC to correlate its evaluation based on the statistical samples taken. Both evaluation reports will be sent to the Bureau of Vocational Education and the Planning Board. Each part will have been inspected by 99 inspectors and a grade will be sent to Vocational Education. These grades will indicate the proficiency of each school. The schools will now proceed to fit and assemble the machines and adjust them to the specifications outlined on the specification sheet. In the meantime, a new set of parts are being made for the next batch of machines, and so on.

This is a practical method of supplying each school with four or five machines each year to cope with the need for more equipment. The cost of these machines will be about 10 or 20 per cent of the imported cost, because existing equipment and personnel are utilized. The course will be the most comprehensive because the student is learning the reproductive process. As more machines become available the schools can operate night classes for adults who want to advance from laborer to skilled craftsman.



Nail Machine with Carbide Tooling Hardened and Ground Slides for easy maintenance.

The training engineering and trade school students will be of a higher quality, which is necessary to get existing industry to advance to machine tool manufacture.

By bringing a higher quality of training to the provinces, workmanship will be improved. Decentralization of the industry will be stimulated because of the availability of the necessary skill.

With 99 other schools inspecting the work of each school, great effort will be stimulated and students and instructors will take more pride in their workmanship. Since most of the material will be cast iron, the government can contribute its scrap to manufacture new machine tools, and thus cut down on machine cost.

Tool Making Program. The same system will be used to implement a "Hand Tool Making Program." The Planning Board will provide the details for hand tools which are essential to a machinist, tool and die-maker, pattern-maker and electrician. The engineering schools will make these designs in complete detail, including the step by step procedures to make. In the first two years of vocational education, the student will make these basic tools and instruments for his own use.

These tools will be his instrument the rest of his life. He will make use of them as long as he practices his trade. It will also help him to earn his living and will be a factor in increasing his income than if he had no tools at all.

It will also be a very convincing factor in obtaining his first job, because the personnel supervisor will be able to see evidences of his skill.

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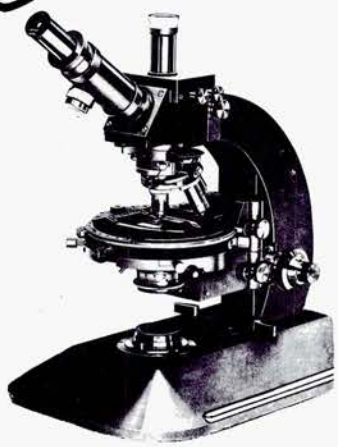
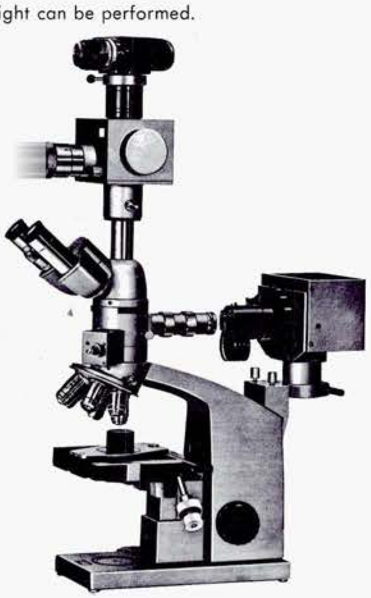


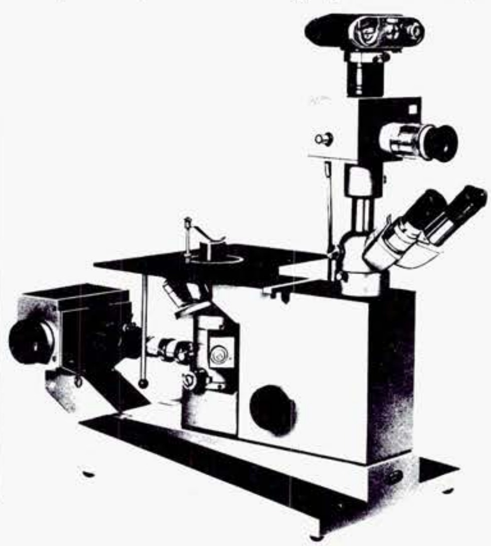
ZETOPAN-POL — A versatile research microsope for microscopy in polarized light. All orthoscopic and conoscopic examinations and measurements in transmitted and incident light can be performed.

DIAPAN-POL — Large Polarization Microscope — This instrument contains in the intermediate tube a centering and focusing Bertrand lens which acts on all bodies and permits observation of axial images also with the binocular and photographic body. The standard illuminator is a high intensity 100W low-voltage quartz-iodine lamp.

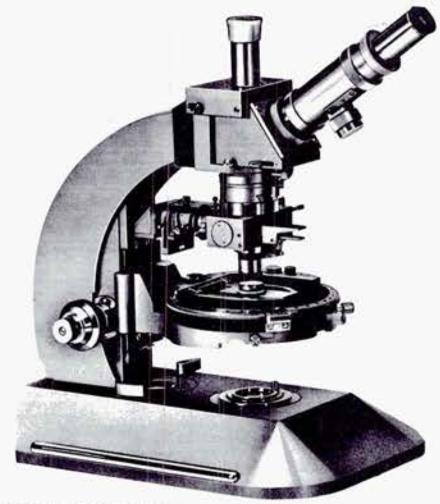
NEOPAN POL II POLARIZING MICROSCOPE — Similar to the DIAPAN-POL except that it is fitted with a 15W low-voltage lamp. A monocular body with iris diaphragm is available for special applications. As in the DIAPAN-POL, the objectives are carried either on a quadruple centering nosepiece or an objective clutch.



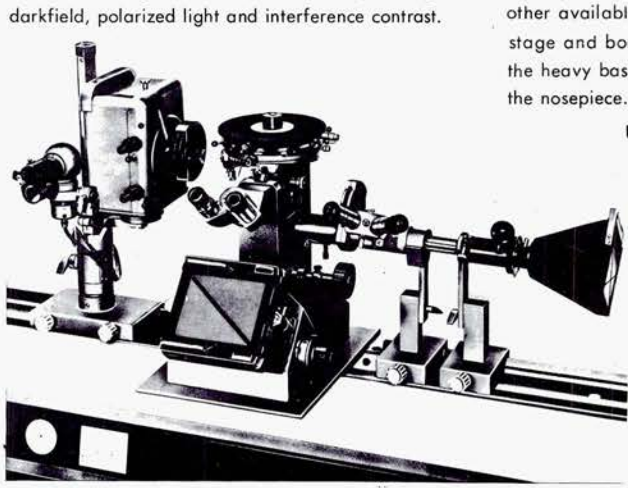
METAPAN 2 — An incident-light microscope system used in METALLOGRAPHY, electronics, minerology, materials testing, etc. The system offers you brightfield, darkfield, polarized light and interference contrast.



METAVERT — An industrial and routine microscope of the inverted type for examinations in brightfield, darkfield, polarized light and interference contrast. Unlike other available microscopes of similar performance, the stage and body of the METAVERT are fixed rigidly to the heavy base as the focusing motions operate only on the nosepiece.



ZETOPAN WITH UNIVERSAL LIGHT EQUIPMENT — Only one opaque illuminator is necessary on the ZETOPAN to perform various methods of observation in incident light. Wtih our strain-free Epi Objectives, the following may performed: brightfield with vertical internal illumination, brightfield with oblique internal illumination, darkfield, polarized light, fluorescence, interference contrast, interferometry, mixed light, etc.



UNIVERSAL RESEARCH CAMERA MICROSCOPE MEF2 — A metallographic microscopes of advanced modular construction, designed for service in a wide variety of applications from low magnification macro lenses to the highest power immersion objectives; for use in bright field darkfield and polarized light. Because of the nearly unlimited scope of the MEF2 Universal Camera Microscope for expansion of its performance, the instrument can be adopted in stages to suit the requirements.

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ADAPTIVE USES OF THE QUALITY CONTROL CHARTS IN THE METALS INDUSTRY

By
DR. BERNARDO F. ADIVISO

PART I

I. Introduction

The efforts to disseminate rapidly the concepts and practices of quality control on a nationwide scale have been impeded by the lack of adequate information and trained personnel. It is unfortunate that no formal educational programs in quality technology have been developed to date in spite of the pressing need for this technical know-how by all industries. To wit, only short and repetitive seminars have been going on for the last decade or so, as compared to the baccalaureate and postgraduate offerings in quality technology by most foreign universities and institutional concerns.

A rapid orientational change in the world trade has taken place. Quality has become the symbolic password as well as the guarantee in multinational trade. To this effect, a conference was held in Washington sometime last May on the theme: **WORLD TRADE THROUGH QUALITY CONTROL.** The aim was to simplify and standardize the procedures of trade through the discussion of the present quality control practices and standard operating procedures adopted by the various trading nations.

Cognizant of the foregoing events and present needs of the local industry, the writer thought of preparing this article especially for layman's reference.

II. Nature and Types of Control Charts

Among the many special methods of quality control, the control charts are the most useful, informative, and easy to know-and-apply. Its applications range from quality evaluation of incoming materials, batches, parts components, assemblies to analysis of man-and-machine performances.

It was Dr. Shewhart who pioneered in the use of the control charts ($\bar{x}$, R chart in particular), The control chart is not a new industrial form of controlling quality variations. Simply, it is a graphic comparison of actual product-quality characteristics with limits reflecting the ability to produce as indicated by past records on the same product characteristics. The comparison can be made from drawn samples on an hour-to-hour or day-to-day basis. The same periodic results become more useful in comparing the weekly, monthly or yearly quality performance of the company.

The control chart can be considered a versatile method for quality control. It is very useful in establishing tolerance limits or even new product standards based on process capability. Once the control limits are established, the control charts can be used with facility in detecting abnormal processing. In most cases, they can adequately provide most of the quality-decisions needed by management.

Basically, two types are commonly in use, namely, the **measurement** or variable chart, e.g. the $\bar{x}$, R chart, and the **go and no-go** or attribute chart, e.g., the p chart. The two actually differ in the details of computing the needed statistics like the averages, dispersions, and control limits. However, they have practically the same basic approach or treatment as outlined by Dr. Peigenbaum in the following steps:

1. Select the appropriate quality characteristics to be controlled.
2. Record the data taken on a required number of samples, each composed of an adequate number of observations.
3. Determine the control limits from these samples.
4. Evaluate if these control limits are economically satisfactory and feasible.
5. Plot the limits and the sample results on suitable graphing paper.
6. Take corrective action if the quality characteristics of the production samples exceed the control limits.

Table I
FOR THE 95 PER CENT CONFIDENCE LIMITS EXPRESSED IN THE AVERAGE RANGE

Sample Size	Range: Lower Limit	Range: Upper Limit	Limit Distance to Standard of Mean	Process Standard Deviation
2	0.04	2.81	1.232	0.887
				0.591
3	0.18	2.17	0.668	0.485
4	0.29	1.93	0.476	0.429
5	0.37	1.81	0.377	0.395
6	0.42	1.72	0.316	0.395
7	0.46	1.62	0.274	0.370
8	0.50	1.65	0.244	0.351
9	0.52	1.58	0.220	0.337
10	0.54	1.56	0.202	0.325
11	0.56	1.53	0.186	0.316
12	0.58	1.51	0.174	0.306
	f_1	f_2	f_3	f_4

III. Basic Information in the Use of Control Charts

It is very essential to have a working knowledge and skill in the statistics like calculation of arithmetic means, ranges, standard deviations and control limits. Some of the more useful formulas are presented here.

1. **Calculation of Averages or Arithmetic Mean.** The average, with the usual symbol of $\bar{x}$ (read as x bar or bar x) is a measure of central tendency. It is simply defined as the sum of observations divided by the number of observations. For a group of samples, the formulae used in calculating the means follows:

$$\bar{x} = \frac{\Sigma x}{n}$$ (1) Average for measurement data

$$\bar{p} = \frac{\Sigma c \times 100}{\Sigma n}$$ (2) Average for per cent defective data where c = the no. of defects.

$$\bar{p}_1 = \frac{\Sigma c}{\Sigma n}$$ (3) Average for fraction-defective data.

For large measurement samples, a more complicated treatment is needed, thus beyond the scope of this paper.

2. **Calculation of Dispersions: Range and Standard Deviation.** The most useful measure of dispersion or variability is the standard deviation (using the symbol σ which is the lower-case form of the Greek letter sigma). It is defined as the root-mean-square deviation of the observations from their arithmetic mean or average. For a small group of samples, the formula can be expressed by the form:

$$\sigma = \sqrt{\frac{\Sigma (x-\bar{x})^2}{n}} = \sqrt{\frac{\Sigma x^2}{n} - \bar{x}^2}$$ (4) Standard deviations of $\bar{x}$

For go and no-go control charts, the formula below is used:

$$\sigma \bar{p} = \sqrt{\frac{\bar{p}\,(100-\bar{p})}{n}}$$ (5) Standard deviation of $\bar{p}$ with sample size n

$$\sigma P_1 = \sqrt{\frac{\bar{P}_1\,(1-\bar{p}_1)}{n}}$$ (6) Standard deviation of $\bar{p}_1$ with sample size n

Another important measure of dispersion used particularly in the control chart is the **range** (having the symbol of capital letter R). This indicates the width of the spread or scatter of the observations or the difference between the largest observed value and the smallest observed value in the sample.

3. **Calculation of the Control Limits.** There are a number of procedures used in computing control

Table 2

FOR PROBABILITY OF EXCESS IN THE NORMAL DISTRIBUTION

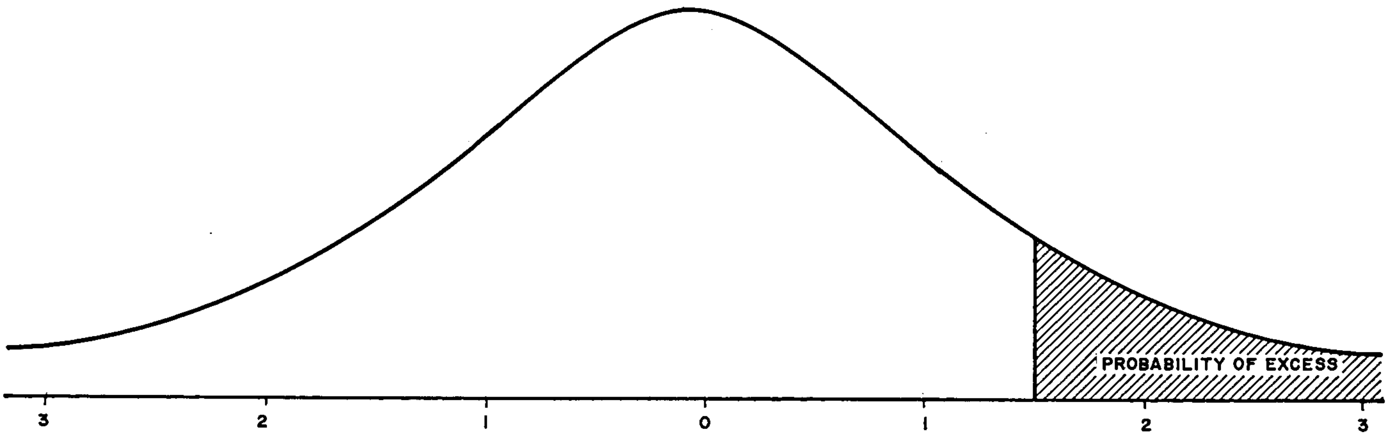


TABLE FOR THE CUMULATIVE NORMAL DISTRIBUTION

u	0	1	2	3	4	5	6	7	8	9
0.0	5000	4960	4920	4880	4840	4801	4761	4721	4681	4641
0.1	4602	4562	4522	4483	4443	4404	4364	4325	4286	4247
0.2	4207	4168	4129	4090	4052	4013	3974	3936	3897	3859
0.3	3821	3783	3745	3707	3669	3632	3594	3557	3520	3483
0.4	3446	3409	3372	3336	3300	3264	3228	3192	3156	3121
0.5	3085	3050	3015	2981	2946	2912	2877	2843	2810	2776
0.6	2743	2709	2676	2643	2611	2578	2546	2514	2483	2451
0.7	2420	2389	2358	2327	2296	2266	2236	2206	2177	2148
0.8	2119	2090	2061	2033	2005	1977	1949	1922	1894	1867
0.9	1841	1814	1788	1762	1736	1711	1685	1660	1635	1611
1.0	1587	1562	1539	1515	1492	1469	1446	1423	1401	1379
1.1	1357	1335	1314	1292	1271	1251	1230	1210	1190	1170
1.2	1151	1131	1112	1093	1075	1056	1038	1020	1003	0985
1.3	0968	0951	0934	0918	0901	0885	0869	0853	0838	0823
1.4	0808	0793	0778	0764	0749	0735	0721	0708	0694	0681
1.5	0668	0655	0643	0630	0618	0606	0494	0582	0571	0595
1.6	0548	0537	0526	0516	0505	0495	0485	0475	0465	0455
1.7	0446	0436	0427	0418	0409	0401	0392	0384	0375	0367
1.8	0359	0351	0344	0336	0329	0322	0314	0307	0301	0294

1.9	0287	0281	0274	0268	0262	0256	0250	0244	0239	0233
2.0	0228	0222	0217	0212	0207	0202	0197	0192	0188	0183
2.1	0179	0174	0170	0166	0162	0158	0154	0150	0146	0143
2.2	0139	0136	0132	0129	0125	0122	0119	0116	0113	0110
2.3	0107	0104	0102	0099	0096	0094	0091	0089	0087	0084
2.4	0082	0080	0078	0075	0073	0071	0069	0068	0066	0064
2.5	0062	0060	0059	0057	0055	0054	0052	0051	0049	0048
2.6	0047	0045	0044	0043	0041	0040	0039	0038	0037	0036
2.7	0035	0034	0033	0032	0031	0030	0029	0028	0027	0026
2.8	0026	0025	0024	0023	0023	0022	0021	0021	0020	0019
2.9	0019	0018	0017	0017	0016	0016	0015	0015	0014	0014
3.0	0013	0013	0013	0012	0012	0011	0011	0011	0010	0010
3.1	0010	0009	0009	0009	0008	0008	0008	0008	0007	0007
3.2	0007	0007	0006	0006	0006	0006	0006	0005	0005	0005
3.3	0005	0005	0005	0004	0004	0004	0004	0004	0004	0003
3.4	0003	0003	0003	0003	0003	0003	0003	0003	0003	0002

limits. Graphs of constant and even slide rules are now in use. For our purpose, tables of constants shall be used for practical reasons.

a. Measurement-Chart Control Limits:

Averages:

Lower Control Limit $= \bar{\bar{x}} - f_3\bar{R}$ (7a)

Center Limit: $= \frac{\Sigma \bar{x}}{n} = \bar{\bar{x}}$ (7b)

Upper Control Limit $= \bar{\bar{x}} + f_3\bar{R}$ (7c)

Ranges:

Lower Control Limit $= f_2\bar{R}$ (8a)

Center Line $= \Sigma \frac{R\text{-}\bar{R}}{n}$ (8b)

Upper Control Limit $= f_2\bar{R}$ (8c)

Refer to Table 1 for the 95% coinfidence limits expressed in the average range of the given sample size n.

b. Go and No-Go chart Control Limits:

$\bar{p}$ limit:

Lower Control Limit $= \bar{P} - u\sigma P$ (9a)

Center Line $= \frac{\Sigma c}{\Sigma n} \times 100 = \bar{P}$

Upper Control Limit $= \bar{P} + u\sigma\bar{P}$ (9b)

P_1 limit:

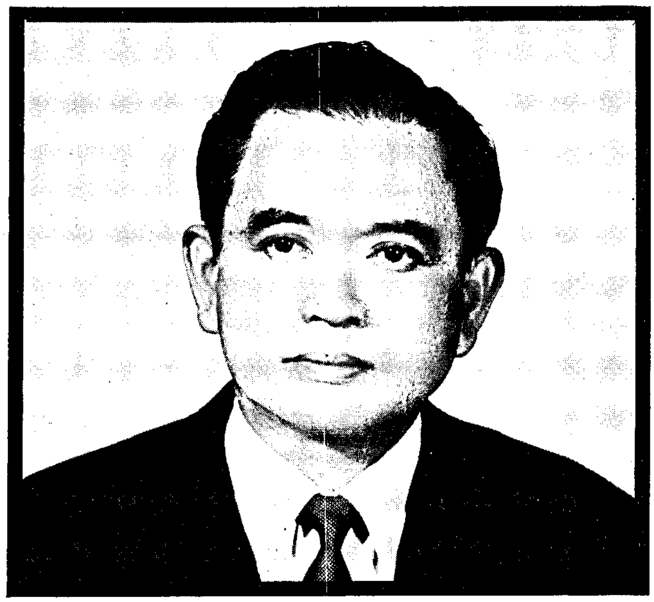
Lower Control Limit $= \bar{P}_1 - u\sigma P_1$ (10a)

Center Line $= \frac{\Sigma c}{\Sigma n} = \bar{P}_1$

Upper Control Limit $= \bar{P}_1 + u\sigma\bar{P}_1$ (10b)

In computing the control limits for per cent-defectives or fraction-defective, it is necessary to set the most economical and feasible percentage of rejection, say at 10 per cent, five per cent, or one per cent, as the case may be. Hence, Table 2 is very indispensable. For example, if we set the probable limit of rejection percentage in the manufacture of metal screws at five per cent, it means having 95 per cent out of 100 items as "good". This five per cent total reject may account for 2.5 per cent probability of having undersized screws and 2.5 per cent oversized. Hence, the value of u to be usedin the formula is 1.96 sigma. Similarly, if the probability of defective is placed at 10 per cent, the control limits shall be a approximately $\pm$ 1.65-sigma. In industry, the use of the $\pm$ 3-sigma limits (or less than one per cent defective) is common for practical reasons. One disadvantage is that the computed limits may be too wide for processes requiring precision like that of the parts manufacturing in the metals industry. Also, it may not adopt well in most developing economies where the industry still lacks the sophisticated and precise facilities as well as the atmosphere of quality-consciousness.

men in the metals industry



LAURO M. CRUZ

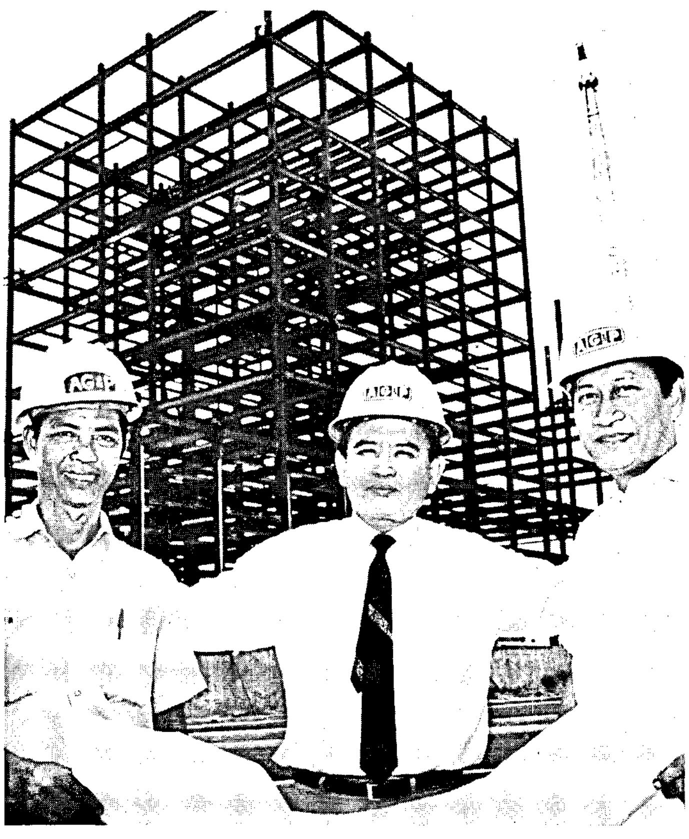
There are a number of "unsung" professionals who go about their varied tasks without publicity or fanfare but whose work in professional and civic organizations, boardrooms, colleges, offices, factories— or where have you — tell the story about their industry and how it is progressing today. Such one professional is Lauro Manahan Cruz, vice-president and general manager of AG&P's Steel Fabrication Division.

After graduating from the University of the Philippines with the degree of Bachelor of Science in engineering in 1944, Lauro Cruz worked as a draftsman in the Luzon Engineer District of the U.S. Armed Forces. He later became assistant engineer, General Engineer District, then assistant engineer of the Manila Real Estate Branch, U.S. Army.

At this point, the professional "on-the-way-up" decided to take a postgraduate course in the United States. In 1947 he received from Yale University a Master's degree in structural engineering. Back in the Philippines, he joined the Manila Railroad Company as designing engineer for its many projects. He held that position until 1950 when he came to the Atlantic Gulf and Pacific Company of Manila, Inc. He has now been with the AG&P for 22 years.

AG & P's Steel Fabrication Division Staff of which Engineer Lauro Cruz (standing, front row) is the head.

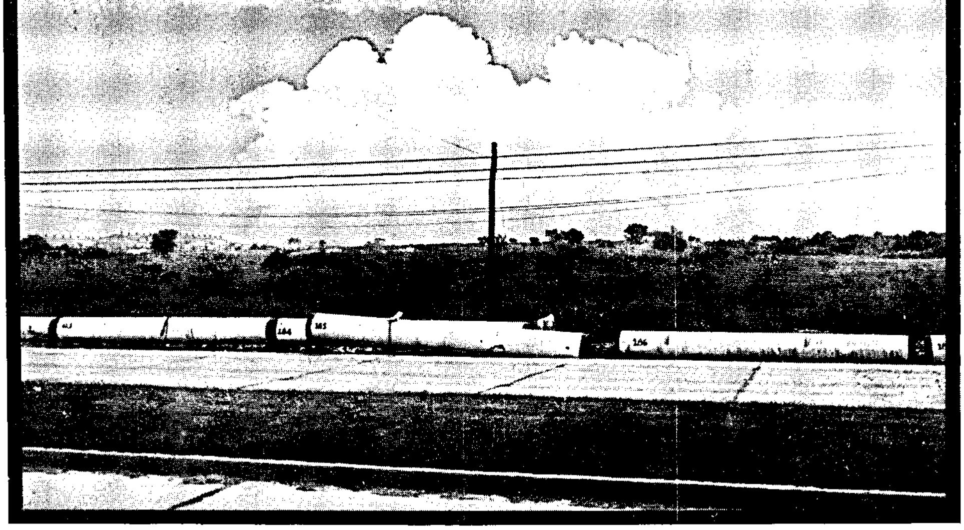
Engineer Lauro Cruz on the job with AG & P's Lito Arguelles (extreme right), supervising sales manager and Francisco de Mesa, foreman. On the background is the Ortigas Building, designed and constructed by AG & P.



The various positions he held with AG&P prior to his appointment as vice-president and manager of the firm's Steel Fabrication Division in May, 1971, include: designing engineer, 1950-60; chief, sales engineer 1960-66; and manager, consultation design and sales department, Steel Fabrication Division, from 1966 to April, 1971.

Not all work has been confined to his AG&P office. He has taught at Feati University, Mapua Institute of Technology, and Polytechnic Colleges of the Philippines. He also actively participated in special courses and seminars to keep up-to-date on his profession, which have included: Review on Soil Mechanics, U.P., 1952; the Harvard Business School Association Seminar on "Ten Advanced Tools for Decision Making," 1965; the Philippine Atomic Energy Commission-sponsored Regional Training Course in Non-Destructive Testing held in Singapore, 1971; to mention only a few. He still devotes a great deal to professional, civic and religious organizations such as the Knights of Columbus of which he is presently District Deputy; the Philippine Standards Association of which he has been Director since 1969; and the Philippine Iron and Steel Institute of which he has been director since 1971.

He is married to the former Margarita R. Tantoco. They have seven children and reside in Quezon City.



INTERNATIONAL PIPE INDUSTRIES CORPORATION

Firm Feature

The importance of a steel pipe industry to a country's economic development is evident to all observers. A host of industries and public services are, in varying degrees, dependent upon steel pipe and tubing. These include waterworks, oil and gas, mining, air, refrigeration, electrical power, and construction among others.

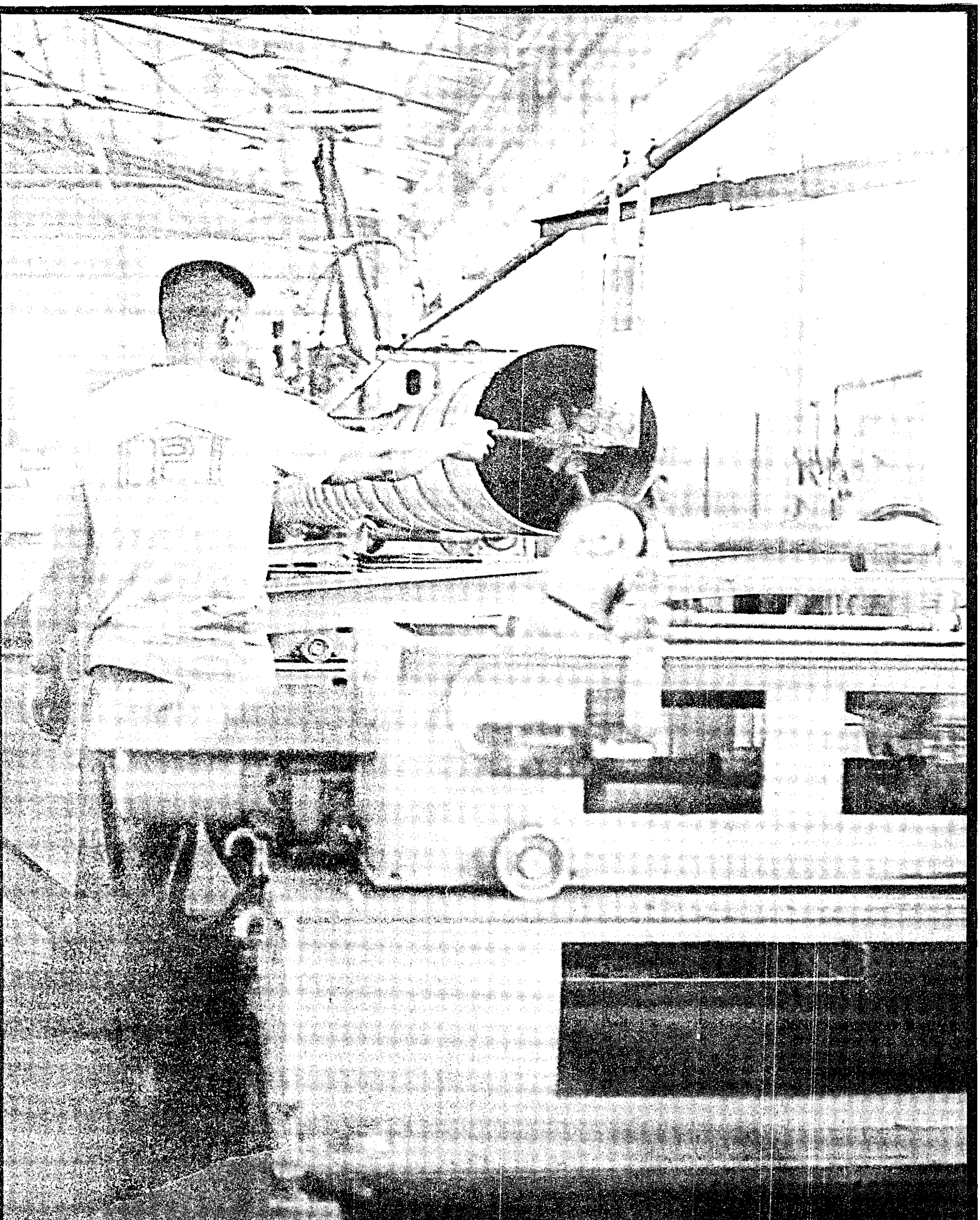
Aware of the absolute essentiality of pipes to Philippine economic and industrial development and the important role that pipes will play in the govern-

Fittings and Specials are fabricated by API Certified Welders.

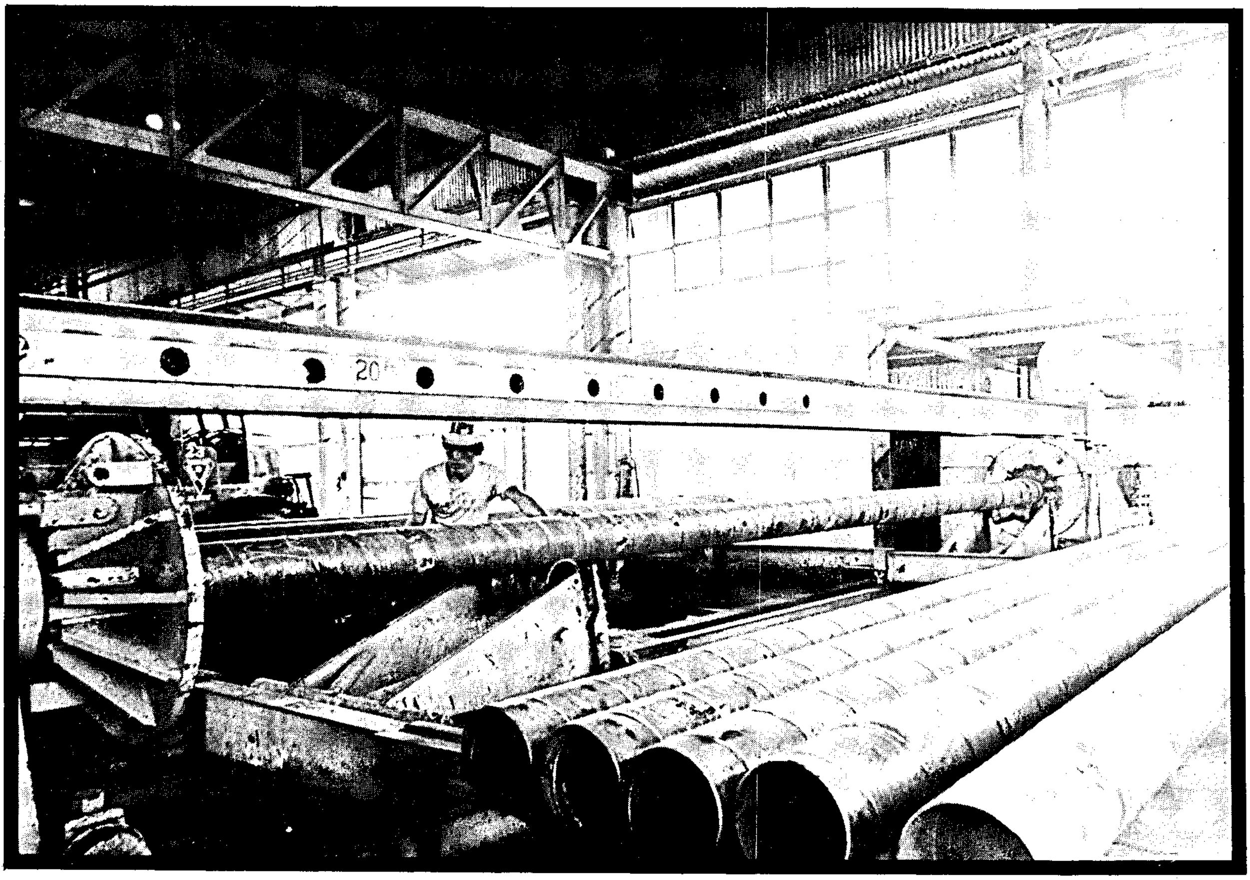
ment public works program — waterworks, irrigation, bridges, port works and electrification, INTERNATIONAL PIPE INDUSTRIES CORPORATION (IPIC) was founded and incorporated on November 24, 1964 under the name Driam (Phils.) Pipe Corporation.

IPIC counts among its principal original investors, Don Gonzalo Puyat of Surigao Development Corporation, and Congressman James Chiongbian, pioneer industrial leaders of the Philippines, as well as the largest steel pipe manufacturer of Holland namely: NV Verenigde Buizenfabrieken VBF, of the Koninklijke Nederlandsche Hoogovens En Staalfabrieken NV (Royal Netherlands Blast Furnaces and Steelworks, Ltd.), and Neris International, Inc., New York, through its associates, Neris Philippines, Inc.

In November, 1966, the company changed its corporate name to International Pipe Industries Corporation with the purpose of widening the scope of its operations. Installations of its initial machinery and construction of its major plant facilities for the pro-



Steel pipes are cut automatically to predetermined lengths on the spiral machines' pipe run-off and ejector assembly.



The Hydrostatic Testing Machine — where every steel pipe is tested to the hydrostatic pressures required by API, ASTM,or AWWA specifications.

duction of large diameter steel pipes were its main activities until the first quarter of 1967. After conducting trial runs, commercial operations started in the same year. The US AID through the Industrial Guarantee and Loan Fund (IGLF) supported the project as long term financier of capital equipment while the Surigao Development Corporation contributed the land for the factory site. Promotion and project studies were conducted by Gascom Engineering Corporation.

Since 1967, IPIC has pioneered in the production of large diameter steel pipes and tubes and has been meeting a major portion of the vital demand of the country.

IPIC plant and offices occupy a total area of two hectares, located at Ortigas Avenue, Barrio Ugong, Pasig, Rizal. Employees total 152. Company officers are: Eugenio J. Puyat, Chairman of the Board; R. G. Vildzius, President; Dominador de Jesus, Vice-President & General Manager; Antonio G. Puyat, Treasurer; and Luciano Salazar, Secretary.

The Board's Executive Committee is made up of R.G. Vildzius, Antonio G. Puyat, Perfecto Mendoza, Erwin Chiongbian and Dominador de Jesus (ex-officio).

IPIC's staff include Patricio de Guzman, Plant Manager; Wolfgang J. Hendele, OIC, Machinery

Division and Research & Development Consultant; Pedro B. Bayle, Design Engineer; Crisanto Laset, Administrative Engineer; Balbino Laset, Production Engineer; and Manuel A. Baguio, Chief Accountant.

PRODUCTION

The spiral or Helical Weld process has an advantage from the production point of view, particularly in the less developed countries whose pipe requirements do not warrant excessive investment in plant facilities.

It is possible to change from size to size much more quickly than with other processes. Coil changes do not have to be made with every pipe diameter unless thickness is required to be changed. Thus, coil stocks in inventory need not be excessive.

The spiral weld process of pipe making has been acknowledged as one of the most modern and highest quality method of manufacturing large diameter welded pipes. Spiral weld pipes are, under the latest API Specifications for Ultra High-Test Line Pipe (yield point as high as 100,000 Psi), as equally acceptable as even seamless pipes.

A longitudinal weld is subjected directly by internal radial pressure to tangential strain. Since these forces do not act at 90° on a spirally welded seam, spiral weld pipes have a safety factor higher than that of other welded tubes or pipes. Spiral weld pipes have 25% more strength and 25% less weight than conventional pipes. Some of the advantages of spiral weld pipes are: infinite lengths, perfect roundness and straightness, greater strength, even thickness, thinner walls, greater resistance to pressures, flexibility and good weldability.

A commonly made objection to spiral weld pipe is the "proudness" of the weld. This is not so with IPIC spiral weld pipes. The inside weld is practically flush with the parent metal and does not interfere to any measurable degree with the turbulent flow of fluids.

The main products of IPIC are large diameter welded pipes and tubes, from 4 inches to 60 inches outside diameter, for use as oil and gas pipes, water pipes, piling pipes, mining pipes, irrigation pipes, and other industrial applications.

Other products include:

a) pressure and storage tanks for water, oil, gas and chemicals in a wide range of pressure requirements, made according to customer's specifications in diameters up to 60 inches;
b) electrical transmission poles for 34.5KV, 69KV and 115KV lines;
c) smoke stacks from 8 inches to 60 inches in diameter to any desired height, with various external protective coatings and fire brick or equivalent internal linings; and
d) special fittings such as bends, tees, angles, elbows, wyes and crosses are fabricated from tested pipe and wrapped or lined as required to match pipes ordered, or zinc coated for above-ground installations.

MANUFACTURING PROCESS

Unless otherwise specified, IPIC pipes are manufactured from steel made by one or more of the following processes: open hearth, basic oxygen or electric furnace. They can also be produced using special steels such as stainless steel, and non-ferrous metals such as aluminum and copper and all other weldable materials when required. IPIC steel pipes are made from hot-rolled steel coils or plates of any standard specification, to suit the different applications. The strip edges are simultaneously welded both internally and externally, by a fully automatic submerged arc welding process.

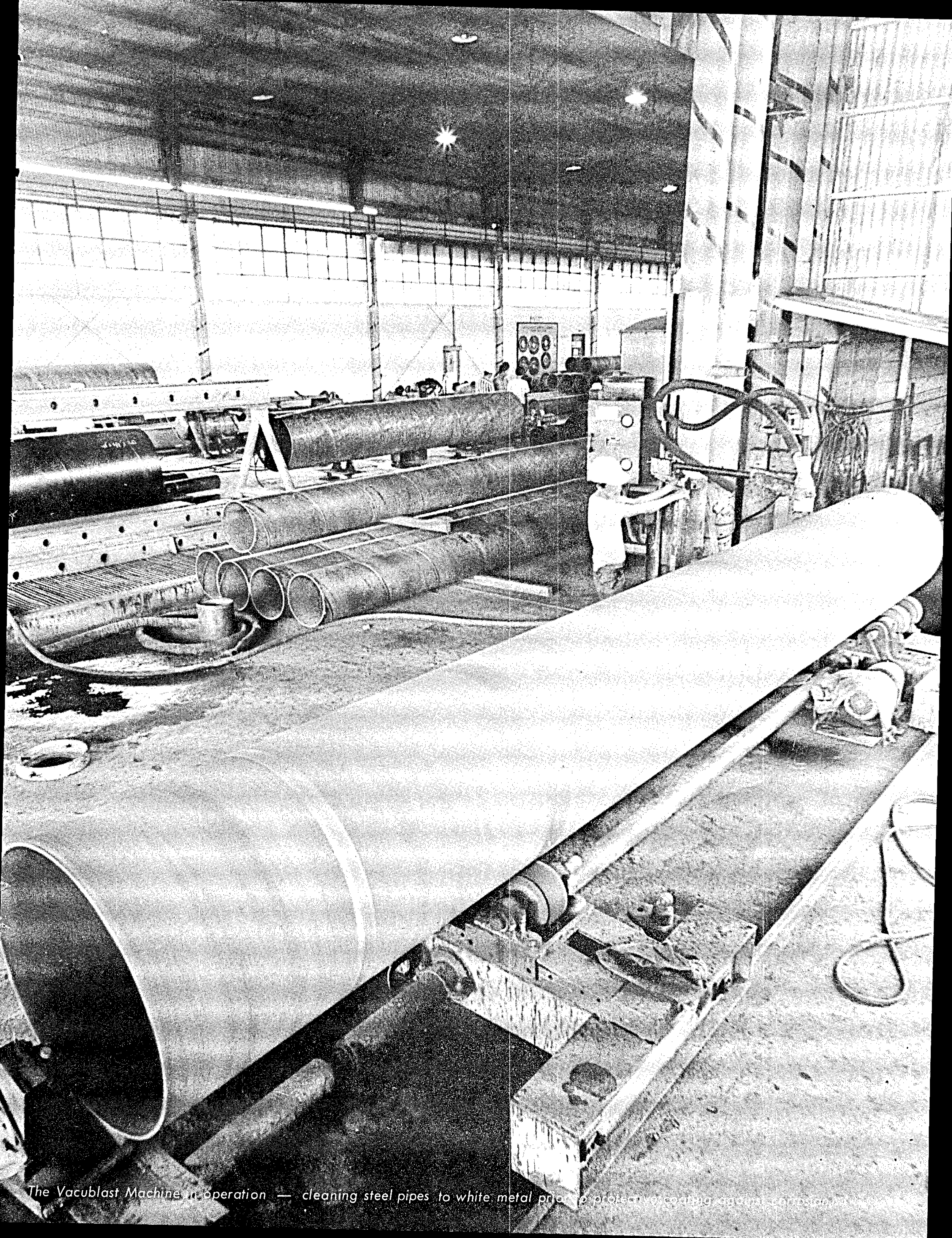
Spiral weld pipe can be made by either the electrical resistance welding process or the automatic submerged arc welding process.

Researches have shown that due to metal flow in the butt weld zone, sensitization of the material in electric resistance welding is strong and the material is slightly lacking in toughness.

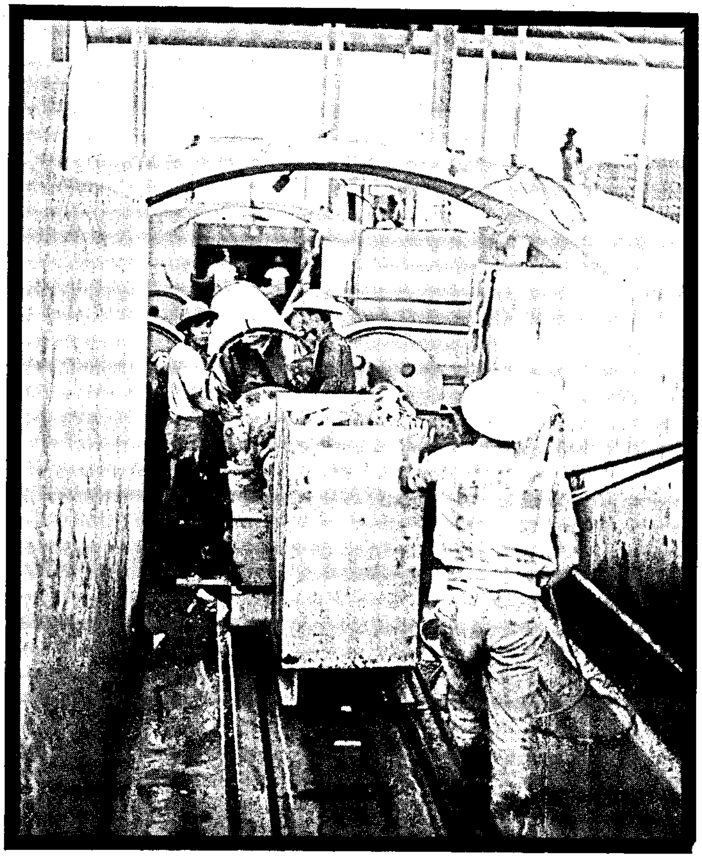
The automatic submerged arc welding process is therefore used in IPIC and most spiral weld plants in the world for the production of high strength pipes.

Coal tar enamel lining or cement mortar internal lining of the fabricated pipes, after having been tested for quality, are also done as required by the customers. Where external protection is called for, the most common external wrapping materials used are coal tar primer, coal tar enamel, asbestos felt, and fiberglass wrap. Zinc coating is also fast becoming a popular coating for structural applications such as electric power, transmission poles, bridges, etc. Where corrosion protection is called for, the pipes are vacublasted to white metal before application of the wrapping or coating.

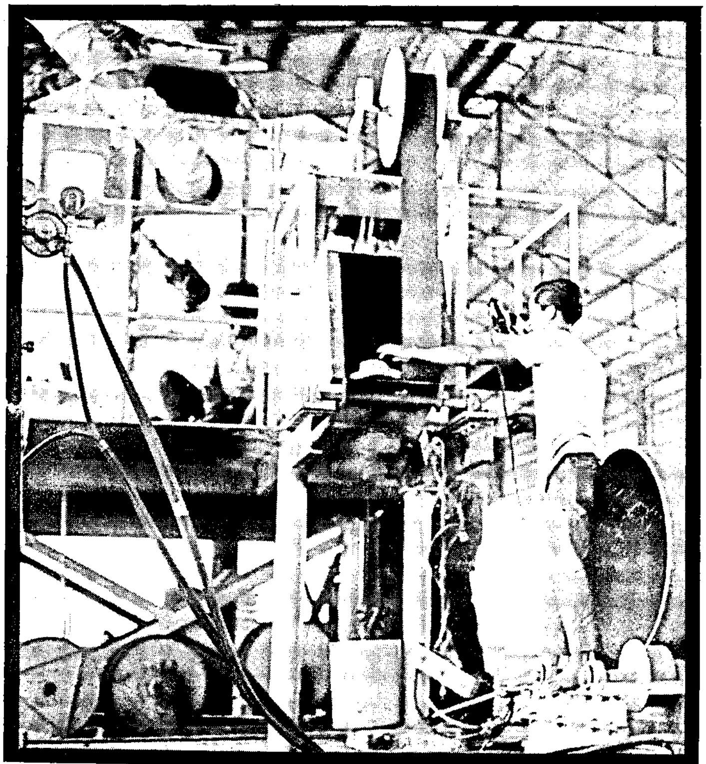
IPIC spiral welded pipes are made according to the physical, dimensional and pressure requirements of all major pipe specifications. Design specifications are approved by the following authorities: American Water Works Association (AWWA); American Petroleum Institute (API); American Society for Testing & Materials (ASTM); British Standard Specifications (BSS); American Standards Association (ASA); Japanese In-



The Vacublast Machine in operation — cleaning steel pipes to white metal prior to protective coating against corrosion.



Cement mortar being fed on a trough to the cement lining machine.



The Coal Tar, Boiler and Wrapping Machine — for giving steel pipes an outer wrap of coal tar and coal tar saturated asbestos felt to protect against external corrosion.

dustrial Standards (JIS); and other international standards.

QUALITY CONTROL, TESTS AND INSPECTION

Quality Control in the IPIC production line has been given particular emphasis. NDT (Non-Destructive Testing) procedures are carried out continuously to assure the quality of production.

On April 9, 1970, in recognition of the high standards to which IPIC adheres, the American Petroleum Institute issued to International Pipe Industries Corporation the authority to use the API Monogram on pipes manufactured to API 5LS Specifications, giving IPIC the distinction of being the only spiral pipe plant in Southeast Asia to be so authorized. Even in Japan, only four (4) pipe mills are API 5LS authorized manufacturers.

Materials Control —

All materials used in the manufacture of IPIC pipes are subjected to both destructive and non-destructive tests. The results of these tests, along with the tests carried out by the plate or coil manufacturer, eliminate the possibility of defective materials being used.

Hydrostatic Pressure Test —

All pipes are subjected to a hydrostatic pressure test as required by various standards. While under pressure, welded pipes are struck with a two-pound hammer or its equivalent, near the weld at both ends of the pipes, to ensure their water tightness.

X-Ray Tests —

Ultrasonic Tests and X-rays are continuously being performed by the IPIC Quality Control technicians and independent inspectors. Such tests are absolutely indispensable in the manufacture of API line pipes.

Inspection —

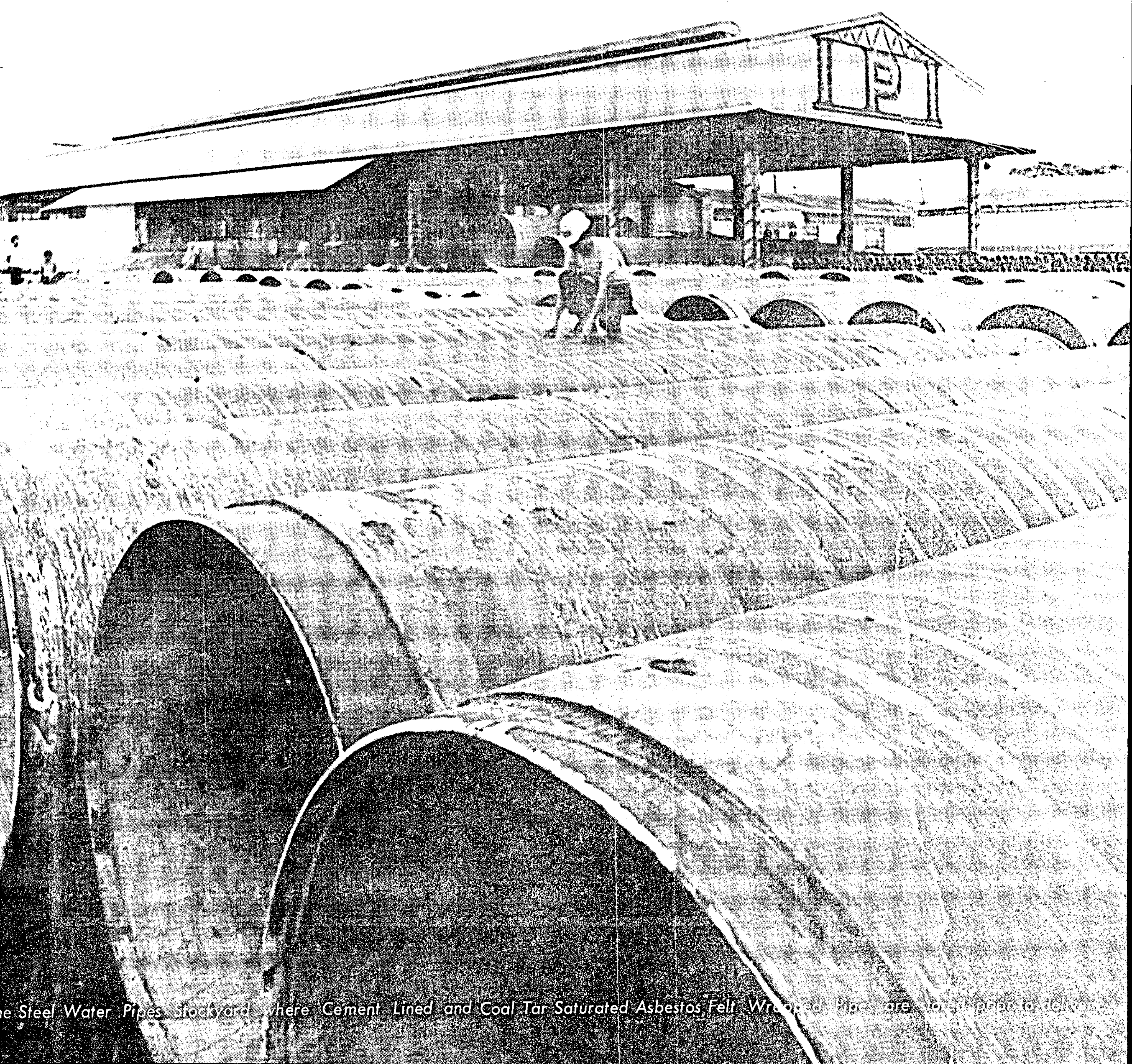
After completion of the various regular production tests, pipes undergo final examination to verify diameter, roundness, wall thickness, tolerances, length and straightness.

Destructive Tests —

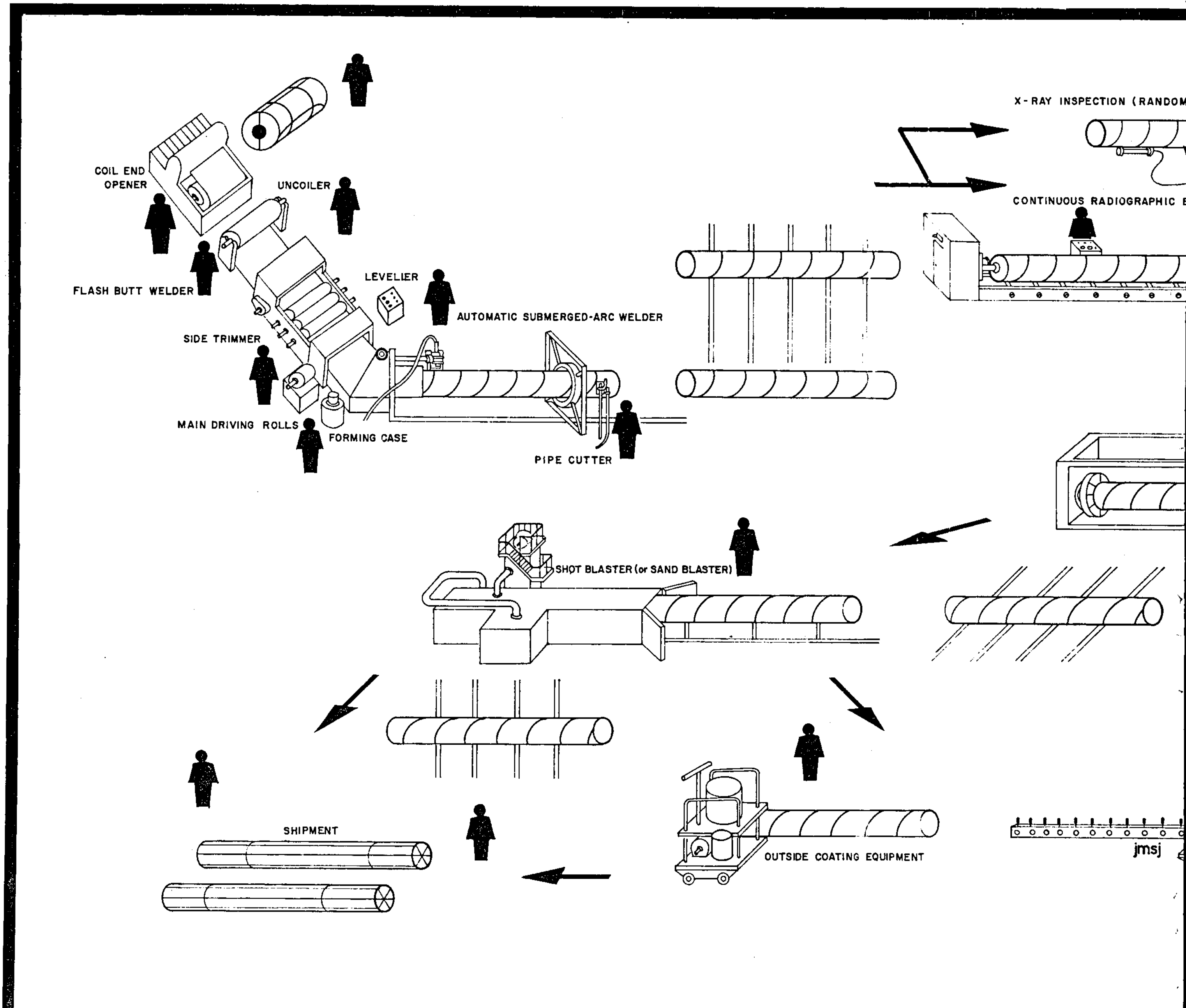
In addition to the foregoing routine procedures, destructive testing is carried out on statistically selected random samples to maintain quality of manufacture. These include tensile tests, impact tests, nick-break tests, Brinnel tests, elongation tests and bend tests.

PROBLEMS OF THE INDUSTRY

Like all segments of the iron and steel industry, the steel pipe manufacturer is faced with competition of low priced (at dumping prices) imports at only 10% duty. IPIC hopes that a protective tariff wall will be



he Steel Water Pipes Stockyard where Cement Lined and Coal Tar Saturated Asbestos Felt Wrapped Pipes are stored prior to delivery



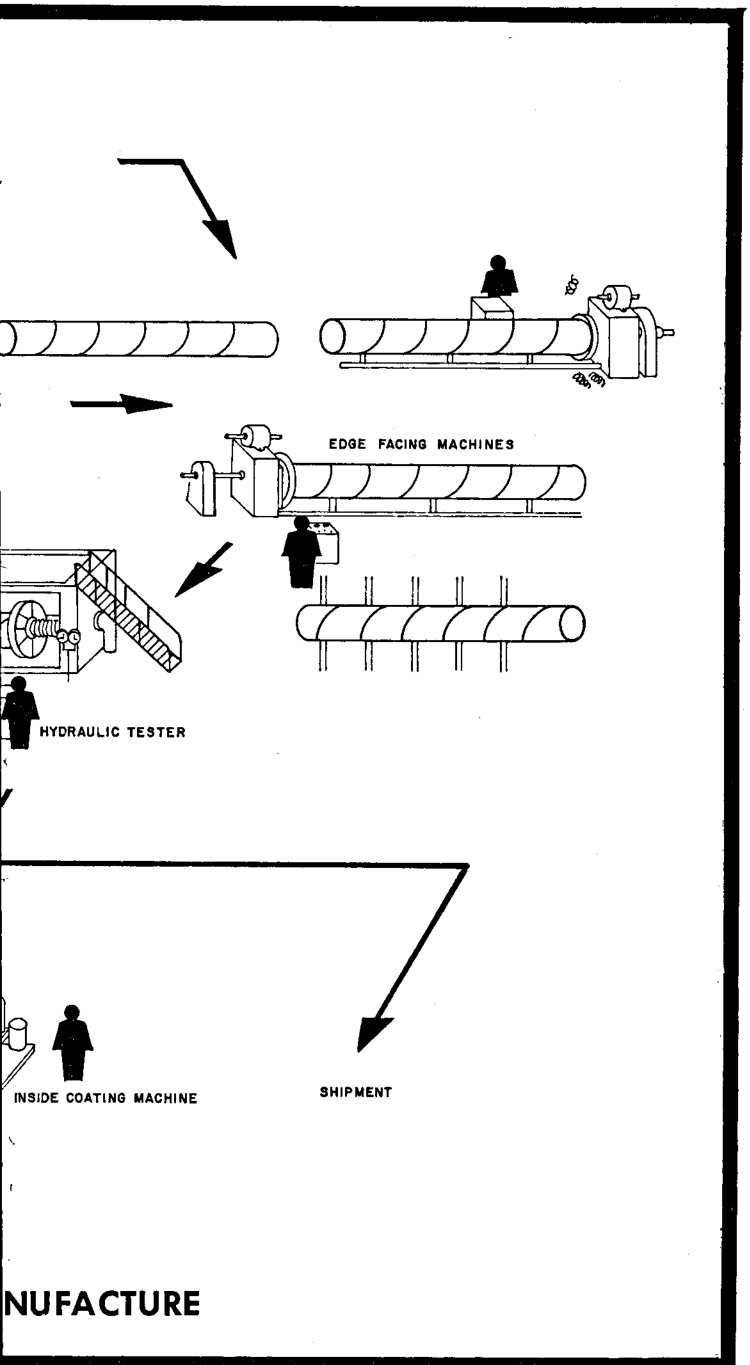
FLOWSHEET OF SPIRAL WELDED STEEL PI

set in the Omnibus Tariff Bill now in Congress, to help the local pipe industry.

Another of its problems is the Japanese policy of high raw material prices and low finished product prices. IPIC has had to import its raw materials from Japanese suppliers who sell in the Philippines their own pipe products under the most favorable financial arrangements. The early realization of the integrated steel mill project or at least the full scale operation of the Philippine hot-strip mill is much awaited by the pipe mills in the Philippines to avoid dependence on raw material imports.

Of course, compounding the ills of the pipe industry is the tax free importation by government and government-assisted or favored industries of huge quantities of pipes under long term financing arrangements.

This last problem is the most serious of all to IPIC. Users of huge quantities of water pipes and other pipe products cannot be prevailed upon to use locally manufactured pipes when the imports are tax free and obtainable under long term and low interest



financing from abroad. A more realistic tax structure removing tax exemptions on products already produced locally seems the only answer.

EXPORT ACTIVITIES

With the domestic market diminished by low priced imports, IPIC had to develop markets elsewhere.

In 1970, in competition against Japanese and U.S. suppliers, IPIC won a bid to supply the US Navy Contractor in Saigon, Vietnam, RMK-BRJ, about US$230,000 worth of elliptical dredge pipe pontoons. In 1971, IPIC exported water pipes worth around US$250,000 to Bangkok, Thailand and Kuala Belait, Brunei.

IPIC also "exports" technical services. At present, it is serving contracts with Sathask-Driam of Thailand for technical management and operation of their spiral weld pipe plant. IPIC has also signed with Krakatau Hoogovens International Pipe Industries Ltd., P.T. (KHI P.T.) of Indonesia a Systems and Construction Services Agreement plus a Technical and Know-How Support Agreement.

Early last year, IPIC established its Machinery Division for the manufacture of spiral weld pipe machinery and accessory equipment.

This coming October, IPIC will start to deliver, in three shipments, complete plant machinery and ancilliary equipment for a spiral weld pipe plant which is valued at $1.025 Million to Indonesia.

This machinery export will not only earn much needed foreign exchange but gain international prestige for the Philippines. This is a "first" for the country.

This will be the first time a Philippine company will export locally manufactured machinery and equipment for a complete turnkey plant, including technical and general management consultancy services for the initial five (5) years of operation.

The machinery is being sold to a joint venture, Krakatau Hoogovens International Pipe Industries Ltd., P.T. (KHI P.T.) which includes the Royal Netherlands Blast Furnaces (Koninklijke Nederlandsche Hoogovens En Staalfabrieken NV) of Europe and Krakatau Steel Mills, which is an affiliate of Pertamina — the state-owned oil company of Indonesia.

IPIC hopes to establish itself as the leader in spiral pipe technology in Southeast Asia and has embarked on an ambitious export program. It believes that after the Indonesia export, new opportunities for similar ventures in Southeast Asia will arise.

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METAL STATISTICS & ECONOMICS

FOREIGN EXPORT PRICES

Table 1
CONTINENTAL STEEL EXPORT
Monthly Price Averages May to August 1972
(In US $ Per Metric Ton)

	May	June	July	August
Billets	—	—	—	—
Reinforcing rounds (a)	102.1	106.2	109.7+	110+
Merchant bars	112.9	116.4+	118.8+	119+
Joists, channels (Brit)	—	—	—	—
Channels (US)	—	—	—	—
W.F. (Uni. beams)	136.1+	139+	141+	141+
Wire rods	122.5	127+	133	133
Hot rolled strip: 1 in.	123.6+	125.2+	—	—
Tube strip	123.6+	125.2+	125.8+	128
Heavy plates (c)	126.9+	129.1+	130.4+	130.5+
Medium plates (d)	124.5+	126.9+	130.4+	130.5+
Universal plates	128+	130+	130+	130+
Chequer plates	127.4+	130+	130.9+	131+
HR sheets: 16g. & up	—	—	—	—
HR coil (dry)	—	—	125	125
CR sheets: 17-20g.	146.4+	150.8+	151.3+	151+
Galv. coils: 17-20g. (b).	180* (e)	180* (e)	190* (e)	190* (e)
Bright wire	140	141	—	—
Black annealed wire	157	160	—	—
Galv. wire: 5-16 1/2g.	161	163	—	—
Barbed wire	—	—	—	—

Source: Metal Bulletin
+ 2 1/2% exporter's commission incl. *less $5; corrugated extra $2; flat sheets $5.
(a) Usual deformed bar premiums; structural $2; intermediate $3
(b) 4-ton coil
(c) over 8 mm.
(d) 3-8 mm.
(e) Some markets quoted on cost and freight basis
MB's appraisal Continental (ECSC) mills' basis (net unless stated)
FOB export prices, ordinary Thomas Commercial quality. Markets, sizes, quantities delivery, etc. can affect prices shown.

Table 2
JAPAN MONTHLY AVERAGE DOMESTIC PRICE
(In US $ Per MT unless otherwise indicated)
May-August 1972

Iron Steel Products	May	June	July	August
Round Bar 9mm	99.80	99.31	103.72	107.20
16-25 mm	107.75	107.75	111.70	113.75
Flat Bar 6 × 50 mm	125.91	125.93	127.16	129.46
Equal Angle 6 × 50 mm	113.26	111.28	113.73	116.83
10 × 90 mm	121.18	118.06	119.18	122.04
Channel 6 × 65 × 125 mm	138.76	143.10	148.22	153.18
H-Shape 9/14 × 250 × 250 mm	154.73	156.90	159.36	161.41
Hot Rolled Sheet (3 × 6) 1.6 mm	148.78	148.74	154.04	158.45
Cold Rolled Sheet (3 × 6) 1.2 mm	162.00	159.50	159.09	160.54
Medium Plate 3.2 × 3 × 6	142.01	140.67	147.19	151.79
Plate 6 × 4 × 8	141.54	140.95	147.14	150.63
9 × 4 × 8	143.33	142.09	148.36	152.25
Gas Pipe (Black) 15A (1/2 inch) (per kg.)	0.16	0.16	0.17	0.17
Water Pipe (White) 15A (1/2 inch) (per kg.)	0.25	0.25	0.25	0.26
Galvanized Sheet				
(plain) 0.30 mm	187.09	187.09	187.09	187.50
(corru.) 0.25 (per sheet)	0.62	0.62	0.62	0.62
Colored Sheet				
(one side, plain) 0.30 mm.	263.5	262.18	261.90	261.36
(one side corru.), 0.25 (per sheet)	0.79	0.79	0.79	0.79
(one side, corru.) 0.25 (per sheet)	0.79	0.79	0.79	0.79
Wire Rod, 5.5 mm	133.52	134.74	134.74	133.93
Round Nail, 100 mm (4 inches)	187.09	185.06	183.94	183.95
Iron Wire, No. 8	166.40	164.85	163.15	163.15
Annealed Iron Wire, No. 8	173.67	166.76	165.27	166.00
Galv. Iron Wire, No. 8	192.37	191.56	191.56	191.97
Barbed Wire, No. 14	252.44	252.44	253.47	254.46
Tinplate, 90 L (0.257 mm)	322.85	322.85	322.85	322.85
Wire Netting, 20 × 15 mm (one roll)	6.37	6.41	6.41	6.41
Welded Steel Netting, (1 sq. meter)				
No. 4 (6 × 150 mm)	0.77	0.77	0.77	0.77
No. 8 (4 × 100 mm)	0.58	0.58	0.58	0.58
Special Steel				
Constructural Carbon Steel (SC)	149.35	152.81	154.55	155.84
Stainless Steel (per kg.)				
SUS 24 (18 CR)				
Sheet (2-6 mm)	0.64	0.66	0.69	0.70
SUS 27 (18-8)				
Sheet (03 mm)	1.35	1.35	1.38	1.39

Nonferrous Metals	May	June	July	August
Electric Copper	1190.21	1160.15	1113.64	1088.47
Electric Zinc	414.77	414.77	414.77	410.83
Electric Lead	354.71	352.44	352.27	352.27
Tin	3981.67	3340.75	3922.71	3921.03
Antimony	1615.26	1615.26	1603.08	1603.08
Nickel	4074.68	4155.84	4155.84	4155.84
Selenium	24431.82	24431.82	24431.82	24431.82
Bismuth	9577.92	9577.92	9577.92	9577.92
Cadmium	6582.79	6582.79	6582.79	6582.79
Mercury	6209.42	6152.60	6087.66	6087.66
Aluminum	637.17	637.17	637.17	637.17
Rolled Copper & Brass				
Copper Sheet, 2.0 mm	1634.65	1601.73	1566.26	1536.02
Copper Tube, 50 × 5 mm	1720.78	1688.31	1653.44	1636.52
Copper Rod, 25 mm	1613.64	1589.29	1561.45	1537.57
Copper Wire, 0.9 mm	1580.09	1569.26	1509.14	1473.41
Brass Sheet, 2.0 mm	1304.11	1269.48	1240.38	1241.50
Brass Tube, 50 × 5 mm	1401.52	1374.46	1354.02	1352.81
Brass Rod, 25 mm	1059.25	1006.49	989.06	989.49
Brass Wire, 6 mm	1242.79	1206.71	1203.70	1201.30
Rolled Aluminum				
Sheet (99%), 1.0 mm (400 × 1,200)	933.44	936.69	941.56	949.67
Circle 1.0 mm	1055.87	1063.31	1079.55	1079.55
Steel Scraps				
Special for Electric Furnace	39.26	38.03	37.36	39.12
Pig Iron Scrap	58.03	58.03	58.53	59.66
Copper Scrap				
No. 1 Copper Wire (Berry)	1098.42	1075.24	1036.07	1026.90
No. 2 Copper Wire (Birch)	1045.05	1010.79	973.49	961.50

Source: Japan Metal Bulletin

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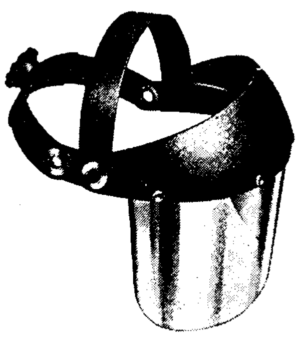

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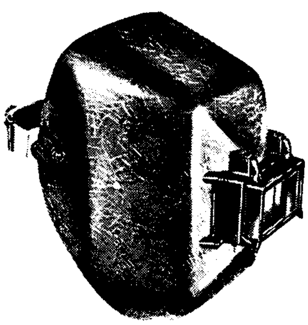

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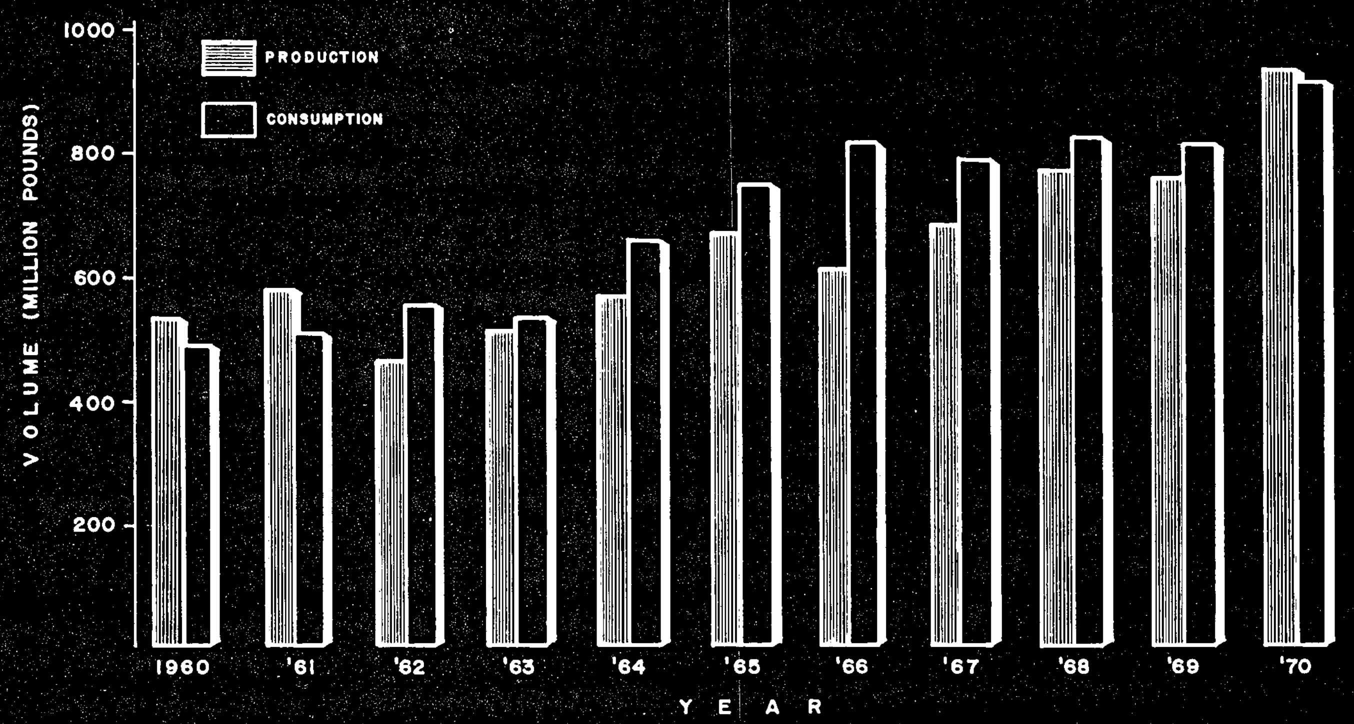


Figure
TOTAL WORLD CONSUMPTION AND PRODUCTION OF NICKEL
(1960 - 1970)

INTERNATIONAL MARKET OF NICKEL

There are more than forty companies in the world today engaged in nickel production. However, only three-International Nickel Company, Societe le Nickel and Falconbridge Nickel Mines, Ltd. – qualify as established major producers. These three companies have over the past fifteen years had a 70-90 per cent combined share of the world market.

The individual companies are described below:

A. International Nickel Company (INCO) has been the predominant force in the nickel industry. Its sales in 1970 amounted to $1,067 million and the company delivered around 519 million pounds of nickel in all forms which represents about 53 per cent of total free world nickel consumption. The market share of INCO has been on the declining trend from the high 60 per cent level of the mid-1950's. This is expected to fall further to 45 per cent in the years 1970-75.

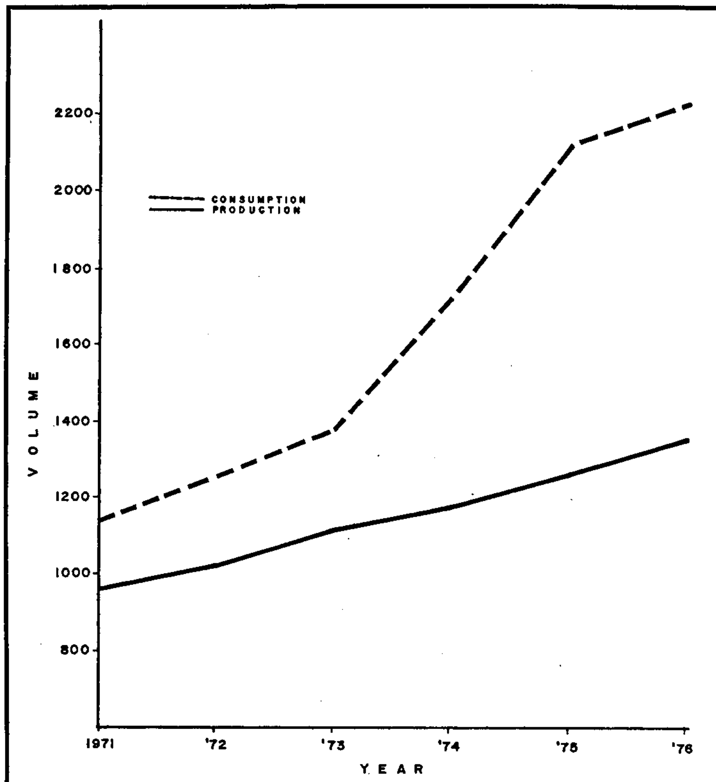
B. Societe le Nickel (SLN)

In the early days of the nickel industry, SLN has always ranked first among the top four producers. Group sales in 1970 was more than $325 million and the amount of nickel delivered reached 128 million representing 13 per cent of the total free world nickel production.

SLN's market share has grown from six per cent in 1955 to 13.5 per cent in 1968. From 1968 to 1975, it is projected that SLN's market share will remain constant.

C. Falconbridge Nickel Mines (FNM)

FNM is the third largest nickel company in the world. Group sales in 1970 totalled $275 million with nickel deliveries at 84 million pounds which represented 8.5 per cent of the total free world nickel consumption.



PROJECTED CONSUMPTION AND PRODUCTION OF NICKEL
(1971 - 1976)

The market share of FNM declined from about 13 per cent in the mid-50's to a low 9 per cent in 1970. This is expected to increase to 15 per cent by 1975.

D. Established Minor Producers

The established minor producers contribute 20-25 per cent of total free world consumption. Not one of these established minor producers have been able to become a major producer. They were not able to increase their deliveries on a regular basis beyond the 30 million pounds level.

DEMAND

World consumption of nickel over the past fifteen years has been increasing steadily at the rate of seven per cent. Seven countries which include the United States, United Kingdom, Japan, Germany, France, Italy and Sweden account for 90-95 per cent of total free world nickel consumption. The table below shows the rate of increase in nickel consumption in these major countries.

Table 1

Country	Rate of Increase in Nickel Consumption Per Year
United States	*3.9*
United Kingdom	*3.5*
Germany	*9.7*
Sweden	*12.2*
France	*9.6*
Italy	*16.3*
Japan	*20.0*

These countries' share of total nickel consumption has been declining from 94-95 per cent in 1955-58 to 90 per cent in 1970. This is expected to dip further by 1975 to an 85-90 per cent range as countries like Australia, South Africa and Canada increase their share of consumption. Nickel consumption by commodity end-use is shown in Table 2.

Table 2
COMMODITY END-USE FOR NICKEL
(Million Pounds)

Commodity	1970	1975
Stainless Steel	*404*	*664*
Alloy Steel	*104*	*158*
Ferrous Castings	*88*	*111*
Electroplating	*130*	*205*
Nickel Alloys	*135*	*237*
Copper Alloys	*32*	*63*
Others	*92*	*142*

Consumption of stainless steel has been growing for the past ten years. Of the total consumption in 1961, stainless steel accounted for 28 per cent increasing to about 42 per cent in 1970. This is followed by nickel alloys and electroplating which contribute 15 per cent and 13 per cent of total consumption in 1970. Consumption of all these commodities is expected to increase by 1975.

Primary nickel consumption in the free world increased from 500 million pounds in 1960 to about 955 million pounds in 1970 as illustrated in the figure. But in 1971, when the nickel slump began, consumption of nickel dropped to 825 million pounds. The sharp decrease in nickel usage affected almost every geographical area of the non-Communist world.

SUPPLY

World production of nickel in 1900 amounted to only 12,000 tons but because of the wide use of nickel and its alloy which resulted in a rapid growth of the industry, production of this metal increased up to the years before and after World War II. Since then, total world production has upped from 780 million lbs. in 1969 to 1015 million lbs. in 1970.

Supply was short of demand from 1964 to 1968. During this short consumption boom, the international market demanded some 40 per cent more nickel. The shortage of nickel was aggravated by the lengthy strikes of the International Nickel Company of Canada, Ltd. (INCO) and Falconbridge Nickel Mines Limited Canada. Another major cause was attributed to the under-estimation of the difficulties in both sustaining existing production levels and also increasing them against the reality of declining ore grades. These difficulties were due to a number of factors, including shortage of labor, which forced the nickel producers to ration their output even while operating their mines at full capacity.

PRICE

The price of nickel increased only very slightly from 1955-1966, averaging around 1.6 per cent annually. However, in the 1965-1970 period, the price increase was tremendous, averaging 12.1 per cent per year. In 1967, price was held at 94 cents, then it started to move up to \$1.02 in 1968. The following year, 1969, price increased to \$1.28 because of the 35 per cent wage boost in Canada. In 1970, the price was raised to \$1.33. It is projected that a five per cent average growth in price will continue over the next five years, bringing the price to approximately \$1.70 in 1975. It is expected that the price will increase by 13 cents (or 10 per cent) in 1972 and a further increase of 20 cents (13 per cent) in 1974.

The major producers of nickel and some of the minor established ones have followed INCO's pricing. During a shortage period, the major producers supply their customers with nickel well below the prevailing market price. In periods of surplus the large nickel consumers are inclined to purchase from the big producers to maintain their access to a steady source of nickel. These powerful nickel producers, prospecting mining and selling nickel on a world-wide basis, have ample capital resources to survive the surplus periods and are able to maintain an adequate reserve production capacity at all times.

MARKET FORECASTS

Metal analysts project 1973-75 as good years for nickel. This will possibly be followed by a decline after 1975. However, a sharp rise in demand is projected around 1977-80. At present, there is a temporary oversupply in the nickel market in the free world. The basic reason for the oversupply could be traced to the slowdown in the economic growth of leading industrial nations like the United States in 1971. This resulted in a decrease in the demand for steel leading to cuts in total world steel output particularly in the alloy and stainless steel sectors of the steel industry.

The latest study on the projected world consumption and production of nickel was based on the 1960-1970 figures as shown in the chart. The slump in nickel consumption in 1971 was not yet considered.

CONCLUSION

The problem of the nickel industry is somewhat related to that of copper and aluminum in the sense that large-scale development of new capacity and resources has temporarily run ahead of demand. Stocks are building up among major producers of refined metal in Canada and Japan. INCO, for one, has managed to get a foothold in New Caledonia by participating in Cofimpac, a partnership venture with a consortium of other French interests. INCO is pledged to 61 per cent of the $400 million financing for a 100 million pound project in the southern part of the island and will get half the nickel output. It has also spent $15 million in Guatemala, preparing the way for a $205 million open pit mine in the northwest shore of the vast Lake Izabal. Falconbridge too has arranged the financing for a $190 million project in the Dominican Republic which is expected to produce 63 million pounds of nickel by 1973. Societe le Nickel has launched the largest project in the industry. One phase will be the production of an additional 60 million pounds of nickel by 1971 and another 110 million pounds may be added around 1975.

The first step made by major nickel-producing countries is to cut down production. INCO cut production by 15 per cent in November of last year and another seven per cent cutback is being initiated August of this year. This means that a potential 60,000 tons of nickel will be withdrawn from world markets, apart from cuts by other leading producers.

The trend in the special steel industry has a major bearing on the business tone of the nickel industry. It is expected that with the improvement in the general economic and inflation problems of major steel-producing countries, the steel industry will be better off in the next few years. Thus, in the same manner, demand for nickel will increase. In effect, demand and supply will be balanced and this will result in adjustment in production.

It is predicted that the nickel industry has good prospects by 1973 after a period of depressed conditions.

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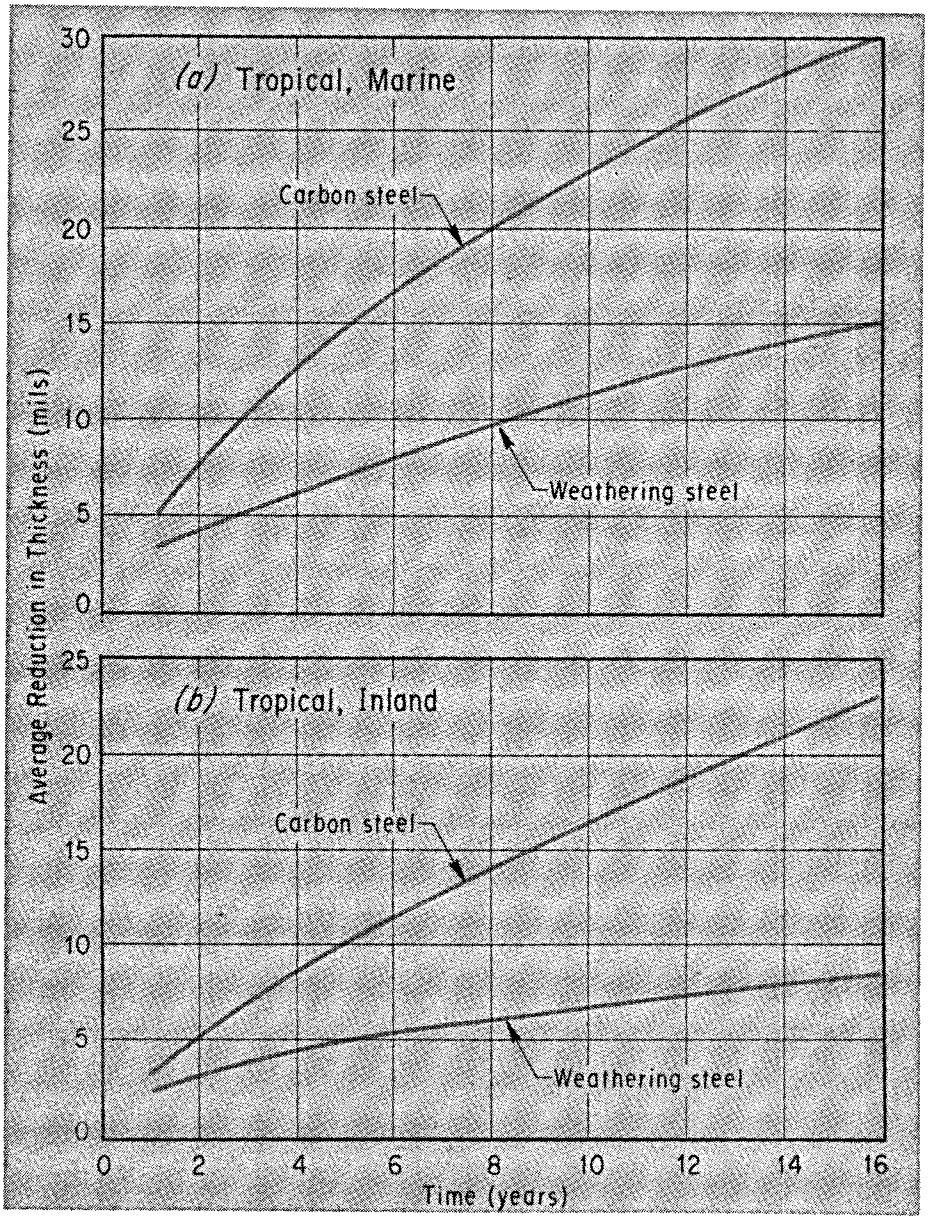
ENGINEERING & TECHNOLOGICAL DEVELOPMENTS

technical abstracts



Resistance of unpainted carbon steel and weathering steel corrosion in two types of tropical environments.

THE WEATHERING STEELS

The distinguishing feature of the weathering steels is that, with exposure to the atmosphere, they develop a tightly adherent, protective, surface oxide layer. Clearly, the layer is a type of rust. At the beginning of exposure, it is similar to the rust that forms on plain carbon steel. It is reddish in color, friable and loose, and much of it runs off in the rain. But within a few months, the color deepens, and the scale becomes tighter and increasingly resistant to permeation by water and air. After a year or so, the surface takes on a deep purple-brown or ox-blood color. In industrial environments, the rate of attack on the weathering steels is negligible after two or three years; attack on carbon steel continues at a relatively high rate. In a 20-year test total loss in thickness of weathering-steel samples was 0.002 in. compared with 0.013 in. in carbon steel. **Machine Design, May 27, 1972.**

HRS PROCESS SPEEDS UP DIRECTIONAL SOLIDIFICATION

A common mode of elevated temperature failure in high-strength, cast superalloys is intergranular fracture. The High Rate Solidification (HRS) Process, developed by Pratt & Whitney Aircraft is a step to overcome this problem. One goal of the process has been to increase the solidification rate during casting, leading to a reduction in casting cycle time (increasing output), and a refinement in the microstructure (improving mechanical properties). This process provides a means of increasing the temperature gradient in the solid. In this method, an open end investment shell mold is attached to a water-cooled chill located in a heated graphite susceptor. After super-heated alloy is poured into the mold, a holding period of a few minutes is allowed for thermal stabilization. During this period, an axial temperature gradient is established near the chill plate and solidification is initiated from the chill surface. The chill and attached mold are then lowered out of the susceptor at a predetermined rate past a radiation baffle located at the base of the susceptor. Withdrawal of the mold from the hot zone is continued until the casting is completely solidified.The directionally solidified casting can then be removed from the furnace for further processing. **Metal Progress, 1971.**

CAST CARBIDE CUTTING TOOLS: THE RESULTS ARE IN

Cast carbide, a new cutting tool material, has been developed by Teledyne Firth Sterling in conjunction with Teledyne Wah Chang. This castable carbide exhibits a tool life advantage of 3:1 to 10:1 over its powder metallurgy counterparts in the C-5 to C-7 range. Cast carbide consists of a dispension of a hard-carbide alloy in a high-strength refractory binder. It exhibits exceptional high hot hardness and strength and is suited for rough cutting of low alloy and stainless steels at high cutting speeds. Flank and crater wear resistance are excellent, and thermal deformation under heavy loads is non-existent.

There are several factors responsible for the observed high strength of the cast material. First, the presence of titanium and carbon and the exposure to high temperatures during fabrication result in very low residual oxygen content in the tungsten alloy. The low concentration of interstitial impurities combined with the effects produced by low level alloying of the tungsten with titanium result in low ductile-to-brittle transition temperatures. The finely distributed carbide provides wear resistance and also acts as a dispersion strengthener and binder for the tungsten base. Interface bond strength between binder and carbide alloy is aided by intragranular metal precipitation in the carbide and intergrowth of the precipitates with the metal binder. Partial annealing reveals that the metal precipitates form an interlocking network within the carbide brains. **Manufacturing Engineering and Management, September, 1971.**

STEEL FOR COLD HEADING DIES

The development of the cold heading process as a production operation is dependent upon satisfactory output from the tools used. Unsatisfactory life of the dies not only increases tooling costs but reduces the output from each machine by increasing standing and setting times spent in changing tools. The surface finish of the die is of great importance for the life, as is always the case with hardened tools.

For these purposes, a plain high carbon steel is suitable since it has a hard shell with a tough center with relatively shallow hardening. The stresses due to repeated blows will be dispersed through the soft core and should any fatigue cracks start in the hardshell, these will not penetrate far, so that the splitting of dies made of plain carbon steel is a rare occurrence. However full consideration must be given to the quality because impurities are source of weakness. The way in which the blank for the die is machined with relation to the direction of rolling or forging together with the necessary heat treatment are also of equal importance to the quality of the die. **The Assab Bulletin, August 1965.**

WINNING HEAVY METALS FROM WASTE STREAMS

Removing even trace quantities of metals that are suspected of having a bad effect on the environment or of being toxic to humans is becoming an increasingly important industrial problem.

Although beginnings of the high interest in metal recovery have to be traced to pressure from ecologists, what many companies are finding out is that they have been careless discarding a source of additional profit.

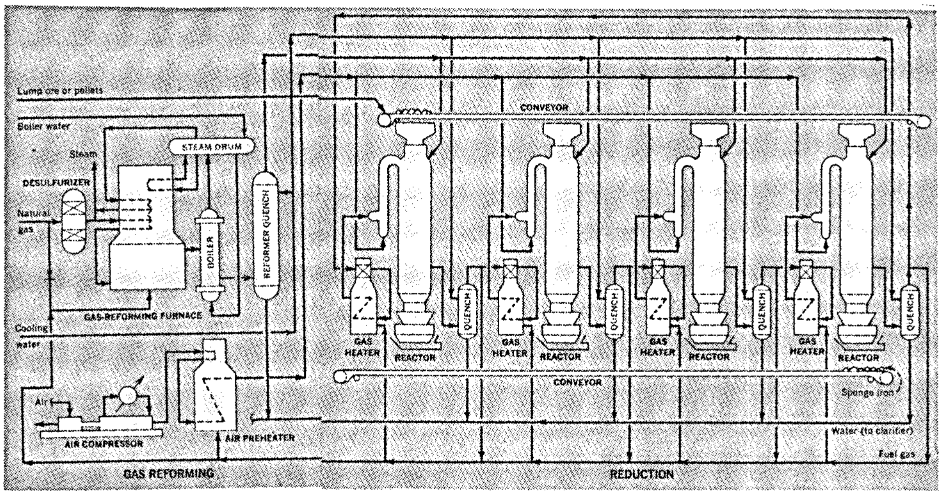
Ion-exchange technology has found an increase usage as industry strove to extract metals from effuents. Ion-exchange resins have been used for some time to extract uranium, and in the plating industry, to recover high-price metals from waste solution.

Basic anion-exchange resins are used to recover gold from the drop-out rinse water in the gold plating industry. Platinum and palladium can be removed and chromate from chromium plating waste water.

Mercury, a priority in heavy metal recovery, can be removed from waste water using a process developed by the Aktiebolarget Belingsfors-Langed of Sweden using ion-exchange resins dubbed Q-13 and Q-Sorb. **Chemical Engineering April 19, 1972.**

DIRECT REDUCTION STRIKES WHILE THE IRON IS HOT

The sponge-iron-making process is increasingly becoming attractive as a source of low-cost metallics to offset the rising price and uncertain availability of scrap and supply of coking coal for the blast furnace. The process involved the conver-



sion of iron oxides as lump ore or pellets to metallics for steelmaking. While other competitive process have been in full-scale use for a year or so, the Hyl system has been in successful commercial operation for almost 14 years. The Hyl process has had a 220-ton iron/day unit at its Monterrey Works since 1957, and put another 550 ton/day plant in 1960. Tubos de Acero de Mexico, S. A., has been running a 550-ton/day facility at Vera Cruz since 1967. Installation of another plant at Puebla, near Mexico City with a rated capacity of 660 ton/day was started in 1969.

Economics are a strong consideration of the process. Investment is less than 50 per cent of that for a comparable blast-furnace/coke-oven complex and operating costs are also lower. Plants as small 220 tons/day may be economical. Product from such a plant have at least 90 per cent metallization (non-oxide iron/total iron content). Sponge iron produced by the Hyl process is nonpyroforic, containing up to 2 per cent carbon. **Chemical Engineering, February 22, 1971.**

STRONG, LIGHTWEIGHT SHOCK-RODS ABSORB TREMENDOUS IMPACT ENERGY

The energy-absorbing rods, or "EA fasteners" as they are called was developed by Omark Industries, Portland, Ore. A threaded high-strength steel rod that is forced through a simple die is the basis for an energy-absorbing device that can withstand colossal amounts of impact energy simply and efficiently. As the rod is pulled through the die, the plastic flow of metal absorbs energy and dissipates energy. As plastic flow occurs, the level of resisting force depends on the entrance angle, and on the difference between the diameter of the rod and the diameter of the die hole.

The plastic flow concept results in an almost perfect force-deflection curve. The resisting force climbs sharply and then remains almost constant during the stroke of the unit. This results in a high energy-absorption rate. **Product Engineering, May, 1971.**

THE EFFECT OF GRAIN CHARACTERISTICS

The study provides a theoretical basis for grain characteristics. As a result, grain distribution in a variable grain aggregate can be described adequately by using only two characteristics: specific surface S_K and specific grain number n'_k. The relation of these characteristics to two other derived quantities—the representative diameter dn and the deviation Ag from the equalsphere aggregate — have been summarized in a basic diagram. The effect of grain characteristics is demonstrated for properties of as-poured unbonded quartz sands and for bentonite bonded quartz sands both in the as-poured and compacted conditions. The results can be applied to other granular aggregates and to other bonding materials.

Finally the importance of grain characteristics of molding sands with respect to some casting properties are discussed in seven examples. **AFS Cast Metals Research Journal, September 1971**

CERAMIC COATINGS IN STRESS ANALYSIS ARE A NEW TEST GAGE

New developments on ceramic coatings had been developed by Magnaflux Corp. Applying ceramic coatings to a test piece is a simple procedure. Before the application of the ceramic coating, the surface must be scrupulously clean. Fine-grit material mixed with a volatile liquid carrier is sprayed on the part to be tested. It must be applied in a uniform thickness. The part is then allowed to air-dry to a soft powder. It is then baked at 1000°F until it has a glazed surface.

The part is now ready for testing. Loads are generally applied in increments until some preselected design or maximum — stress condition is reached. As the load on the part increases, cracks begin to appear. Threshold strains on the ceramic-coating formulations range from about 400 MII to cover 1100 MII (micro inches per in). To get a more accurate picture of stress patterns, an electrostatically treated powder is sprayed onto the cracked ceramic coating. Positively charged, the powder is applied from an air-gun at 20 psi. Negatively charged ceramic-coating particles are attracted to the positively charged powder's particles, giving a highlighted stress picture. **Product Engineering, May, 1971.**

CHOOSING HARDENABLE STEELS SYSTEMATICALLY

Selecting a hardenable steel is often a difficult task of sorting out overlapping properties and characteristics of thousands of alloys. Factors such as the stress state of the application and cost must also be included in the choice. Assuming that a part is in the preliminary design stage and that the stress in the part under load is known, the selection procedures in selecting the hardenable steel that will provide the required mechanical and physical properties are as follows: 1) determine the critical point of an equivalent round section with respect to the type of service load anticipated, 2) convert the required mechanical properties to tensile strength, hardness and tempered hardness to minimum as-quenched hardness before tempering, 3) determine the per cent carbon necessary for the as-quenched hardness and per cent martensite, 4)select a scaling or nonscaling austenitizing and tempering furnace atmosphere, 5) determine the round equivalent of the part, 6) select a quenching medium and degree of agitation that will provide the fastest quench without causing cracks or distortion, 7) for a general case in which guaranteed-hardenability steels are used, determine equivalent Jominy distance for the part with respect to its critical diameter and the quenching medium selected and, 8) select a group of hardenability steels on the basis of the equivalent Jominy distance, carbon content and as-quenched hardness. **Machine Design, June 10, 1971.**

COLD BENDING OF STAINLESS SHEET AND PLATE

In cold bending stainless steel sheet and plate, greater pressures are required. Austenitic stainless steel have a low yield stress in the annealed state but have a tendency to work harder. The ferritic stainless steels have a higher yield stress than mild steel even in the annealed condition.

Annealed austenitic material with a thickness (t) of up to 4 mm. can be bent over a radius of t/2 and can usually be folded. The straight chromium steels with 18% Cr have different bending characteristics for longitudinal and transverse bends in relation to the direction of rolling. Severe bends should always be made transverse. Ferritic material in thicknesses of up to 1.2 mm. can be bent to 90° over a sharp edge, irrespective of the grain direction. For thicker matetérial, the radius should be 1-2 times the sheet thickness. Bending, to 180° and folding can be done in thicknesses of up to 1.2 mm provided that the bend is made across the direction of rolling. To reduce friction between tool and material when bending in a press brake, the tool is polished and a lubricant is used. **The Assab Bulletin, February 1965.**

ZINC RESEARCH PAYS OFF IN BATTLE FOR ENGINEERING-MATERIAL MARKET

Several of the newest zinc alloys are designed for competition not only with plastics but with other materials as well. Recently, the International Lead Zinc Research Organization (ILZRO) introduced three new alloys developed to provide specific properties for particular applications, and thus widen the market horizons for zinc die casters.

ILZRO 12 provides good strength and machinability at low cost. It has excellent castability, and in gravity casting is relatively insensitive to cooling rate. More recently, research has indicated that ILZRO 12 may be adaptable to certain die castings applications.

ILZRO 14 was developed to provide superior creep resistance and stability in heated environments and is beginning to find uses in the automotive industry.

ILZRO 16 has been developed most recently to meet demands for service at elevated temperatures not possible with other zinc alloys. Anticipated applications include pumps, automatic transmissions and gear housings.

Still another area of alloy development is superplastic zinc systems, which are so ductile that under controlled conditions, they may be formed on vacuum – forming machinery commonly used for plastics. Alloys containing zinc and aluminum, and aluminumand magnesium are being evaluated because they might eventually make possible manufacture of car bodies and other sheet-metal shapes that could be formed economically. **Product Engineering, May, 1971.**

A NON-POLLUTING ZINC PLATING PROCESS

This entirely new zinc-electroplating process called the Kenbrite process is non-polluting because all the bath ingredients except the zinc are biodegradable, and the zinc-metal content in the final plant effluent is held to very low levels by recycling. Hence, the effluent may be discharged into sewers.

The neutral chloride bath has greater conductivity than the conventional cyanide bath. In using the neutral chloride bath, electric current can be increased 25 to 30 per cent compared to the cyanide process. Most zinc-plating processes cause hydrogen embrittlement of the plated steel or steel alloy. But users of the chloride-zinc process have found very little, if any, hydrogen deposited with the zinc. So the baking cycles that follow the plating can be reduced or eliminated. Cast irons, malleable iron and carbo-nitrided steel parts are plated in neutral chloride without difficulty. **Chemical Engineering, November 1971.**

ANISOTROPY AND WELDABILITY

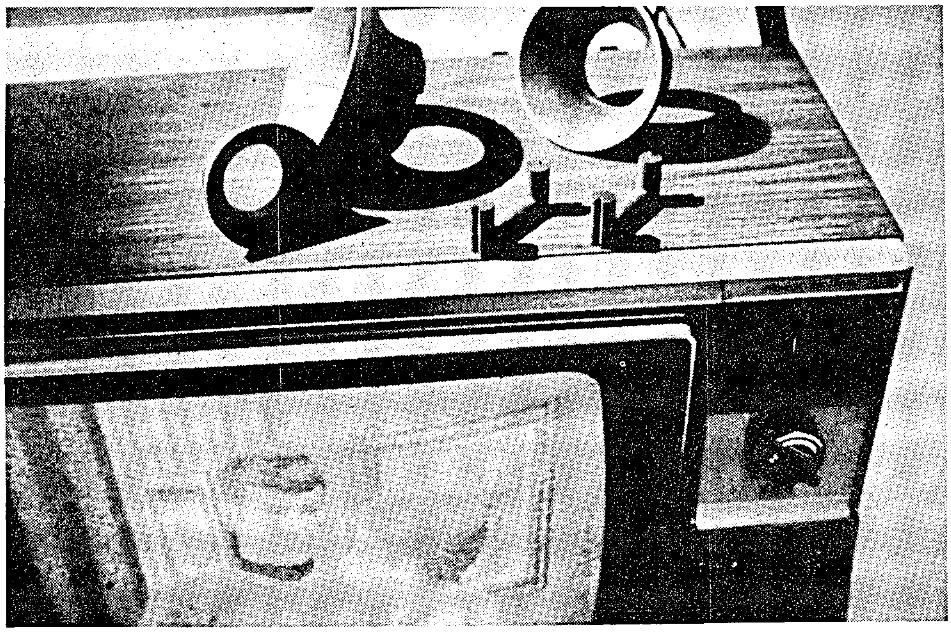
Some otherwise weldable steels are subject to through-thickness tension decohesion cracking under static non-load conditions during or soon after welding. The cracking occurs at temperatures below about 450°F. Geometrical arrangements of individual parts, specified by the designs in corner and tee joints, result in transmission of welded stresses in the through-thickness direction. The cracking is maximized when using welding conditions that result in high levels of internal tensile stress.

These decohesion cracks are associated with highly anisotropic plates having low tensile ductility, low fracture strength, and low impact energy in the through-thickness direction. Unwelded plates, evaluated with smooth bar tensile specimens, provided elongation at rupture values of from 0.03 to 6.0% charpy V-notch energy values of from 3 to 10 ft. 16 were obtained at ambient temperatures. Ductility values were not improved by heating to commonly used preheat temperatures. **Welding Journal, March 1971.**

CUTTING TOOLS: 1971

A number of new high-speed steel alloys have been developed through improvements in processing and heat treating. The recently introduced M40 series of steels represent carefully balanced compositions offering improved hardness, toughness and grindability compared to earlier premium grades such as M15 and T15. More recently, the principles of alloy balance have been applied to more dilute, lower-cost steels; one commercial composition used primarily for end mills contains approximately 20 per cent alloying additions compared to a range of 23 to 31 per cent for M41-M46 HSS.

Cast to shape tools of the Co-Cr-W-C system have found limited applications at cutting speeds between those of high-speed steels and cemented carbides while compositions of these materials have changed very little, significant increases in hardness and toughness have been obtained by improved casting techniques. More rapid chilling rates have produced transverse rupture strengths above 325,000 psi. Co-Cr base alloys were produced by atomizing and subsequent hot consolidation of the rapidly chilled powders. The uniformly distributed fine carbides produce increased strength as well as higher hardness. These materials are capable of turning R_c52 steel at speeds 80 per cent higher than attainable with the M40 series high speed steels. Most of the compositions are age-hardenable with values of Rc 69-70 achieved. Transverse-rupture strengths are generally 250,000 psi for the very hard alloys and up to 400,000 psi for materials in the Rc 60-63 range. **Manufacturing Engineering and Management, January 1971**



Color television receivers account for the largest single use of soft ferrites.

THE ATTRACTION OF FERRITES

Ferrites are magnetic mixed oxide having iron as the principal metallic component. Ferrites have good magnetism and high resistivity which eliminates eddy-current loses associated with metallic magnetic materials, even in very high-frequency applications. Ceramic (ferrite) permanent magnets are replacing Alnico magnets. Ferrites are lighter with a specific gravity of below 0.2 lb/cu. in. They have very low flux-loss rates with time and are more resistant to external demagnetization effects at low temperatures than are metallic alloys. Metallurgical changes, causing irreversible flux losses, are less likely to occur at high temperatures up to about 1080°F. against only 550°F. for Alnico and ductile materials. Ferrites, however, have extremely low and unpredictable tensile properties.

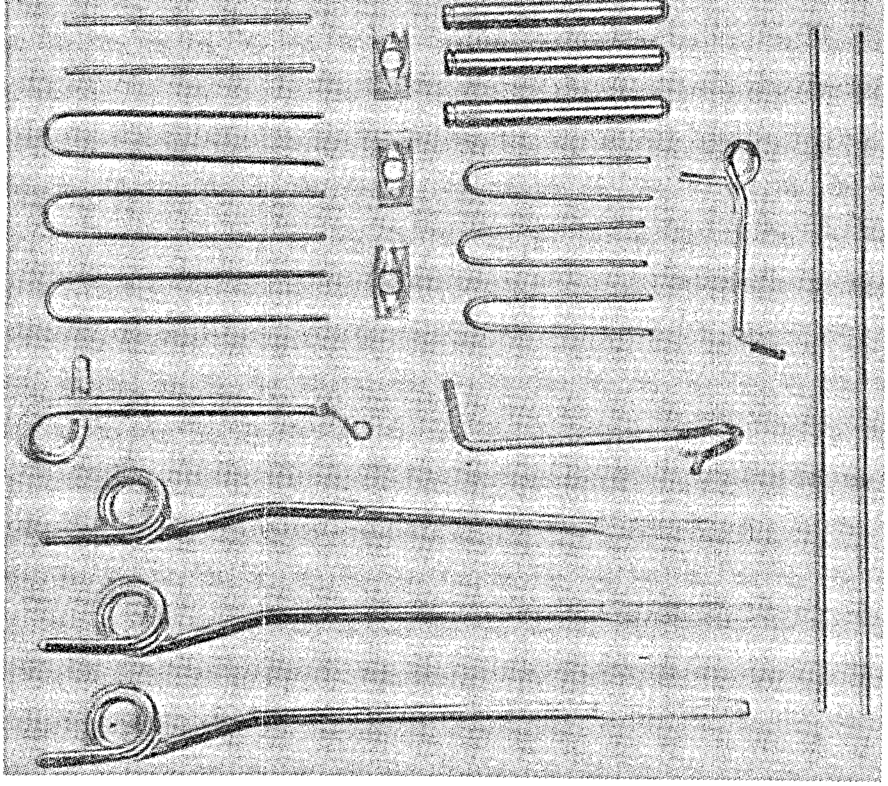
Magnetic ferrites are generally classed into hard and soft. All ferrites can be magnetized by applying an external field winding, with the strength of the induced magnetism depending on the field strength, up to the materials saturation point. It is the resistance to demagnetization which distinguishes the hard from the soft ferrites. Hard ferrites made by calcining, compacting, and sintering ferrites of barium, lead and strontium are much more difficult to demagnetize than the soft ferrites. They are used for permanent magnets in applications ranging from small motors to refrigerator latches. Soft (linear) ferrites are used in various types of transformers, conductors and recording heads, Microwave ferrites are used in microwave systems such as in gyrators, phase shifters and other devices in radar systems. **Machine Design, April 29, 1971.**

FORMING PARTS FROM VAPORS

Through still far from being a workday manufacturing process, chemical vapor deposition, is playing an increasingly important role as a method for coping with difficult metal-working jobs. It can, for example produce intricate shapes or thin-wall tubing in tungsten – a metal that is all but unworkable by conventional methods. It can form complex parts in nickel where casting, drawing or electroforming might be unacceptable. And it can deposit heat-resistant ceramic and refractory – metal coatings more dense and more durable than those formed by thermal-spray processes. In the chemical vapor-deposition process vapors containing metallic or non-metallic elements are blown over a surface where at the proper temperature and pressure – they react to form a deposit. The surface on which this condensate forms can be a permanent substrate so that the deposit serves as a coating, or the surface can be a temporary mold or mandrel which is later removed to leave a freestanding shape of the deposited material. The process is often referred to as CVD or sometimes as gas plating. **Machine Design, June 24, 1972.**

MECHANICAL PROPERTIES OF STEEL AT ELEVATED TEMPERATURES

The properties of steel change with temperature. For steel above about 300°C, there is a gradual elongation or plastic deformation (called creep) which continues under a constant load. The extent of the creep is dependent upon load, temperatures and time. If the creep



Wear on thread guides is reduced substantially by a 0.0002 inch coating of vapor-deposited titanium carbide.

deformation will continue for sometime, it will result in rupture.

Creep characteristics affect the planning of heat resisting constructions to some extent. Before starting out with a construction work, the designer needs certain material constants such as the modulus of elasticity, elastic limit, yield stress at elevated temperature, creep strength and elongation. Some components will not be detrimentally affected even by a fairly large creep deformation such as supports in furnace construction, superheater tubes, tubes in oil cracking plants, etc. while in others only a very small deformation is permissible such as in stationary and moving blades of steam and gas turbines. **The Assab Bulletin, March 1966.**

A NEW TECHNOLOGY FOR ROLLING SHEET AND STRIP

A new process of rolling and drawing (RD) has been developed in which the work rolls are developed by the metal being rolled. Tension is applied to the ends of the strip, and the ratio of the circumferential velocities of the rolls is made equal to the reduction of the strip. Research has proved that, when cold-rolled strip or sheet is produced by the RD method, the pressure of the metal on the rolls and the power consumption are greatly reduced, while the relative longitudinal fluctuation in thickness decreases and the geometry of the sheet metal is improved, the output of the process is raised and the cost of the product lowered. The automatic regulation methods and systems are simplified and roll life is lengthened. When the RD process is used it is possible to roll and dress strip and sheet made of particularly strong steels and alloys. **Steel in the USSR, April 1971.**

THE ADVENT OF THERMAL DEBURRING

Controlled short bursts of high heat are now being used to quickly and automatically remove burrs or flash from machined, cast and molded parts made from a wide variety of materials. A standard 200 ton thermal deburring unit is available in three models, with 300, 600 or 1000 psi charging pressure ranges. Charging pressures required vary from about 50 psi for thermoplastics to 1000 psi for high alloy steels. The unit consists essentially of a C-frame and a hydraulic power supply.

The workpiece is manually placed on lower closures as they are indexed into the loading station. After this has been done, it is then lifted, sealed and locked by a powerful hydraulic cylinder and toggle mechanism, thus forming a tight thermal chamber that can withstand generated pressure. Oxygen and hydrogen gases contained in two individual gas cylinders provide positive control of gas flow in the charging system. A mixture of the two gases pressurize the thermal chamber. Once the required charge pressure is reached, the mixture is ignited in the block. Both internal and external burrs or flash are burned off.

Optimum deburring is obtained by controlling three variables: the gas ratio, which vary from 60 per cent hydrogen — 40 per cent oxygen for ferrous parts, change pressure and energy level. Production rates depend on the size of the parts and burrs. **Manufacturing Engineering and Management, August, 1971.**

CSLD COATING PROCESS

A "cold" process piwder spraying system, called the RoToTec process, has found wide applications in the maintenance and repair of worn sections of cylindrical parts (bearing areas, packing areis), rolls, and shafts which can be easily mounted on a lathe and roaated. The process uses a simple and easy-to-operate gun ta feed, melt and impel special alloys onto a metal surface producing a coating which has extraordinary bond strength and excellent wear qualities in the as-sprayed condition. The addiaian of new metal to worn sections of parts can therefore be achieved without the hazards of conventional high-heat-input processes, ahereby eliminating mase-metal distortion. Such repairs could translate into a variety of savings, drastic reductions in downtime, and the elimination of spare-part inventories. **Mechanical Engineering, April, 1971.**

DEBURRING WITH HIGH PRESSURE WATER JETS

Deburring of diecast aluminum alloy valve bodies for automatic transmissions is being done by abrasive blasting with crushed walnut shells, but the process is time consuming and presents certain problems like the parts must be perfectly dry before being blasted and the parts must be vibrated and picked manually with handtools. These problems had been eliminated while speeding the deburring and avoiding the need for subsequent operations by the Ford Motor Company plant at Livonia, Mich. using high pressure water jets to deburr valve bodies. This Hyper-Jet process, for which patents have been applied, was develed by Condeco Automation, Inc., Novi, Mich.

Before the deburring begins the valve bodies are washed to remove chips and machining oils. Complete drying is accomplished by simply blowing water from the parts with air at room temperature. Mating lower and upper valve bodies are both deburred on the same machine. The two different parts are manually placed in alternate fixtures mounted on an endless chain conveyor. Spring loaded clips retain the parts in the fixtures while they are deburred, cleaned and dried. When the fixtures are returned to the operator's station, the completed parts are manually unloaded.

The high pressure water jets consists of two positive displacement pumps, each driven by a 125-Hp electric motor, deliver plain recirculated water under a pressure of 5000 psi to the 26 deburring jets in the machine. Each jet emits a solid water stream at a rate of 3 gpm from headers. These high pressure stream act as shearing blades to remove burrs, chips and dirt. The jets are designed to minimize induction of air into the streams. A third pump is used to recirculate the water.

This new process of deburring automatic transmission valve bodies is believed that it will also be used for piston transmission cases, crankshafts, carburator components and otherautomatic parts. **Manufacturing Engineering and Management August 1971.**

NEW TECHNIQUE REDUCES BREAKAGE ON HIGH SPEED STEEL BAND SAW BLADES

A new method of welding and annealing high speed steel band saw blades has been developed by the Disston Division, H. K. Porter Co., Inc. Danville, Va. This technique reduces the frequency of breakage at welds on endless bands. This new technique is called the Disston "Di-Arc" method of welding and annealing that utilizes new solid state electronic equipment.

The high speed band saw blades are produced in regular and lancer tooth patterns in one-inch widths, welded to length as specified. **Industrial Heating, July 1971.**

CHEMICAL TREATMENT OF WASTEWATER FROM MINING AND MINERAL PROCESSING

Any type of mineral processing waste can be treated by chemicals. A variety of treatment processes may be required in a large plant to achieve the bast overall results, and the decisions as to the methods to be used should be based in part on feasibility studies that include tests to determine responses of the wastes to the treatment planned.-

The starting point for controlling pollution in any industry is an inventory of raw materials particularly chemicals that might be water-soluble or dispersible. The next step would then be a study of main products and by-products of the mill. The common chemical methods used to control waste discharges are neutralization, discharge of acids and alkalies to a sewer may cause spalling of concrete pipe, corrosion of metallic lines and sludge deposits; oxidation by aeration, wet combustion or chemical means; reduction; coagulation of colloidal particles; precipitation and ion exchange. **E/MJ, April 1971.**

ELECTROFORMING PROVIDES NEW CAPABILITIES WITH ADVANCED PROCESS TECHNOLOGY

In electroforming, metal ions are transferred electro-chemically through an electrolyte from an anode to a surface. There they are deposited as atoms of plated metal, called mandrel, is conditioned so that the plating does not adhere. The plated metal or electroform, is lifted away and retains its as-deposited shape as a component. A part formed by this process has several unusual characteristics:

1) it can have extremely thin walls-less than one nil; 2) surface features of the mandrel are reproduced with extreme fidelity on the surface of electroform; 3) complex contours are produced quite easily; 4) Dimensional tolerance can be held to high accuracy; and maximum size is limited only by the size of the available plating tank.

The electroforming process produces parts with complex shapes that would be difficult to cast or machine and this would include: E.D.M. electrodes, electronic equipment, hollow ware, industrial moulds and patterns, jet engine components, optics, precision screens and mesh, surface comparators, typeface, vibratory feeding bowls, and wave guide components. **Industrial Heating, July 1971.**

AVOIDING PITFALLS IN SPECIFYING COLD-DRAWN TUBING

Determining physical size and grade of metal is only the first step in specifying tubular parts. However, there are more important things to be considered like whether commercial-quality material is acceptable or if the product requires a higher cost, low-defect material. The user should know when to specify tubing by tensile strength rather than by temper or when a nonround tubing is more practical than a round one. Situations should be recognized where selecting a more expensive alloy provides the least expensive part. **Machine Design, May 13, 1971.**

WELDING TECHNIQUE PRODUCES "IMPOSSIBLE" JOINING

Ultrapulse welding—a new different type of resistance – welding process generates so little heat that no or very little melting of the base metal takes place.

Key to the technique is extremely high input power. Up to 10 times the power used for conventional resistance welding is applied, but only for a few milli-seconds. This split second burst of energy concentrates the welding heat at the joint area, thereby minimizing the heat affected zone and completely eliminating the weld – nigget characteristics of conventional resistance welding.

The new welding process is expected to be used in applications where welding has proved impractical or not feasible.

Some of its advantages are: a) joins components of greatly varying thickness without distortion or burn-through, b) welds sheet metal that has been pre-finished on one side without damage to the finish c) welds most metals from aluminum to zirconium and d) high production rates – 3,600 or more ultrapulse welds per hour. **Machine Design, February 18, 1971.**

WORK HARDENING IN STAINLESS STEEL

Stainless steels, particularly the austenitic type, are highly ductile in the annealed condition. Cold working such as bending and deep drawing subjects steel to work hardening resulting in increased resistance to deformation. For ASSAB 910 (an austenitic steel of the 18-8 type intended for deep drawing work), the resistance to deformation will increase two or three times as rapidly as in a straight low carbon steel.

The amount of work hardening varies from grade to grade, depending on the relative amount of carbon, nickel and chromium. At low nickel contents with carbon content of less than 0.08 per cent, the rate of work hardening increases rapidly as the percentage of chromium decreases, whereas at high nickel contents it is relatively independent of the chromium. In 18-8 steels, the rate of work hardening increases rapidly with increasing carbon content up to about 0.08 per cent C, after which the rate of increase is smaller. At high nickel content, the hardening effect is smaller and increases only slightly with the carbon content. **The Assab Bulletin, February 1965.**

PHYSICAL ASPECTS OF THE LEACHING OF GOETHITE AND HEMATITE

The leaching with hydrochloric, sulphuric, and percloric acids, of suspensions and massive specimens of different hematite and goethite samples have been studied. "Accelerated" and "non-accelerated" types of leaching curries have been observed. The grain to particle size ratio of the oxide being leached is concluded to determine which type of leaching curve is obtained. **Institution of Mining and Metallurgy, September 1971.**

BACTERIAL LEACHING OF CADMIUM SULPHIDE

Pure cadmium sulphide was leached by the action of the bacterium Tiobacillus thiooxidans in the presence of finely divided sulphur. The influence of time, temperature, pH and concentration of inoculum on the extent of the cadmium extraction was studied. Under optimum conditions, up to 72 per cent of the cadmium could be dissolved over a six-week period.

A cursory study of the role played by elemental sulphur seems to indicate that its presence is essential but that the sulphuric acid produced through its oxidation is a minor factor in the cadmium extraction. **CIM Bulletin October, 1971**

ROLE OF CAPILLARY EFFECTS IN BUBBLE-PARTICLE COLLISION IN FLOTATION

Some thermodynamic aspects of the bubble-particle collision in flotation have been examined.

An investigation has been made of so-called "salt flotation" induction time and contact angle. High purity quartz and virtreous-silicon plates, which had been methylated by reaction with trimethyclorosilane, were used for the experiments. In this system the alkyl groups are firmly attached to the solid surface, and experiments can be made in the absence of soluble surfactans.

Contact angle, induction time and salt flotation were found to depend on the pH of the solution. It was shown, however, that the contact angle did not depend on the concentration of KCl solution, but flotation and induction times were markedly influenced by KCl. Account has therefore to be taken of second-order capillary effects.

The salt flotation experiments indicated that the water film on the hydropholic sold becomes unstable with increasing concentration of inorganic electrolyte, in contrast to the film on hydrophilic solids. **Institution of Mining & Metallurgy Transactions Section C, v.79, 1970**

TRAVELING SHEAR

Sergio Bayan of Quezon City
Assignor to Marcelo Steel Corporation of Malabon, Rizal
Application filed on April 14, 1959

This invention relates to heavy duty shears, and more particularly to shears for cutting traveling stock along the intermediate conveyor in steel mills. The main object of this invention is to provide a suitable type of shear which can be placed under the conveyor so to have its jaws protrude through the center of the conveyor in order to allow the stock to travel between the jaws with this arrangement, one shear will do the work of the two shears used heretofore, more accurately, efficiently and economically. Another object of this invention is to provide a type of shear, the bladed jaws of which, when engaged, become a single unit capable of traveling with the moving stock until the latter is cut, and after which the said unit, automatically returns to normal position to remain idle until it is engaged again for the next cutting operation. This result in a simplified process of cutting and also in the wear-and-tear of the mechanical parts being minimized.

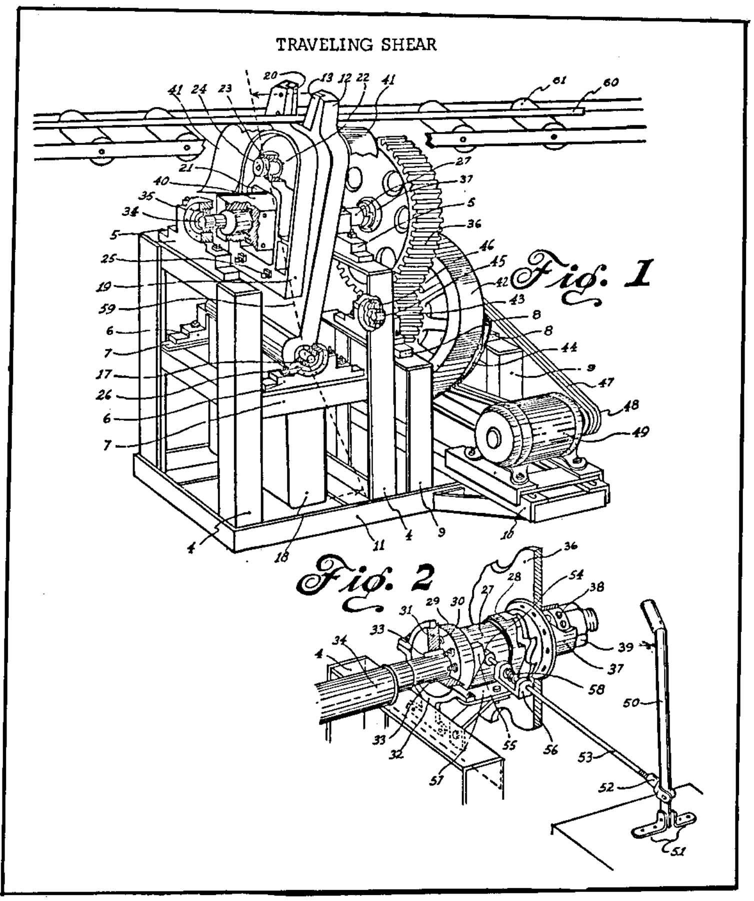


Fig. 1 is a perspective view of the complete set-up of the traveling shear. The heavy duty framework of the shear comprises two heavy duty angle iron stands supporting two bronze bearing housings and another two bronze bearing housings supported by two angle iron cross pieces.

It is being claimed that the traveling shear for cutting traveling stocks along the intermediate conveyor in steel mills comprising a frame; shearing means supported within said frame consisting of a stationary jaw and a movable jaw protruding through the center of the conveyor where the stocks to be sheared are passed between said jaws, said movable jaw pivotally and adjustably fixed to the stationary jaw, said jaws swingably supported to follow the traveling stock until the shearing operation is accomplished and after which said jaws are restored to their original normal position by means of a counterweight under the stationary jaw for the next shearing operation; means by which the movable jaw is actuated about the stationary jaw to effect a shearing operation with said stationary jaw; and means for effecting the shearing stroke of the movable jaw with the stationary jaw. The traveling shear has a shearing means comprising of a stationary and movable jaw having replaceable blades, said stationary jaw having a downwardly depending body member and a counterweight between which a shaft journalled to both bearings mounted on the frame is provided, said shaft allowing the stationary jaw and the movable jaw which is pivotally fixed to the stationary jaw to swing in a limited motion toward the direction of the traveling stocks.

APPARATUS FOR ROLL COMPACTING METAL AND METAL COATED PARTICLES

Metal powder is compacted initially into a "green" shape, such as in the form of sheet or strip, by feeding it, usually at a predetermined, uniform rate, into the roll gap of a pair of oppositely positioned, horizontally disposed, pressure rolls. The rolls are spaced such that a self-supporting partially desified "green" shape of desired density and thickness is produced. It is essential to produce a "green" strip or sheet which is of substantially uniform thickness, of substantially uniform density between its longitudinal marginal edges and with closely controlled weight of metal powder per unit area in the marginal edge zones.

Apparatus for compacting metal and metal coated particles comprises a pair of oppositely positioned rolls mounted on roll shafts for rotation in a horizontal plane, a roll gap between the rolls, and means for preventing leakage of metal particles from the ends of the roll gap which comprises a freely rotatable endless belt mounted at each end of the roll gap, each belt having a surface maintained in frictional engagement with surfaces of the ends of opposing rolls from a point above to the bottom of the said roll gap; means for feeding metal particles to said roll gap; means for regulating the effective surface area of said belts in contact with the metal particles contained in said feeding means whereby the rate of feed of particles to the end of said roll gap is controlled independently of the rate of feed of particles to the roll gap between the ends; and means for maintaining the exposed surface of each belt in frictional engagement with the surfaces of the opposing ends of said rolls.

MACHINE FOR APPLYING SUSPENSION LOOPS TO THE ELECTRODES USED IN ELECTROLYTIC OPERATIONS

F. H. Reed, Assignor to Service Machine Co., Elizabeth N. J. a Corporation of New Jersey.
Filed on January 21, 1964

The invention disclosed is a machine for applying suspension loops to the electrode plates used in electrolytic refining, electroplating and other electrolytic operations. Objects of the invention are: to provide practical and efficient mechanism for shaping conducting strips into the form of open loops, positioning the open ends of the loops over the plates which are to form the electrodes and the forcing integral portions of the loops into and through the material of the plates with a mechanical "stitching" and riveting effect. Further object is to accomplish these results at low cost and at reasonably high production rate.

This invention claimed a machine for forming and applying suspension loops to electrode plates, comprising the combination of means for locating an electrode plate in a definite location; forming means

MACHINE FOR APPLYING SUSPENSION LOOPS TO THE ELECTRODES USED IN ELECTROLYTIC OPERATIONS

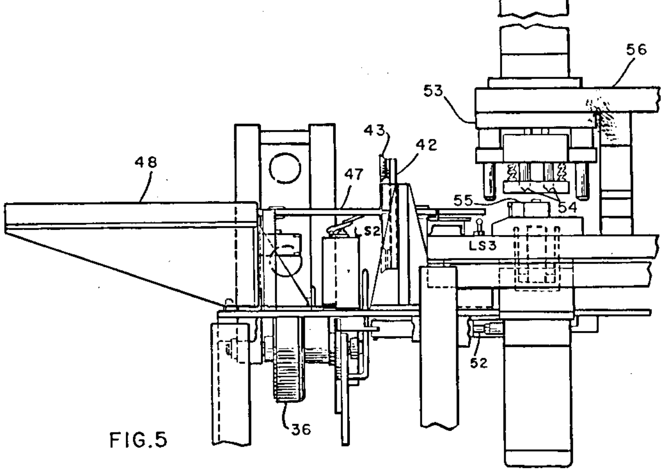


FIG.5

for bending individual strips into U clip formation; a first transfer device for transferring the top strip in said machine to said forming means; second transfer device positioned to receive the bent clips from said forming means and to transfer a received clip into position over the edge of said definitely positioned plate; a stitching die for driving portions of the thus located clip through said plate and for upsetting protruding portions of said strip at the far side of the plate; means for effecting cooperative operation of the foregoing in the timed relation described; means for forming strip material into U-shaped clips, means for positioning said clips over the edge of said positioned plate with the spaced arms of the clips over opposite side of the plate; and, means for driving material of the thus positioned clips through the material of the plate and clinching the driven material over the plate material.

APPARATUS FOR DEEP DRAWING METAL

Jess Lee Massingill and Donald Clifford Gregokenko, Michigan, USA, Assignors by Mesne assignments to S.T.D. Services Ltd., of Birmingham, England, a British Co.
Filed on October 25, 1965

This invention relates to the art of drawing metal and provides apparatus for the economical production of ultra deep draw metal cans, shells, tubes, and the like, from first operation cap shells, flat blanks, flat sheet metal strips, and the like. It provides improved press apparatus for the deep drawing of metal work pieces through a series of progressively smaller dies by a complimentary series of telescoping

APPARATUS FOR DEEP DRAWING METAL

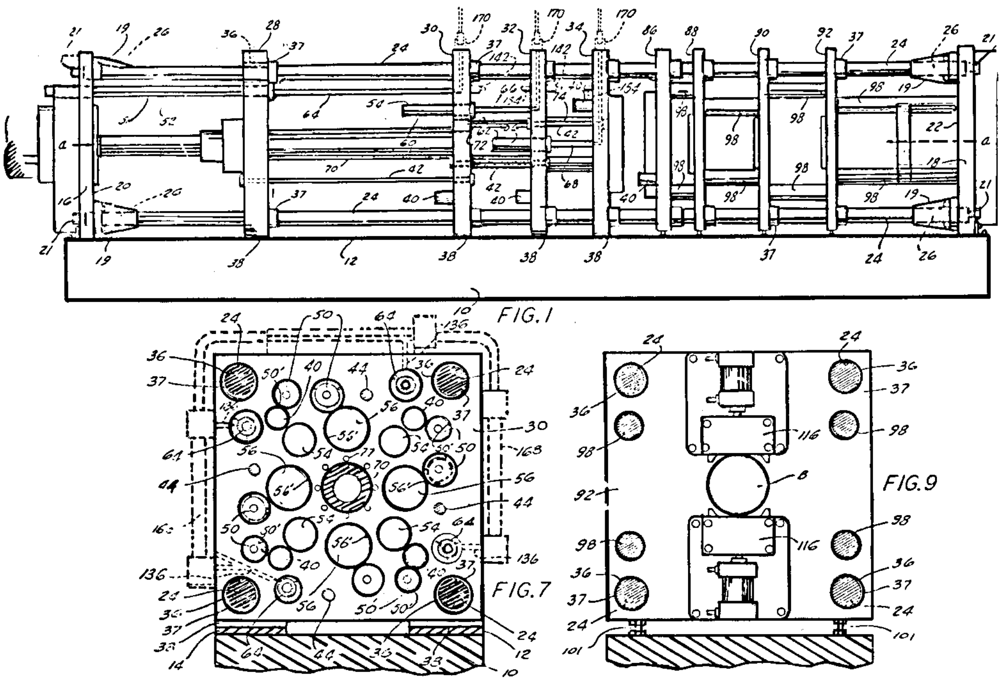


FIG. 1 FIG. 7 FIG. 9

punches on a single continuous working stroke of the press ram wherein:

a) a sequence of drawing operations is performed without intermediate annealing through novel and coordinated control of punch movement, through the regulation of the restraining pressures on the workpiece at each drawing operation, and through the nature of the relation of the workpiece with the punch and die structure of each drawing operation;

b) the stresses of the drawing operation are uniformly distributed throughout the circumference of the workpiece to permit substantial increase in the percentage of reduction of the workpiece during the drawing operation as compared with the standard practices and without, experiencing metal rupture;

c) movement of the ram on working stroke is transferred to the punches and thence to the workpiece through a series of relatively movable punch carriers which co-act with each other to maintain parallelism between telescoping punches;

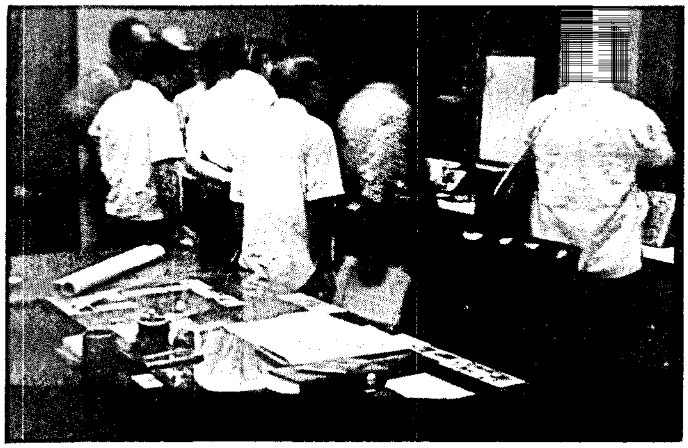
d) the punch carriers are movable both in unison and relative to one another by the ram of the press through the control of fluid punches; and

e) the fluid cushion structure for controlling relative movement between the punch carriers also functions to control the force applied to the punches during the drawing operation.

The claim defining the invention is as follows:

In a deep drawing press, two separate drawing dies of different sizes, an outer punch for drawing the work blank in the larger die, an inner punch for redrawing the work blank in the smaller die, said punches and dies bring all longitudinally aligned for the drawing of the work blank through said dies during one continuous stroke of the press, said inner punch telescoping with said outer punch and having a nested relation with said outer punch during the drawing operation in said larger die, the end of said outer punch and a face of said smaller die defining opposed surface portions, spacer means for spacing said surface portions an amount approximating wall thickness of said work blank to provide "stop arrested blank-holding", pressure means acting upon said outer punch and resisted by said spacer means to provide "pressure blank-holding" for the work blank, and regulating means for controlling relative movement between said punches to project said inner punch to reduce the work blank in said smaller die by transferring the same from said outer punch, between said surface portions, and through said smaller die on to said inner punch.

SME VISITS MIRDC LABORATORIES

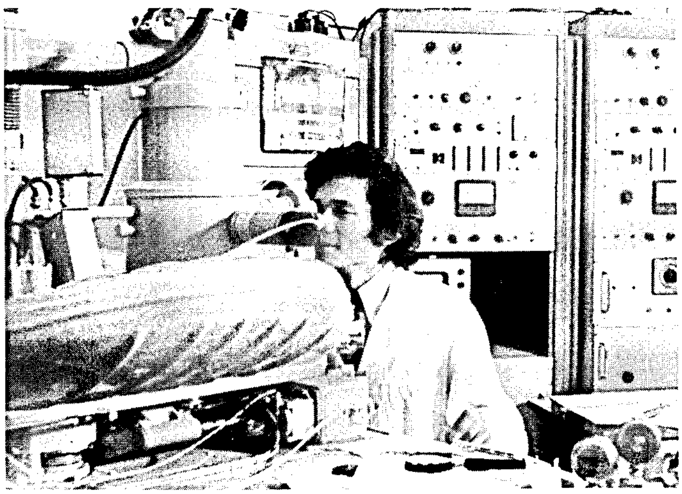


The Society of Manufacturing Engineers visited the MIRDC Laboratories at Bicutan, Taguig, Rizal last August 25, 1972. On hand to welcome them were Dr. Antonio V. Arizabal, MIRDC Director; Raul P. Sulit, Assistant Department Head, Technical Workshops and Training Department, MIRDC; and the technical staff who explained and demonstrated the operation of the different equipment. In the open forum that followed, Dr. Arizabal explained the role of MIRDC in the development of the industry particularly in the field of training.

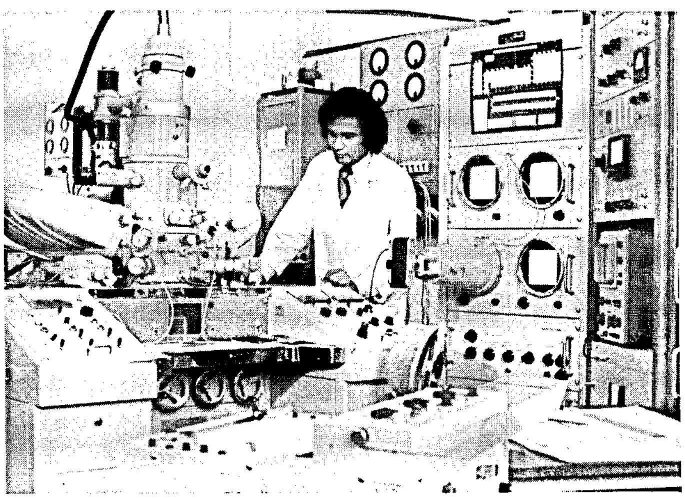
Among those present were SME officers, namely: Albino R. Maglalang, Chairman; Juan S. Barrera, First Vice-Chairman; Alfred S. Fabra, Second Vice-Chairman; Roger H. Roxas, Third Vice-Chairman; Louis O. Miciano, Secretary; and Yu Mun, Treasurer.

MIRDC corner

MIRDC TRAINEES ABROAD



Marcelo B. Villanueva is shown operating the micro probe analyzer, a sophisticated apparatus in electron microscopy.



Marcelo B. Villanueva, MIRDC mechanical metallurgist is now undergoing a crash training course in materials technology at the Institute of Ferrous Metallurgy of the Rhein Westfallen Technical University at Aachen, West Germany, after finishing a three-month intensive language course at Saarbruchen and Essen. A trainee under the bilateral agreement between the German and Philippine governments, Villanueva has been trained at Aachen on the following:

I. Metallography
   a) Metallographic examination of heat treatment products
   b) Metallographic examination of prepared samples, representing different structures.

II. Heat Treatment
   a) Normalization
   b) Jominy Testing
   c) Fracture Test
   d) Case Hardening

III. Materials Testing
   a) Hardness Testing
   b) Universal Testing Machine Operation
   c) Ultrasonic Testing
   d) Dye Penetrant Testing
   e) Fatigue Testing
   f) Impact Testing
   g) Creep Testing

IV. Electron Microscopy
   a) Micro Probe Analyzer
   b) Electron Microscope

These will constitute a strong technical information background when he undergoes training at various German industrial firms on quality control and inspection of various iron and steel products namely, foundry, rolling mill, and forged and machine shop products.

Villanueva, who left last December 1, 1971 is expected to return in March, 1973.

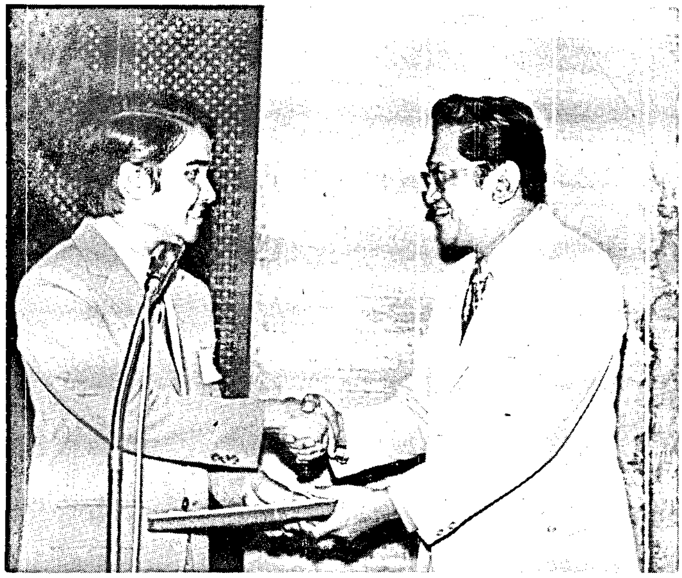
NINE-YEAR OLD PISI REDEFINES OBJECTIVES

The Philippine Iron and Steel Institute recently marked its nine years of existence by redefining its objectives directed towards the solution of industry problems which include among other things the stabilization and rationalization of the local market; promotion of exports; making representations with governmental bodies on matters affecting the industry such as the restructuring of the Tariff Code; working tor the technical requirements of the industry and establishment of standards for iron and steel products; and serving as an industry-wide agent for the organization and dissemination of information.

Chosen Board of Trustees for 1972 were Messrs. Jose T. Marcelo, Jr., Marcelo Steel Corporation; Lauro M. Cruz, Atlantic Gulf & Pacific Co. of Manila, Inc.; Gonzalo Puyat II, Puyat Steel Corporation; Dominador de Jesus, International Pipe Industries Corporation; Jose C. Quema, Atlas Consolidated Mining and Development Corporation; Daniel Mijares, Philippine Blooming Mills Co., Inc.; Bernardo P. Abrera, Iligan Integrated Steel Mills, Inc.; Jose V. Martel, Marsteel Corporation; L. C. Young, Philippine Iron Manufacturing Co., Inc.; Francisco Tong, Pag-Asa Steel Works, Inc.; Raul T. Concepcion, Concepcion Industries, Inc.; Dante Santos, Philippine Appliance Corporation; Amando D. Dumlao, Jr., Super Industrial Corporation; Nicanor Villasenor, Elizalde Iron & Steel Corporation; and Antonio Arizabal Jr., ex-officio, MIRDC.

Chosen PISI officers for 1972 were: Dominador de Jesus, International Pipe Industries Corporation, president; Jose T. Marcelo, Jr., Marcelo Steel Corporation, vice-president; Lauro M. Cruz, Atlantic Gulf & Pacific Co. of Manila, Inc., secretary; L. C. Young, Philippine Iron Manufacturing Co., Inc., treasurer and Daniel Mijares, Philippine Blooming Mills Co., Inc., PRO.

The Philippine Iron and Steel Institute was established on July 6, 1963 to promote the development and advancement of the iron, steel and allied industries. "If the PHILIPPINE IRON AND STEEL INSTITUTE is to continue its role as spokesman for the iron and steel industry in the Philippines, it needs to get more vigorous support from more and more members", appealed 1971 PISI president DJ de Jesus in a message published in the Philippine Iron and Steel Institute Annual Report 1971. "Each of the present



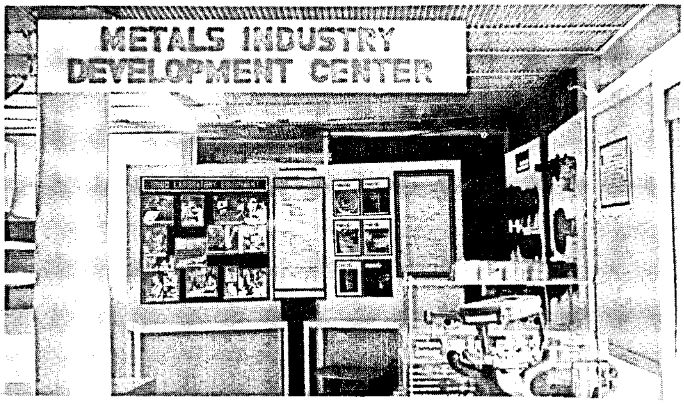
Dominador de Jesus, PISI President presents membership plaques to Jose T. Marcelo Jr., PISI Vice President (shown above) and to Jose C. Quema, member PISI Board of Trustees (below).

PHILIPPINE IRON AND STEEL INSTITUTE member should undertake a personal campaign to bring in additional members to our fold. It is desired that the majority or all of the firms engaged in the industry identify themselves with the PHILIPPINE IRON AND STEEL INSTITUTE so that the Institute may be recognized for what it represents — the iron and steel industry in the Philippines."

PFS HOLD INDUCTION OF OFFICERS

The Philippine Foundry Society held its charter presentation and induction ceremonies in the evening of July 15 at the Architectural Center Club, Inc., at 136 Ayala Ave., Makati, Rizal.

The induction of the Philippine Foundry Society officers for 1972 by Dominador de Jesus, PISI President.



The MIRDC booth. Shown at foreground is a Toyota engine, courtesy of Delta Motor Corporation.

Dominador de Jesus, PISI President, presented the charter members and inducted into office the 1972 PFS officers: Ernesto M. Patenia, president; Prospero Z. Salvacion, vice-president; Servillano Lim, treasurer; Abraham A. Averilla, auditor; and Antonio Abastillas, J. Hermes Bautista, Clarito M. Ilustre, and Leonides S. Valdez, directors.

The charter members include: I. Carvajal, AG & P production manager; Constante Ventura, Honiron Philippines, Inc. general manager; J. Hermes Bautista, Delta Motor Corporation engineer; R. Salgado, El Varadero de Manila works manager; C.R. Villarama, Union Steel Manufacturing Co., Inc. department head; A. Segismundo, NASSCO chief engineer; Prospero Salvacion, Philippine Sewing Machine Manufacturing Corporation general manager; Leonardo Cruz, AG&P Quezon City supervisor; Antonio Abastillas, Marsteel Corporation division manager; Servillano Lim, Master Steel Products, Inc. general manager; Ding Valdez, L. S. Valdez Metal Products manager; Robert Young, Philippine United Foundry and Machinery Corporation manager; Jess Mangilit, JDM Engineering Services general manager; Clarito Ilustre, AG & P Co. Consultant; Ang Le, Dong Tek Foundry Shop president; Ernesto Patenia, AG & P sales manager; and Manuel Kong, Dong Tek Foundry Shop sales manager.

The guest speaker, Frank Dugal, UNDP project manager for the Metals Industry Research and Develment Center was introduced by Patenia, PFS president while Robert Young, chairman of the Committee on Induction Ceremonies, delivered the closing remarks.

Miss Pilar L. Fernandez of MIRDC acted as emcee during the entire program.

The Metals Industry Research and Development Center is the secretariat of the Philippine Foundry Society.

MIRDC PARTICIPATES IN NATIONAL SCIENCE WEEK EXHIBITS

The National Science and Technology Week with the theme "Philippine Science in the Second Development Decade" was celebrated July 10-15 at the Dr. Paulino J. Garcia Memorial Hall, at Taft Ave., cor. Herran St. Activities in connection with the celebration included scientific symposia as well as exhibits and displays projecting various phases of scientific research and development efforts of the different government agencies.

MIRDC had for its exhibits the various parts to be manufactured locally for the Government's Progressive Car Manufacturing Program, courtesy of Engineering Equipment, Inc., Acme Tools Manufacturing Company, Philippine United Foundry and Machinery Corporation and Delta Motor Corporation. Also displayed were photos of the Center's laboratory and testing facilities and equipment, copies of the Philippine Metals magazine and the published industry study "The Nonferrous Metals Industry of the Philippines".

MIRDC CONTRIBUTING MEMBERS = 44 IN ALL; MANY ARE JOINING

There are some 44 contributing firms of the Metals Industry Research and Development Center — an all-time high in point of membership — and more are joining.

The 44 contributing firms are the following;

1. Acme Tools Manufacturing Company
2. American Wire & Cable Co., Inc.
3. Atlantic Gulf & Pacific Co. of Manila, Inc.

4. Atlas Consolidated Mining & Development Corporation.
5. Bacnotan Consolidated Industries
6. Borden Chemical Co. Philippines, Inc.
7. CCP Securities Corporation
8. Central Steel Manufacturing Co., Inc.
9. Consolidated Mines, Inc.
10. Ekman & Co., Inc.
11. Elizalde Iron & Steel Corporation
12. Engineering Equipment, Inc.
13. Feati Industries, Inc.
14. Filipino Pipe & Foundry Corporation
15. General Construction Supply Co., Inc.
16. Honiron (Philippines), Inc.
17. Hooven (Philippines), Inc.
18. Iligan Integrated Steel Mills, Inc.
19. International Pipe Industries Corporation
20. Jalwindor Manufacturers, Inc.
21. Lepanto Consolidated Mining Co.
22. Mabuhay Vinyl Corporation
23. Marcelo Steel Corporation
24. Maria Cristina Chemical Industries, Inc.
25. Marinduque Mining & Industrial Corporation
26. Marsteel Corporation
27. National Shipyards & Steel Corporation
28. Pellet Corporation of the Philippines
29. Phelps Dodge Philippines, Inc.
30. Philex Mining Corporation
31. Philippine Appliance Corporation
32. Philippine Blooming Mills Co., Inc.
33. Philippine Iron Manufacturing Co., Inc.
34. Philippine Sewing Machine Manufacturing Corporation
35. Philparts Manufacturing Co., Inc.
36. Precision Iron Manufacturing Co., Inc.
37. Puyat Steel Corporation
38. Radiowealth, Inc.
39. Reynolds Philippines Corporation
40. Super Industrial Corporation
41. Superior Gas & Equipment Co.
42. Union Carbide Philippines, Inc.
43. Union Steel Manufacturing Co., Inc.
44. Victorias Milling Co., Inc.

metals NEWS

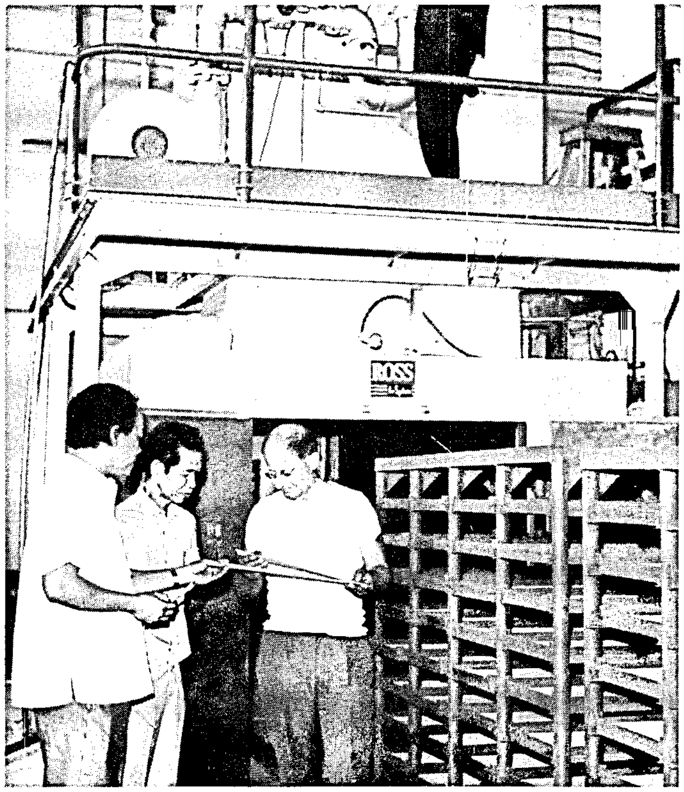
BELL HOBART'S WELDING ELECTRODE PLANT STARTS OPERATION.

Bell Hobart Manufacturing, Inc., a new Smith Bell Group subsidiary, has just inaugurated its new Parañaque plant which will manufacture welding electrodes under the Hobart brand for the domestic market and for export through the international marketing facilities of Hobart Bros. A.G. Special alloy welding electrodes will also be produced in the new plant.

All the products of Bell Hobart will bear the same quality of Hobart electrodes which are designed to meet quality control standards. Technicians of Hobart Bros. A.G. supervised the trial-runs of the plant and trained a group of Filipino technicians who will operate the electrode plant.

If the company's application with the Board of Investments is approved, Bell Hobart will also locally manufacture transformer welders and other welding equipment not only for the local market but for the Asian market as well.

Bell Hobart is a Filipino-owned company. Its operation ensures the adequate supply of welding electrodes and welding equipment required by some of the country's vital industries such as car manufacturing, construction, shipping and infrastructure projects.



Trial runs in the Bell Hobart Manufacturing, Inc. plant in Parañaque where welding electrodes undergo final tests under the supervision of Hobart Bros. A.G.'s technicians. Photo shows Hobart technicians examining welding electrodes fresh from the baking oven.

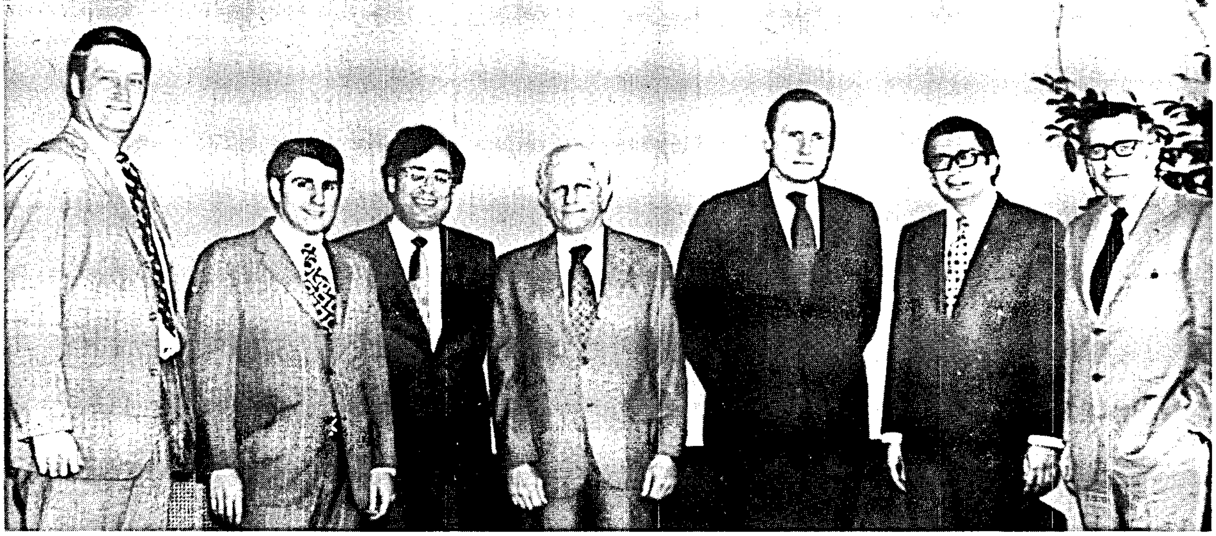
MANTRADE INDUSTRIES, INC. TO GO INTO MALLEABLE IRON PIPE FITTINGS

Mantrade Industries, Inc. (MII) is investing some ₱5 million for the production of malleable iron pipe fittings for the construction industry. The project will be undertaken by MII's foundry in Parañaque, Rizal and is expected to be implemented by Precision Iron Manufacturing Co. which is engaged in foundry and machining operations. The plant will start commercial operations by the end of this year.

The malleable pipe fittings project is registered with the Board of Investments with a capacity of 1200 metric tons a year, non-pioneer. The company is planning to tap not only the local but the export market as well. The products are expected to be marketed by Mantrade Machinery and Equipment Co.

AG & P TO TIE UP WITH ISC

Representatives from International Systems and Controls Corporation of Houston, Texas, led by John T. Kenneally, chairman, and Daniel L. Goldy, president, with William A. Krause, president of J. F. Pritchard and Company of Kansas City, a subsidiary of ISC, recently held business conferences with Atlantic Gulf & Pacific Company officials, Roberto T. Villanueva, chairman; Ricardo P. de Leon, president, AG & P Contsruction Group; Allen K. Hackett, president, AG & P Manufacturing & Sales Group; and Alejandro J. Lukban, vice president, AG & P Metals



OFFICIALS OF ISC of Houston, Texas, a foreign stockholder of AG&P, recently held business meetings in Manila with AG&P to discuss joint engineering and construction ventures in Southeast Asia. From left are: Frank X. Marshik, ISC Far East representative; Herman M. Frietsch, ISC senior vice president; Vincent V. Checchi, Checchi & Co. president; Daniel L. Goldy, ISC president; John T. Kenneally, ISC chairman; Roberto T. Villanueva, AG&P chairman; and William H. Krause, J. F. Pritchard & Co. president.

Fabrication Group. International Systems and Controls is one of the foreign stockholders of AG & P.

The ISC team came to the Philippines to discuss with AG & P the prospects for joint ventures in construction projects and other business opportunities in Southeast Asia. The new policy of AG&P, as stated by AG & P Chairman Roberto Villanueva, is "to expand AG & P's international engineering and construction activities throughout Southeast Asia."

The operations of International Systems and Controls Corporation are organized into three functional groups: Engineering, Manufacturing and Finance. Each group consists of subsidiaries, divisions, and affiliates engaged in similar types of activities.

The Engineering Group of ISC includes J.F. Pritchard and Company of Kansas City, Missouri, which is a process engineering firm providing feasibility studies, process design, plant engineering, construction supervision and plant start-up services to the gas, petroleum, chemical and petro-chemical industries.

Black, Sivalls & Bryson, Inc., one of the Manufacturing Group of ISC, manufactures proprietary equipment and pre-packaged plants for processing liquids and gases which are used primarily in oil and gas separation, dehydration and treatment. At the present time, AG & P working with BS&B are building three offshore oil platforms for Indonesia at AG&P's Steel FabricatingPlant at Poro Point.

Leo V. Laconico

MARSTEEL ENGINEER OFF TO USSR

Leo V. Laconico, production planning and control engineer of MARSTEEL's Metalcasting Division left for Zaporozhye, USSR last 24 May 1972 to attend the Eight In-Plant Group Training Programme for Engineers and Technicians in the Iron and Steel Industry. He is one of the selected representative participants to this six-month training course organized by the United Nations Industrial Development Organization in cooperation with the government of Ukranian Soviet Socialist Republic.

The programme is designed to cover most aspects of the iron and steel industry and will be conducted at the Zaporozhye Steel Plant. The program aims primarily to contribute to the development of foundry engineering of the developing countries. Included in the course are theoretical instructions and discussions, in-plant training on foundry practices and field studies.

PROSPERO Z. SALVACION

In Memoriam!

The good die young. And it will entail great work and men to continue the good work done.

For a man like Prospero Z. Salvacion, there was so much to be done — the wheels of managing a business has to keep on churning and the future was there because much effort and vision had been laid into the enterprise. To executives of his caliber, the work was the thing; it was the center of all his energies and the centrifuge of his dedication.

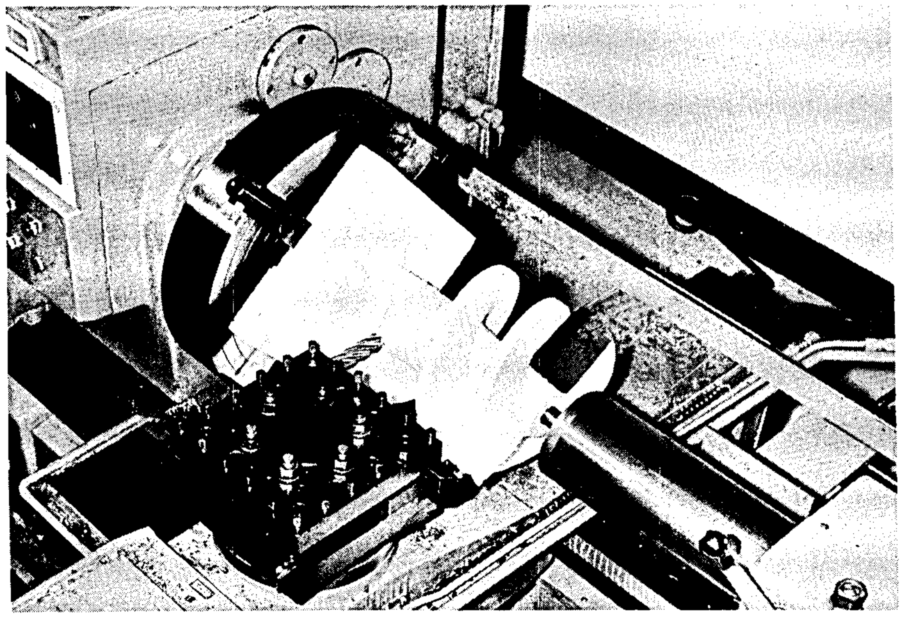
As another professional summed him up, "He was an eager-beaver." He exuded vigor and spirit of camaraderie in the office or board room. He was very active and cooperative in affairs of the metals industry, the Philippine Iron and Steel Institute, and specially with the Philippine Foundry Society where he was Vice-President.

But for an assassin's bullet that cut him down at the early age of 36, Prospero Z. Salvacion could have still gone further up the ladder of success and could have given more service to industry, country and people. He was general manager of the Philippine Sewing Machine Manufacturing Corporation where he brought experience and professionalism garnered from a decade of executive and technical positions in Mancor Engineering Services, Inc., as project manager, shop superintendent, and assistant to the general manager; in Ysmael Steel Manufacturing Corporation as production supervisor, chief production supervisor, and chief, product engineer; and at Philippine Appliance Corporation as engineering manager before joining Philippine Sewing Machine Manufacturing Corporation as Research Development and Engineering Manager and later general manager in 1969.

He graduated from the De La Salle College with a Bachelor of Science degree in Mechanical Engineering in 1958. Subsequently, he took Tool and Die Designs at the Acme School of Die Designs Engineering, Inc. Foreign observation trips took him to Tecumseh, U.S.A. for orientation on the manufacture of Hermetic Compressors and to Japan and Taipeh in connection with the manufacture of pumps and other agricultural implements.

A member of the American Society of Tool and Manufacturing Engineers, the Mandaluyong Chamber of Commerce and Industry and the Makati Central Lions Club, Mr. Prospero Z. Salvacion, who died August 11, is survived by his wife and five children.

Foreign news



More than 100 cubic inches of polyfoam material per minute is removed by an end mill mounted to air motor shaft.

MACHINING POLYFOAM PATTERNS

Utilizing a numerically controlled lathe, LeBlond, Inc., Cincinnati, has developed a new process for machining patterns for extruder screws and augers. A Tape-Turn INF lathe capable of swinging a workpiece 32 inches in diameter over the bed and a piece 20 inches in diameter over the cross-slide was used to machine various configuration of augers. A high speed milling cutter was mounted to the lathe's standard turret to machine the various forms of the coarse threads at a high rate. To produce the pattern at an economical rate, a 20,000 rpm air motor was used to machine the pattern material at a removal rate in excess of 100 cu. in. per minute. The actual cutting is performed by an end mill mounted to the air motor's shaft. Configuration differences vary the time necessary to program similar parts. Variable lead and depth combinations can be programmed and machined with this lathe. Castings of rotating parts of almost any shape can be produced easily from foam material patterns made by this method.

ISCOR TESTS FORMED COKE

South Africa's Iscor is to carry out blast furnace trials at its Vanderbylpack works using formed coke briquettes produced from coal mined at Hoornbosh in the Ellisras district of Northern Transvaal. The aim is to limit the ash content of the briquettes to 10 per cent approximately 6 per cent lower than the ash content currently used by Iscor.

SIMPLIFIED CHROMIZED SHEET PROCESSING

A new method for embossing steel strip that eliminates the use of spacer wires in open coil annealing and other open coil processing was patented by Bethlehem Steel Corporation. The method is used in making chromized sheet, a low carbon steel with a ferritic stainless coating, at the Sparrows point plant. The coating is applied by compacting ferrochrome powder on the surface of the strip, after which the strip is open-coiled and heated in a furnace to cause diffusion of the powder into the surface of the steel to form the coating. Under this method, indentations are made along each edge of the strip itself. When coiled, the strip surfaces are held apart by the indentations which are spaced unequally along the edge to prevent their nesting. Furthermore, the indentations on one edge are misaligned with the indentations along the other so that if the indentations on one edge should nest at a particular spot the other edge will hold the laps apart.

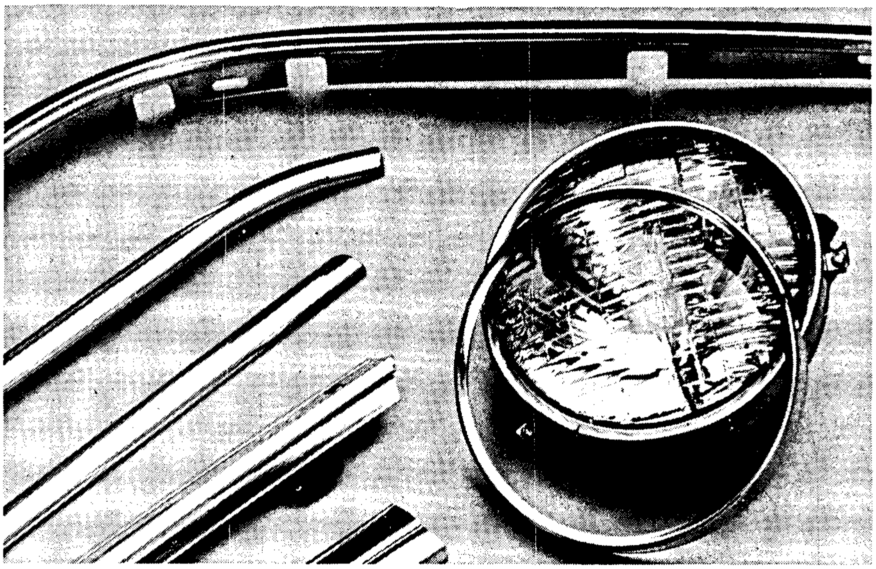
FAST TEST PREDICTS DUCTILE IRON QUALITY

A fast test for predicting quality of ductile iron while the molten metal is still in the ladle was developed at the General Motors Research Laboratories. The new method predicts the microstructure from an analysis of cooling curves through metallurgical thermodynamic principles. Within two minutes after drawing a sample, the analysis provides a measure of graphite nodularity and per cent carbides. Success of the test, however, depends on a unique sample method that provides nodular iron cooling curves sensitive to the metallurgical reactions affecting final microstructures. An expendable sampling device is used, consisting of a chromel-alumel thermocouple positioned in a steel cup.

RAPID HEATING ADVANCES COMMERCIALLY

Hanworthy Engineering has demonstrated recently a rapid billet heating machine for development trials in the ferrous forging industry designed to heat billets to 1200°C at the rate of 600 lbs/hr. The demonstration brought out both its high productivity and the high quality of product since the amount of scale on the heated billet was unusually low.

The machine consists of opposing rows of tunnel burners, 24 to a side in banks of eight. The fuel used throughout the test runs was propane. Two sizes of test billets were used 2" x 2" x 3½" and 3" x 3" x 5". It was concluded that this rapid heating machine will process 3-inch square steel billets at the rate of 710 lb/hour and 2-inch square steel billets at the rate of 431 lb/hour. The average billet temperature at the exit from the machine was 1210°C. Thermal efficiencies obtained were 12.7% for the smaller billets and 21.0% for the larger billets. The important point in rapid heating is the increase in the processing rate and also the reduction in the time that the steel is above 800°C, where decarburization is occurring.



Because the bond between the stainless steel and aluminum is metallurgical, the trim material can be formed with complete bond integrity. Forming characteristics are similar to those of stainless steel.

U.S. STEEL TO USE GERMAN DERIVED STEELMAKING METHOD

U.S. Steel will be the first U.S. user of the Q-BOP process, a basic-oxygen variant invented by Eisenwerk-Gesellschaft-maximilianshutte mbH. The method, which boasts of lower investment, higher yield, better ability to feed on scrap, and lower operating costs than conventional basic-oxygen or open-hearth methods is being used in ten furnaces in Europe and Africa, the largest being 80 tons. U.S. Steel has groomed the process so larger heats can be made.

Ordinarily, a basic-oxygen furnace injects oxygen from above. The Q-BOP version instead feeds oxygen at the bottom, as well as lime and other additives for the batch. This method can use about 20% more scrap than conventional basic-oxygen units, and its heat time is about 10% less.

CHROME-BRIGHT STAINLESS/ALUMINUM TRIM PREVENTS CORROSION OF AUTO BODIES

Texas Instruments, Metallurgical Materials Division has come up with a material that gives the auto industry, a decorative trim with the durability and attracive finish of stainless steel plus long lasting protection against corrosion of adjacent pointed steel. The material is made by metallurgically bonding type 434 stainless steel (40%) and aluminum (60%). The stainless gives a chrome-like exterior to the viewer while the aluminum underside galvanically protects the body. The trim exhibits dent and abrasion resistance of stainless, and costwise it is competitive with stainless steel. Although the trim material was developed for automotive application, it can also be applied for decorative purposes on other products where galvanic protection is a consideration.

NEW GOLD PLATING PROCESS AVAILABLE

Lea-Ronal, Inc. has developed a new gold plating process for the jewelry industry that can be used to plate 16 to 18 K gold in precise, heavy thicknesses and precise colors in one operation and without any change in the users' present equipment. The new process is called Endura Glo. This allows the users to plate thicknesses of up to 40 microns in a color range of 1N to 5N. Further, it allows the users to obtain deposits that are crackfree; hardness variations from 220 to 320 knoop; and total uniformity of distribution over parts.

The Endura Glo series is now available in the US and Canada through Lea-Ronal, Inc. Freeport, N.Y., in Europe through Lea-Ronal, U.K. Ltd., Brixton England and in the Far East through Japan-Ronal, Inc. Tokyo, Japan.

DETECTING SURFACE FLAWS IN STEEL BARS AT 90 TONS PER MANHOUR

Sumitomo Metal Industries, Ltd., Osaka, Japan has developed a magnetic inspection machine which detects automatically surface defects in hot-rolled steel bars. This is a production line equipment where round bars are magnetized and inspected without being descalled. The scanner, which respond to leakage flux from surface defects in the magnitized bars, utilize a new magneto-resistive element. The machine includes three scanning stations, each of which has an exciting magnet and six pairs of detectors. Harmful defects are detected at high, constant sensitivities without the appearance of indications caused by surface roughness, camber, eccentricity and ellipticity of the bars. Also including feed in and run-out conveyors and a mechanism for rotating bars, this machine can be applied to tubing, billets, and other steel products.

The system can handle bars from 40 to 100 mm. in diameter and 3.5 to 7.0 m. in length. Seams as small as 0.10 mm. in depth and 20 mm. in length can be detected.

NEW RUHRKOHLE COKING PROCESS

West Germany's Ruhrkohle is installing a 600 tons per day plant for the continuous production of form coke by a new process it has jointly developed with Lurgi and the Clausthal Technical University's Institute for Chemical Technology. It is claimed that the new process yields "perfect coke" for blast furnace consumption from coal of only 30% good coking quality.

Previous attempts to produce form coke is aided with binding agents such as a sulphite solution or tar. Ruhrkohle's processs utilizes no binding agents but still yields strong, abraision-resident briquettes, without adding new chemical substances into the process. During production, non-coking coal, heated to 700-800°C, is blended initially with good quality coking coal fines at a temperature of about 450-500°C. The mass becomes plastic and binds. The finished form coke briquettes are then subjected to "after-coking" by further heating. Tests with an experimental blast furnace showed that the "after-coking" stage can be omitted and green briquettes fed directly into the furnace, since "after-coking" occurs during the ironmaking process.

FINE-DIAMETER FIBERS SPUN FROM STAINLESS STEEL

Continuous metal fibers in diameters ranging from 25 microns to 0.5 microns are being produced by Brunsmet Metal Fibers and utilized in numerous applications such as accoustical panels, filter media, gaskets and wicking material. This material is drawn from ultra-clean filaments made from a number of stainless steels including several austenitic alloys and Custom 455, an age-hardening stainless steel. When twisted into continuous yarn, it is as soft, flexible and strong. It can be processed on standard textile machines and formed into conventional textile geometries.

One textile form readily fabricated from these fibers is an air lay web, a randomly oriented batting-like structure, which can be compacted to the desired density and sintered into rigid porous structures to make effective sound absorbers. Standard filters can also be made for high corrosion resistance at elevated temperatures and high stress environments. Gaskets made of the material are said to effectively eliminate leakage around cabinets, closures and joints. Also parallel bundles of the ultra-fine fibers can be a superior wicking product that permits controlled wicking rates for various high-temperature and corrosive liquids.

SINTERAL REPORTS BREAKTHROUGH IN ALUMINUM POWDER METALLURGY

Sinteral Corporation, Queens, New York has developed a new air-sintering process that makes use of aluminum in powder metallurgy commercially feasible. The new process uses a simple air atmosphere, in contrast to the hydrogen or nitrogen installations required by present aluminum sintering methods. It is claimed that the process will do away with the heavy capital investment required by existing methods, reduce production costs, and enable aluminum to compete in price and quality with iron and copper which now dominate the market. The aluminum parts that can be produced will also compete in quality, matching their counterparts in strength, light weight, corrosion resistance, ductility, conductivity and other attributes of aluminum. The new process could be used to produce such components as cams, gears, self-lubricating bearings, flanges, control knobs, bushings, heat sinks, valves, connecting rods and capacitor anodes.

EXTENDED HOLDING OF DUCTILE IRON

A technique for extended holding of magnesium-treated iron was developed in the Birmingham Research Laboratory of INCO. The method involves holding the treated iron in basic neutral-lined furnaces before tapping. It was found that magnesium loss from treated metal held in acid lined furnaces and ladles occurs mainly by reaction with the acid lining and that use of a basic or neutral lining is desirable to minimize such loss. The "held" iron is clean and low in drossing tendency because magnesium sulfides and oxides float out on holding at maintained or increasing temperatures. It was found also that spheroidal graphite was achieved even when magnesium content was as low as 0.015 per cent after holding for as long as 1½ hours. It was claimed that the use of nickel-magnesium treatment agent is the most convenient and surest way of adding magnesium to base iron. The presence of nickel also tends to show the magnesium fade.

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VOL. II • NO. 4, OCT.-DEC., 1972

A QUARTERLY PUBLICATION OF THE METALS INDUSTRY RESEARCH AND DEVELOPMENT CENTER

Severe demands are placed on the refractory lining in arc furnaces.

Tapping an arc furnace.

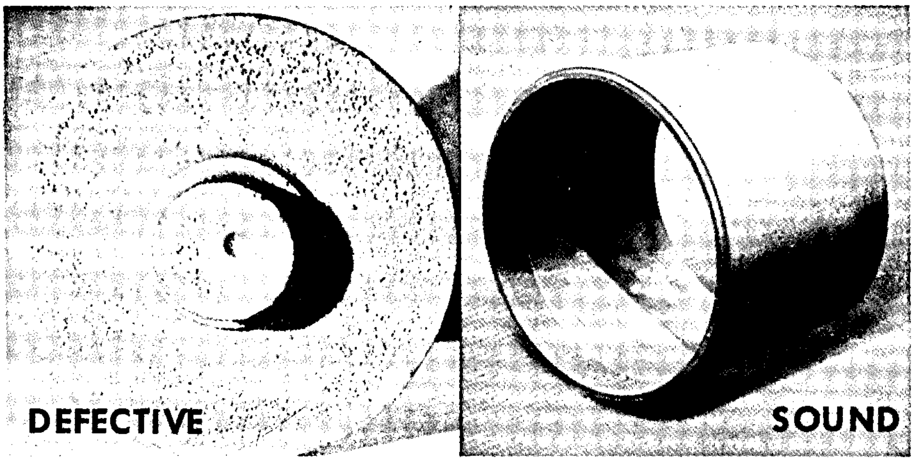
Installing an arc furnace roof lining of Alro 80 refractories.

Published quarterly by the

Metals Industry Research and Development Center

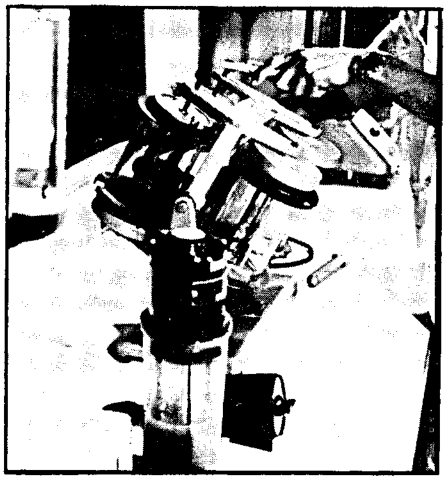
5th Floor, Ortigas Building
Ortigas Avenue, Pasig, Rizal
Tel. Nos. 692-66-20; 692-66-23

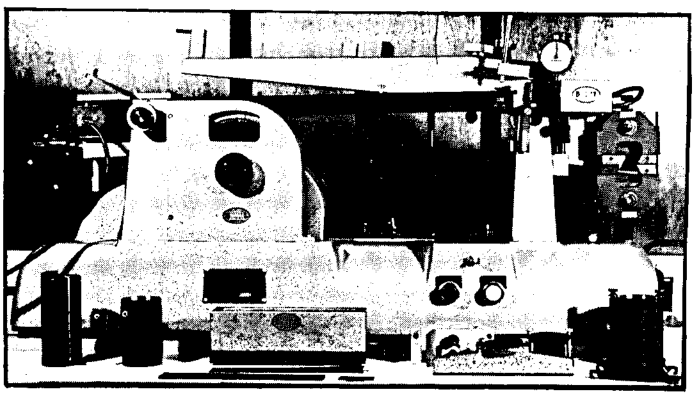
Even if utmost care is used in the selection of charges, melting and pouring processes, quality castings cannot be produced without proper sand control.



SAND TESTING IS VITAL IN FOUNDRY OPERATIONS

THE SAND TESTER





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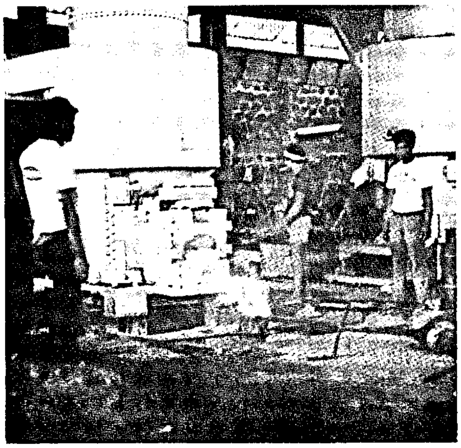


COVER STORY:
The 5 ton per hour cupola furnace being tapped at PHUMACO's foundry shop.

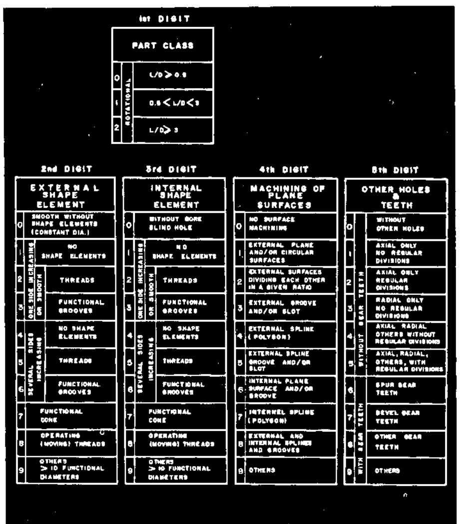
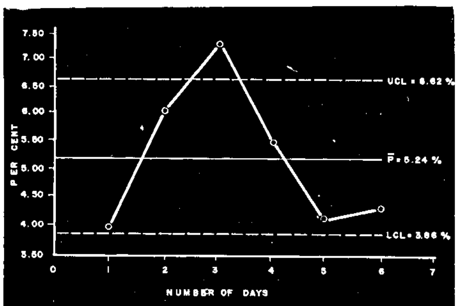


Figure 1
OPITZ CLASSIFICATION AND CODING SYSTEM (ROTATIONAL COMPONENTS)

Introduction to Group Technology, page 17.



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MIRDC AND THE GOVERNMENT'S COUNTRYWIDE FARM MECHANIZATION PLAN

The Government today, after extensive studies on land and labor productivity in agriculture, recognizes that the Filipino farmer cannot produce efficiently with only his plow and his work animal. If the Philippines is to succeed in its economic development program, the agricultural base must of necessity be industrialized. Therefore, mechanization must eventually replace traditional methods of farming.

The International Rice Research Institute which is engaged in the development and propagation of appropriate agricultural mechanization technology for wetland rice-producing Asian countries like the Philippines is pursuing applied research, prototype development and the adaptation of farming machinery (power tillers, threshing and drying machines, stripper-harvesters, etc.) to the farming conditions of Asia. Tested and approved, IRRI prototypes (economical machines made of local components and geared for the tropics) are offered to interested parties for commercial manufacture.

To accelerate the pace of farm mechanization, there is the need for a more vigorous promotional program, the establishment of repair and maintenance shops, and training programs for both farmers and skilled workers in farm machinery technology. The Metals Industry Research and Development Center, created by law to assist the metals and engineering industries, is working alongside the BOI-initiated Progressive Car Manufacturing Program by providing, among other things, technological direction in the form of engineering consultative services, quality control, manufacturing standards, and the training of skilled and technical manpower. It can, in the way of technology transfer, be of considerable assistance to the Government's agricultural mechanization plan. The Center can train people how to manufacture metal components for agricultural equipment and machinery.

It has also the facilities and expertise to assist the government and local manufacturers in the standardization of agricultural machines for small-scale industries. By encouraging closer rapport between the farm machinery manufacturers and the metal forming and fabricating firms, the Center can promote the more efficient utilization of existing and underutilized capacities.

The Government has expressed its desire to help labor-intensive, small-and medium-scale industries according to the horizontal integration system. The mechanization of farming, as exemplified by Japan that grows rice on conditions approaching ours, is expected not only to increase both land and labor productivity but also hasten countrywide industrial dispersal and generate more job opportunities for the country's unemployed. Farm mechanization therefore, provides one of the most important forms of industrial support for land reform. The role of MIRDC on technology transfer in the agricultural mechanization scheme is a crucial one to which the Center is fully committed.


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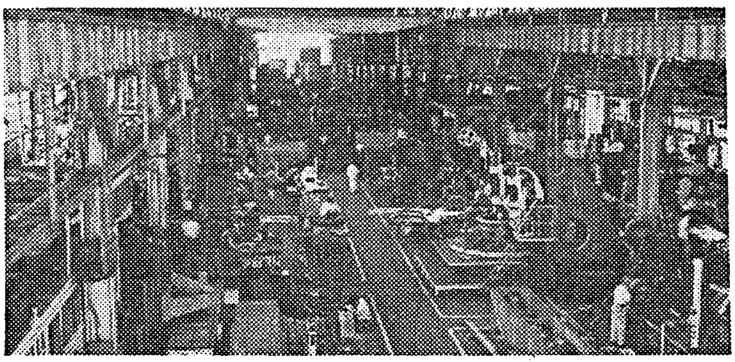

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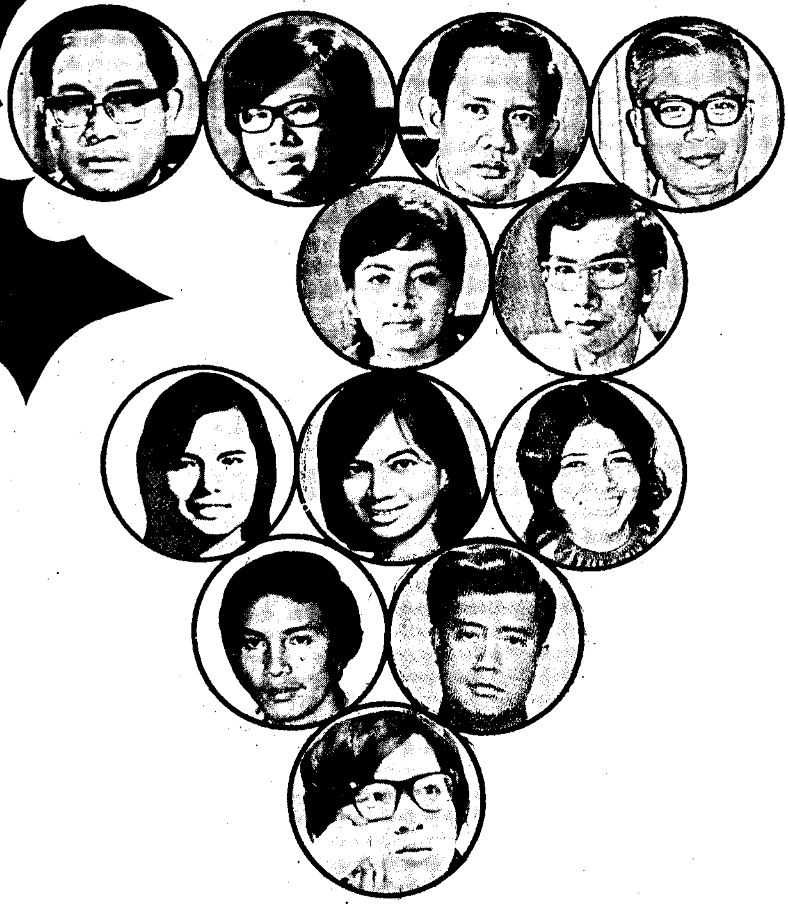

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THE MANUFACTURE OF SPECIAL WELDING ALLOYS

By ALBINO F. MAGLALANG

Albino F. Maglalang is General Manager of Wimpey International, Inc., manufacturer and distributor of special welding alloys. A mechanical engineer, he has traveled extensively in the USA, Europe, Australia and Japan where he trained in management and administration of hydraulic dredges, observed the manufacture of special welding alloys and welding electrodes and rods.

Maglalang is President of the Philippine Welding Products Manufacturers Association and Chairman of the Society of Manufacturing Engineers (SME.) He is a member of the Philippine Association of Mechanical and Electrical Engineers (PAMEE), American Welding Society, Philippine Association of Mechanical Engineers and the Philippine Chamber of Industries.

Special welding electrodes and rods are used in the maintenance, repair, salvage and production welding necessary for industries to keep machineries running and productive. Parts of machinery and heavy equipment which are generally expensive when imported may be successfully reconditioned to become as good as new and of comparable quality as that of imported ones.

THE MANUFACTURING OPERATION

Special welding alloys could be alloys of copper, nickel, aluminum, zinc or silver, depending upon the material to be welded. Welding electrodes are composed of a core wire of varied composition coated with powder and binders called the flux.

Preparation

A manufacturing program for the production of special welding electrodes and rods is first established so that proper control of manufacturing procedures can be instituted. Product cards for each batch of production are maintained showing the pertinent and relevant information regarding the product in process. Each manufacturing program prepared should stipulate the quality of finished product required and designate a batch number which must be changed under the following conditions:

1. Change of alloy
2. Change in diameter
3. Change of concentrate delivery or batch number
4. Change of core wire supplier delivery or batch
5. Any other significant change in material or manufacturing procedure including the drying cycle

Notes of all batch numbers are recorded on the product cards and include the above information.

The purpose of the batch number is to trace the complete history of manufacture for each batch in the event questions may arise later concerning the use of the product. The batch number must appear on all individual packages of the finished products.

Raw Materials

Core wires of different alloys which are imported from abroad come in different diameters and on specified lengths. However, if the supplier sends the drawn wire in coils, a semi-automatic straightening and cutting machine is used. Powered by an electric motor, it is capable of cutting lengths from 9" up to 36" and diameters of 1/16" up to 1/4". The speed of the machine is variable, depending on the type of alloy wires being cut. Powder binders are imported either from Japan, Germany, Switzerland, the USA or Australia.

Mixing of Flux Concentrates

The flux concentrate used in the manufacture of welding electrodes is obtained in powder form. The concentrate is composed of such compounds as calcium carbonate, chromium powder, iron powder, molybdic oxide, titanium oxide, etc. Handling and storage is critical in the operation.

Some separation may occur within the drum of the concentrate during transit from overseas and due to long storage. The contents of each drum is thus loaded into the mixer and reblended for five minutes before use and the powder is placed back into the poly bag in the drum ready for use. An inspection sample of one to two ounces of concentrate is taken from each imported batch and kept for future reference.

If small dry lumps are present in the mix these are broken down by hand or by rubbing through a 60-mesh sieve.

Procedural instructions for each product give the breakdown of concentrates and binders relative to the mixers used in flushing. The quantities to suit local size of mixers must be established and it is essential that the percentage ratio is exactly the same as the flushing mix with respect to the AA and AAA quantities. Variations in binder additions can be tolerated $\pm$ 10% depending on humidity conditions, but the ratio of the binder specification must not vary.

Concentrates should be weighed out accurately. If the concentrate is in two or more parts they must be dry mixed together as per procedural instructions before adding the liquid binder.

Binders

There are a number of binders used in the preparation of flux material. Considered to be the most commonly used are potassium and sodium silicates. These solid binders mixed with water make up the binder materials.

Liquid binders are weighed and mixed together following procedural instructions. Solid binders are added to liquid binders and stirred continuously until completely dissolved before the next material is added. Binders can be made in large quantities and stored in order to save time. However, no mixed binders should be stored longer than one month.

Mixing Operation

After dry mixing the powders, the liquid binder is added and mixed for several minutes. The mixer is stopped and the mix is scraped off the mixer sides, bottom plough blades and rollers. Wet mix for the time indicated in the procedural instruction with a tolerance of $\pm$ 10%. During this period stop at least once to scrape and stir in non-moving, dry or overwet material.

Mixing times specified do not include time for dry mixing or scraping down. These operations are done on additional time.

The total wet-mixing time laid down by more than 10% are not shortened without reference. Therefore, if mixing time quotes 20 minutes in the instructions plus five minutes each for dry mixing and scraping down, the total time for the whole mixing operation will be 30 minutes. After mixing, the flux from the mixer is removed and pressed into slugs or used loose whenever necessary.

The mixer is scraped clean immediately after use, otherwise the flux residue will become hard and difficult to remove or break up as hard pieces in the next mix. If any further mixes are required or there is a change of product, then the mixer should be washed with water and dried out. The flux is kept in an air-tight container until put into the extruding machine to avoid a dry hard skin forming on the outside.

The amount of flux prepared should not be more than what can be used in one hour. Plan to mix only sufficient flux to be used on the same day. During the mixing operation the flux is not allowed to become warm as this will cause rapid drying and hardening of the flux. A few ounces of water may restore the flux.

If mixers are fitted with water cooling jackets, the cooling water should be circulated during the mixing operation. Each successive mix that is made is recorded so that at the end of the shift or batch, the total amount of flux manufactured will be known.

Extrusion

The most practical hydraulic press is the horizontal design that utilizes the in-line principle of flow wherein the flux and core wire are fed along the same line rather than at an angle to one another. This principle offers a desirable flow pattern, resulting in lower extrusion pressures and also permits concentricity of the coating around the core wire to be maintained without adjustment.

The press consists of a base frame which also serves as an oil reservoir, the hydraulic cylinder and extrusion cylinder. The hydraulic cylinder and extrusion cylinder are connected together by a bayonet-catch and can be disconnected from one another by means of a hand lever, and tipped into the vertical position for filling with flux.

The automatic wire feeder is mounted on the press frame and is driven by a variable speed gear reducer. The V-groove feed rolls are driven directly from the gear reducer through a flexible coupling and a pair of spur gears. The tapered pick-up rolls are driven from the feed rolls with two V-belts. The speed of the rolls is adjusted by a hand-wheel on the variable speed reducer. The rolls are adjusted in relation to the center line by means of individual adjustment screws. The rolls are closed by turning the adjustment screws clockwise, and are opened by spring pressure when the screw is backed off.

The rear and plate of the wire hopper is adjusted for different wire lenghts. Adjustment is made by removing the plate, removing the screw on the plate bracket, and moving the plate bracket to the desired position. Screw holes have been provided in positions for the various lengths.

The agitator roll turns in opposite direction of the falling wire and is driven by an agitator motor through a friction clutch and roller chain.

The wire hopper is adjustable for various diameter and length of wire by means of adjustment screws and stopper plates.

A conveyor unit is used for brushing or stripping the flux coating from the core wire on the two ends of the coated welding electrodes. One end is stripped in order to make contact with the electrode holder and the opposite end is stripped to assure that enough of the core wire is exposed to strike an arc.

The extruded electrodes are conveyed first under a rotating wire wheel running on a 90° axis to the electrode by a belt conveyor. A specially designed hold-down belt mounted over the conveyor belts and running at a higher speed rotates the electrodes on the conveyor belt while they are in contact with the wire wheel — thus the grip end is produced.

Prior to entering the brushing unit the electrodes are aligned at 90° to the conveyor belts by a special corrugated belt and are aligned endwise by two aligner belts running on vertical axis. After the brushing operation for "grip" end, the electrodes are realigned and conveyed under a second hold-down belt which rotates them while the coating is removed from the opposite or "strike" and by an abrasive drum sander.

This unit can handle 9", 14" and 18" long welding rods of all diameters with speed of up to 1000 rods per minute.

Oven Baking and Drying of Electrodes and Rods

All baking must be carried out in accordance with the production specification with reference to the required temperature. For this purpose an electric oven as recommended.

On certain products a definite period of air-drying is advisable before proceeding as per baking instructions to prevent cracking of coating. If ever a doubt exists, a very small quantity of electrodes should be taken through the complete baking cycle and inspected for cracking before going into a full production batch.

The baking temperatures given in the specification are those which the electrode must attain and not the temperature of the oven casing. Therefore, depending on the size of the electrode, the thickness of coating, the load in the oven and the design of the oven, the temperature of the final baking cycle might have to be lengthened to ensure an even temperature throughout the entire oven load. After the baking cycle, it is important that electrodes are selected for weld test from top, middle and bottom trays within the oven.

For electrodes requiring a high baking temperature (450°-650°F), the rise in temperature should progress evenly to ensure that the temperature throughout the oven rises at the same time.

Oven which are forced air circulated tends to heat more rapidly at the side of the oven from the direction of the circulating air.

Effects of Adverse Humidity Conditions

All extruded products are susceptible to moisture deterioration. After extrusion, if products must stand for some time before baking they must be subjected to de-humidified conditions. They must be baked within 48 hours unless exceptional circumstances prevail. Storage for a longer period in a de-humidified room and at controlled temperatures are not good substitutes. Neither is storage at temperatures as low as 75°-180°F in dehumified rooms because this does not remove enough moisture to prevent chemical decomposition of the coating and binder.

Baking for 30 minutes above 110°C (230°F) for all electrodes (not gas rods) will prevent decomposition, but the final welding properties will require baking at the maximum specified temperatures as laid down in the specification and must be strictly adhered to before final packing takes place.

After baking, if packing is not done immediately, the electrodes are stored under warm and dry conditions until final packing may be conveniently made.

Ideally after baking, products should be packed while still warm. If the packing cycle is such that a whole batch can not be packed immediately they should be stored in air/moisture tight bins or drums until they can be fitted into the packing line.

All rods should be packed in plastic bags and sealed to prevent ingress of moisture. Care must be taken in placing the rods in bags to prevent the rod ends from damaging the bag. Bags must not be blown by the mouth as this will line the bag with condensation.

Extruding Faults

If concentricity is found to wander excessively during checking (checking should be carried out at least once every 200 rod production) the operation proceeds as follows:

1) Remove die head.
2) Check for consistency of flux. Presence of unusually hard or dry material will cause uneven pressure on the side of the rod and hence deflection of the wire through the die.
3) Check for foreign matter around extruding die.
4) Check for excessive clearance between extrusion die and wire guide.
5) Bent wire.
6) Check for excessive clearance between wire and guide nipples.
7) Check for excessive clearance between guide tube and head.

The pressure of the machine should be adjusted until the coating is well compressed. The coating must not show cracks or porous structure due to low pressure.

Too much pressure results in the swelling of the diameter or wrinkling like orange-peel, or the flux may not adhere to the wire in the form of a tube. A flux tail may also appear on each rod. This could be minimized by lowering the pressure until the flux appears solid. This can also be eliminated by increasing the wire feeder's speed accordingly.

When the slag or loose flux is placed in the flux cylinder, a certain amount of air is entrapped in the flux. This air may eventually come out through the flux die and the following may happen:

1) The flux coating may blister or crack.
2) The coating does not bond onto the wire and breaks under the brushing units.
3) Sudden softening of the flux causing it to spaw or split out of the die much faster than the wire.

If the air trap lasts more than a minute or so, production should be stopped. The wire from the extrusion die must be withdrawn seeing to it that a wire remains in the guide tube.

Some flux are allowed to extrude from the die for 10-20 seconds until trapped air is removed. The operation is continued when it is found out that the coating bonds to the core wire again.

It may be noted while extruding that a collar releases itself from the back of the extruding die and attaches itself to the rod. The collar is very soft and if not removed prior to baking it will become impossible to remove without damaging the electrode. The principal cause of this is a bruising of the internal diameter surfaces of the extruding die. This can occur on die faces which appear to be highly polished and should be remedied by changing the die. The faulty die should be repolished to remove bruished surfaces.

A roughening of the surface coating may occur similar to under pressure characteristics. This is caused by using unpolished dies. These dies should be replaced or repolished.

Large swellings in localized areas on the coating indicate an uneven feed along the wire train system, caused by a momentary jamming of wires within the feed system. The principal cause of this is that the wires are carrying a burr on one end and such burred wires should never be used. Other causes are the use of bent wires or the feed system is not aligned.

Re-Use of Flux from the Extruding Line

When rods are to be scraped, the flux can only be re-used if the rods are stripped immediately after extrusion and the flux stored in a closed cylinder. This flux must not be put back into the flux during the following mix. If the flux appears too hard or dry for re-use it should be discarded because the use of such flux will cause trouble in the die head and cause accentricity. Wires from scraped rods can be washed off, redried and re-used, provided they are not bent.

Recording and Quality Control

After baking, rods taken at random from the batch should be tested by a competent welder for quality. The usual procedure is to burn off ½" and examine the end. If the electrode is not properly dried, it may show one of the following defects:

a) Excessive spatter and fierce arc.
b) Small blisters or cracks close to the burnt end.
c) Some swelling and the possibility of a little stream or water vapour from the surface.
d) Burning unevenly at the end.

If the electrode is off-center, it will burn down unevenly on one side. In the case of dampness, the uneven burn-off wanders from side to side.

After drying, printing and color tipping, three rods are selected at random from each batch. These rods are then sealed in plastic envelopes with the following identification.

a) Quality control number
b) Product
c) Diameter
d) Date of manufacture

These packages should be stored in the plant for reference purposes, in case of complaints or questions in the future.

Inspection and Packing

After quality approval, the batch of electrodes can be packed in approved type boxes, cans or cartons.

Electrodes and rods must be printed and color-tipped in accordance with standards.

Electrodes are inspected before packaging for any of the following defects:

1. Chipped off or deformed coating.
2. Minor or major cracks along length and diameter.
3. Electrodes "under pressure" during manufacture (showing porous surface).
4. Excessive length or under length brushing.
5. Damaged striking end.
6. Excessively marked with printing ink.

The packages are labeled with an approved procedure label and the ends of the carton or cans are stamped showing the following:

a. Alloy
b. Diameter/size
c. Weight in lb. or kgs.
d. Batch number

It is essential that higher priced alloys are pre-packed in polly bags prior to can packing.

Cleanliness in Production — Warning

All fluxes dry very hard and very quickly when exposed to the air. Therefore, special attention must be given at all times to the following points:

1. Soft flux must be enclosed in air-tight containers until ready for use.
2. All flux intended for use again must be sealed in air-tight containers as quickly as possible after extrusion to prevent it from becoming

hard. If the flux feels harder or has a hard skin, it must not be used.

3. All moving parts of the extrusion press and die head must be cleaned frequently with scraper and wet cloth to prevent the build-up of hard flux and allow smooth movement. Surfaces not in direct contact with the flux should be lightly filmed with oil. The adjusting screws on the die holder should be removed regularly and oiled. When not in use, all surfaces may be oiled to prevent rusting.
4. All conveyor belts and pulleys must be regularly and frequently cleaned during extrusion. Hard pieces of flux on the conveyor belts make unacceptable marks on the soft electrode coatings.
5. The mixing machine must be thoroughly cleaned after each mix. All corners, blind and dead area such as the back of plough, blades, scrapers supporting arms and various ledges must be thoroughly cleaned to prevent hard flux dropping to a subsequent mix. The presence of hard pieces of flux in the die during extrusion will cause stoppage of the process, contaminating of the electrode, or the electrode becoming "off-center." All containers must be washed after use, including binder buckets and surfaces of weighing machines and benches.

Floors should also be continually swept to prevent flux sticking to shoes and floors and therefore, its being spread around. Scrap bins can be used for wire and flux and garbage cans for paper, rags, etc..

ANNOUNCEMENT

The Metals Industry Research and Development Center (MIRDC) is coming out with an industry study entitled "The Primary Iron and Steel Industry of the Philippines". This is the second of a series of industry studies being undertaken by the research staff of the Center's Information and Industrial Economics Department. The status of the local iron and steel industry is presented and correlated with trends in the Philippine economy. It further describes local manufacturing processes, market study and financial analysis of the different sectors of the industry which include: Hot-Rolled and Cold-Rolled Sheets and Strips, Tinplates, Galvanized Iron Sheets, Pipes and Tubes, Billets, Merchant Bars and Wire Rods. It also gives an insight into the possibility of backward integration and for potential export markets in Asia. The problems of the industry are dealt with towards the end of the text.

"The Primary Iron and Steel Industry of the Philippines" will be available for sale at the Metals Industry Research and Development Center, Publications Section by January, 1973.

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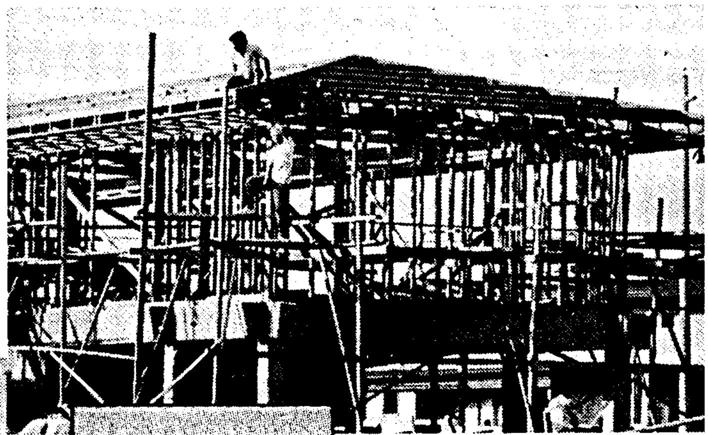

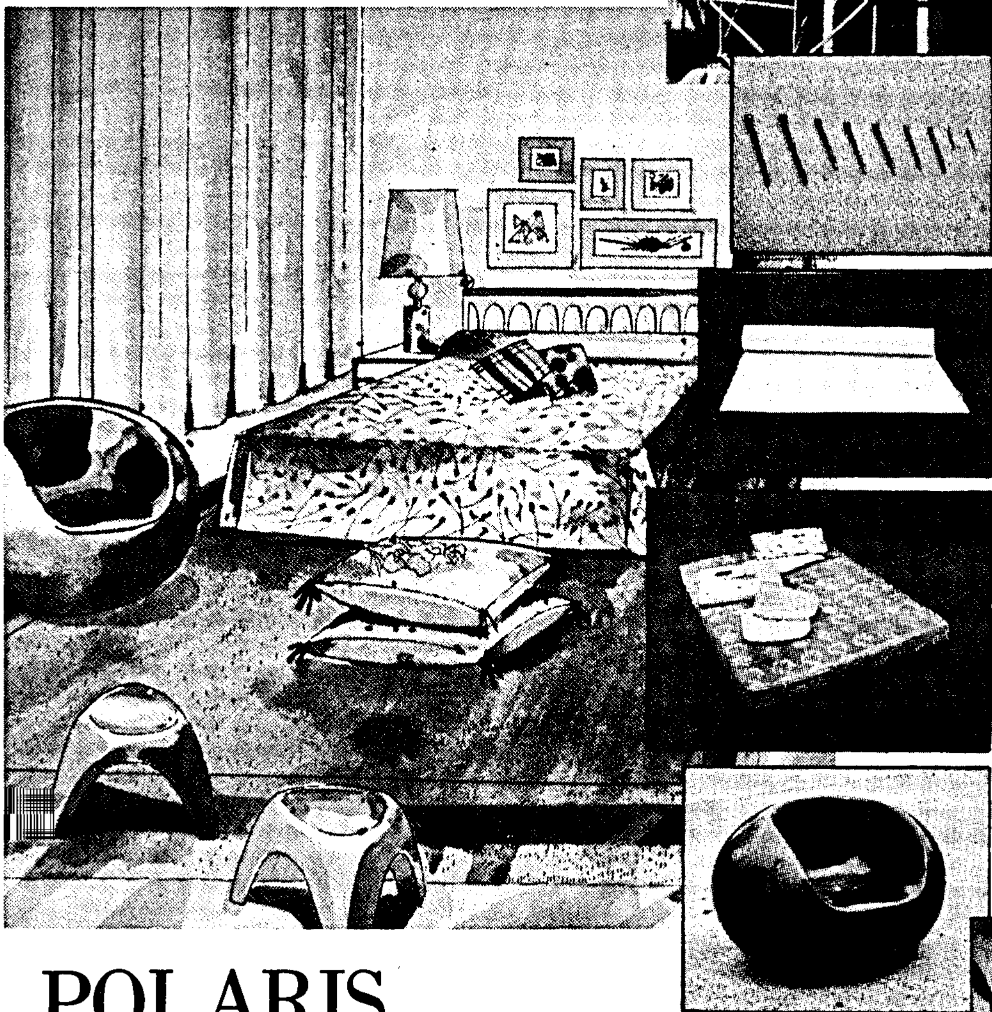

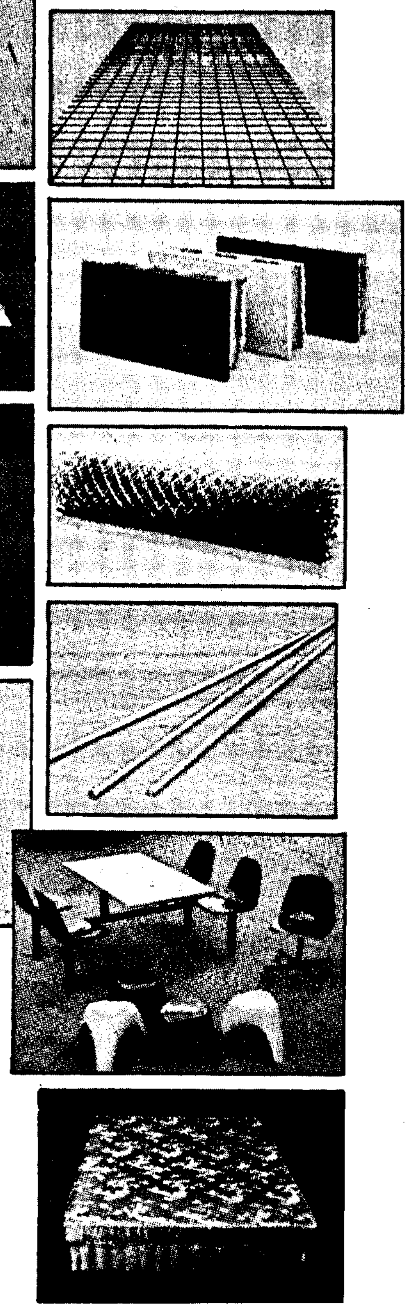

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INTRODUCTION

The aim of rationalization and optimization in manufacturing is to increase productivity and reduce production cost. In mass production, suitable machines and tooling can be designed and standardized to enhance productivity. In jobbing a small batch production, the input of various components and continuous change of necessary set-ups create difficulties in developing special tooling or using special machines as they are not economic. Hence, flexible facilities must be incorporated in a shop where design and rationalization is difficult. If one were to look at the sources and magnitudes of costs in the metal-working industry, he would find that actual metal cutting is often a relatively insignificant fraction of total costs, and the real economic problems lie in areas such as tooling set-ups, production scheduling, labor and equipment utilization and in-process inventories. Because of this situation, a growing amount of attention has been turned, particularly in Europe, to a manufacturing system which deals with the areas of job-shop manufacturing. This system is Group Technology.

By: DR. INYONG HAM

INTRODUCTION TO GROUP TECHNOLOGY

Dr. Inyong Ham is Associate Professor and Full Member of the Graduate Faculty of Industrial Engineering at the Pennsylvannia State University, USA. He is a member of the ASME Production Engineering Division, Materials Processing Field Committee, and Literature Review on Metal Cutting Practice. He is also a member of the ASTME Technical Committee, Metal Removal Committee, Executive Committee of Tool Cutting Processes, Subdivision and Chairman of Educational Committee, ASTME Local Chapter. Dr. Ham has made research activities in metal cutting, machine tools, laser application, electron microscope analysis, activation analysis, frictional interface reaction study, radioisotope applications and deep drawing.

DEFINITIONS

Group Technology is a system of many names and definitions. It is also known as Part Family Manufacturing, Family Planning, Family Grouping, and by a number of other names appearing in German, Japanese, Russian, U.K., U.S.A., and other foreign sources. The general concept of Group Technology was given by Prof. V. B. Soloja of the Institute of Machine Tools, Belgrade, Yugoslavia, and is:

> "Group Technology is the realization that many problems are similar, and that, by grouping similar problems, a single solution can be found to a set of problems thus saving time and effort."

In this editor's forward of the English translation of Mitrofanov's book on Group Technology, T.J. Grayson describes as follows:

> "Group Technology is a method of manufacturing piece parts by classification of these parts into groups and subsequently applying to each group similar technological operations. The major results of this method of manufacture is to obtain economics which are normally associated with large scale production in the small scale situation and it is therefore of fundamental importance in the batch producing and jobbing sections of industry."

J. Gombinski relates this concept to manufacturing by defining Group Technology as:

"A production method that involves the machining of parts in families."

F.R.E. Durie defines Group Technology specifically as a production method, stating that:

"Group Technology is the replacing of traditional jobbing shop manufacture by the analysis and grouping of work into families and the formation of groups of machines, to manufacture those families on a flow line principle with the object of minimizing setting times and through-put times."

The Group Technology Center in U.K. defines Group Technology in their seminar manual as follows:

"Group Technology is a technique which allows the production of components in small batches to achieve similar economic advantages to those associated with continuous flow line production."

HISTORICAL BACKGROUND

Group Technology (G.T.) has been practiced in various forms since the beginning of this century. In Europe, very little practical work was done with the concept until the Germans used it somewhat in World War II and then the Swedes around 1948. In 1954 the Russians took renewed interest in G.T. and its development as a manufacturing technique culminated in the publication of S.P. Mitrofonov's book: **"Scientific Principles of Group Technology"**, in 1959. In 1958 the first well documented G.T. operation was started at Forges and Ateliers de Constructions Electriques de Jeument, France. Serious study has been going on for a number of years under Prof. H. Opitz at Aachen Technical University, Germany, resulting in a universal industrial coding system, investigations into production techniques in machining, and statistical studies of the use of machine tool capacity in industry. Similar studies have also been going on in Italy, Japan, England, Yugoslavia, Czechoslovakia, etc..Recently, in U.K., since early 1960, the Government (G.T. Center), industry and educational institutions (University of Birmingham and University of Manchester) are very active in G.T. research and applications. Currently G.T. is a technique of rapidly growing popularity in industry in England, Japan, and most of Europe.

In the U.S.A., the general concept and approach of G.T. has been practiced for a long time under different names in various forms of industrial engineering functions for more efficient, scientific optimum manufacturing activities. However, it has not received the formal recognition and rigorously practiced as a systematic scientific technology applied to small-lot productions which are most common to small and medium industry. Athough there have been many application examples of G.T. in various form and degrees in this country, there is a very little published studies, data and case histories available to the public compared to those of European countries and Japan.

CONCEPT OF GROUP TECHNOLOGY

Group Technology is a manufacturing philosophy which identifies and exploits "the underlying sameness" of items and the processes used for their manufacture. Whereas in the past industrial engineers have tended to view each component produced in a company as being unique, G.T. draws components together in families. As in any human family, each member is unique but each has some charateristics similar to others. It has been shown from previous studies that in the industrial environment, production engineers are not dealing with random and unique but with related and ordered components. Further, it is possible to asses the related-ness of the processes required for the manufacture of these components. The relationship of component, one with another, is not immediately obvious if the total component population of a company is visually examined; there is even a danger that this approach will lead to a rejection of the basic G.T. philosophy. If, however, the components are identified by examining their fundamental attributes and families are formed from those with common incidence of certain attributes the process of identifiction is simplified and families can be formed. This approach has been successfully employed in many countries by the use of a component classification and coding system. There are, in fact, numerous systems in use throughout the world each with a group of supporters and equally a group of opponents.

Group Technology is not a new system for mass production, but is rather a method of alleviating problems associated with short run job shop work. Although the basic idea of G.T. is quite old and commonly known, the potential advantages of G.T. are only now being appreciated because the prerequisites for the optimal practice and applications of G.T.

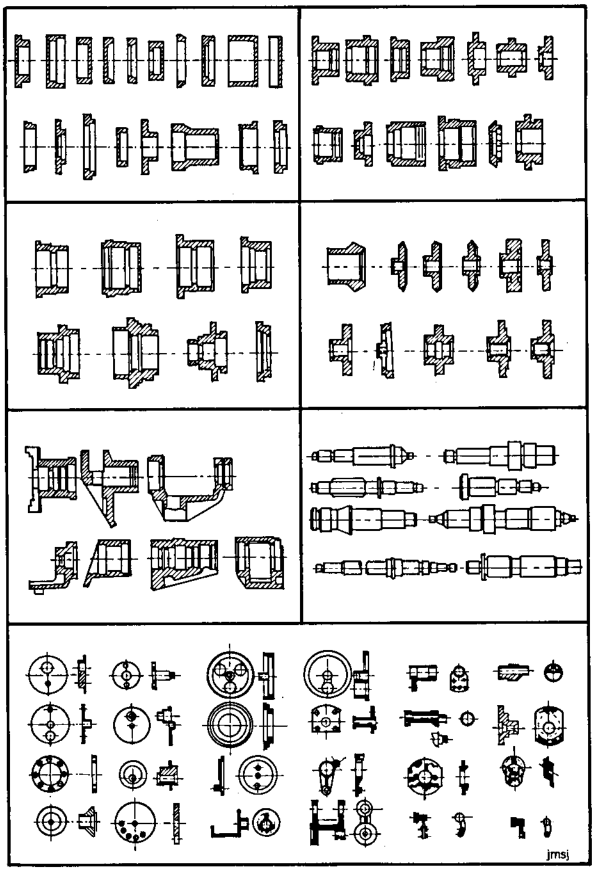

Figure 1
EXAMPLES OF TYPICAL GROUPS OF PARTS

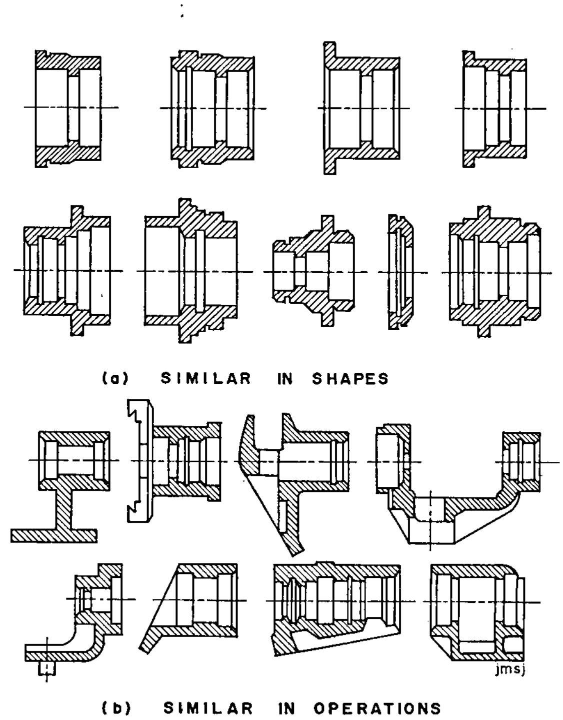

Figure 2
EXAMPLES OF TYPICAL GROUPS OF PARTS OR PART FAMILIES

are more readily acceptable in the present situation with ever increasing problems in industry. In the job shop, because of the variety of jobs encountered, and the short number of parts in each run, set up time may be the most significant part of production time. The shop usually uses a process type layout of equipment with no interrelation between groups of different functions. Each job takes a confused, unpredictable path through the shop in order to reach all the necessary equipment involved in its processing. Every time a job is moved there are delays in finding transportation equipment or personnel. Production scheduling is often reduced to a matter of plugging a job into the first available machine or extra capacity becomes apparent. Production control becomes extremely complicated and it is almost impossible to get reliable up-to-the-minute information on the production status of any particular job.

Group Technology overcomes these problems by grouping parts (see Fig. 1) so that all jobs requiring similar machines and tooling are processed in a sequence which increases the number of parts per set-up and thus reduces set up time considerably. It takes the machines needed for this group of similar jobs and places them near each other, drastically reducing the scope of the production scheduling and control problems and improves communication.

PART FAMILIES (GROUP OF PARTS)

The grouping of related parts into families is the key to the Group Technology concept. These families may be constructed in one of two ways as follows:

(a) The first family, A_1, consists of parts which are similar in shape within a certain dimensional range, and have most or perhaps all machining operations in common. (See Fig. 2-a)

(b) The second family, A_2, consists of parts of dissimilar geometry, but have one or more machining operations in common. This is a similarity in production process rather than form. (See Fig. 2-b)

CLASSIFICATION AND CODING

The problem which immediately presents itself is how are the parts to be efficiently grouped into these families? The job could be done by a visual comparison of parts, comparison of names, or some rule of thumb. However, since all of a company's active parts should be grouped, the job can quickly become too much for a man with a quick eye and a long memory and a more reliable and comprehensive method must be found. The best and most comprehensive grouping can be accomplished by combining parts according to the same or similar code numbers in some type

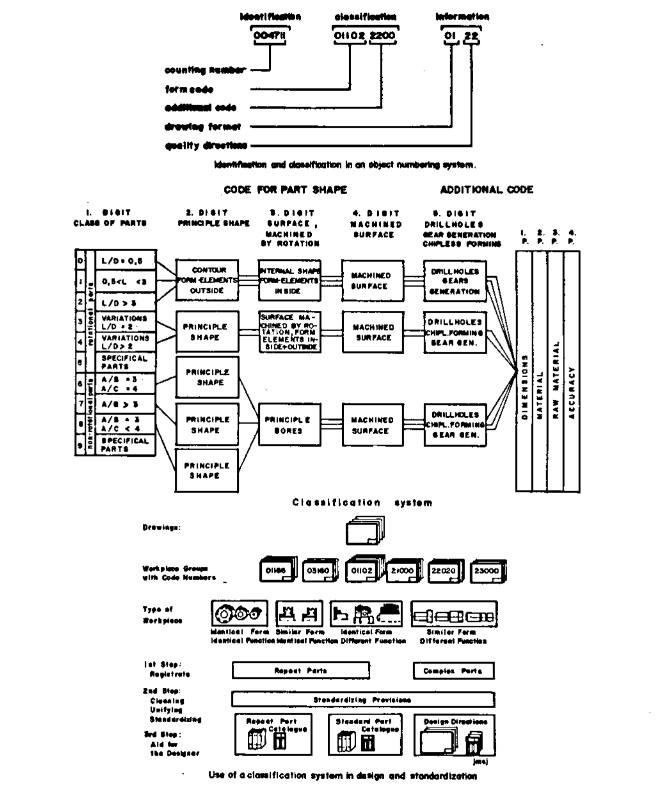

Figure 3

OPITZ CLASSIFICATION AND CODING SYSTEM AND ITS APPLICATIONS

1st DIGIT

PART CLASS		
0	ROTATIONAL	L/D > 0.5
1	ROTATIONAL	0.5 < L/D < 3
2	ROTATIONAL	L/D > 3

	2nd DIGIT		3rd DIGIT		4th DIGIT		5th DIGIT
	EXTERNAL SHAPE ELEMENT		INTERNAL SHAPE ELEMENT		MACHINING OF PLANE SURFACES		OTHER HOLES & TEETH
0	SMOOTH WITHOUT SHAPE ELEMENTS (CONSTANT DIA.)	0	WITHOUT BORE BLIND HOLE	0	NO SURFACE MACHINING	0	WITHOUT OTHER HOLES
1	ONE SIDE INCREASING OR SMOOTH: NO SHAPE ELEMENTS	1	ONE SIDE INCREASING OR SMOOTH: NO SHAPE ELEMENTS	1	EXTERNAL PLANE AND/OR CIRCULAR SURFACES	1	WITHOUT GEAR TEETH: AXIAL ONLY NO REGULAR DIVISIONS
2	ONE SIDE INCREASING OR SMOOTH: THREADS	2	ONE SIDE INCREASING OR SMOOTH: THREADS	2	EXTERNAL SURFACES DIVIDING EACH OTHER IN A GIVEN RATIO	2	WITHOUT GEAR TEETH: AXIAL ONLY REGULAR DIVISIONS
3	ONE SIDE INCREASING OR SMOOTH: FUNCTIONAL GROOVES	3	ONE SIDE INCREASING OR SMOOTH: FUNCTIONAL GROOVES	3	EXTERNAL GROOVE AND/OR SLOT	3	WITHOUT GEAR TEETH: RADIAL ONLY NO REGULAR DIVISIONS
4	SEVERAL SIDES INCREASING: NO SHAPE ELEMENTS	4	SEVERAL SIDES INCREASING: NO SHAPE ELEMENTS	4	EXTERNAL SPLINE (POLYGON)	4	WITHOUT GEAR TEETH: AXIAL RADIAL OTHERS WITHOUT REGULAR DIVISIONS
5	SEVERAL SIDES INCREASING: THREADS	5	SEVERAL SIDES INCREASING: THREADS	5	EXTERNAL SPLINE GROOVE AND/OR SLOT	5	WITHOUT GEAR TEETH: AXIAL, RADIAL, OTHERS, WITH REGULAR DIVISIONS
6	SEVERAL SIDES INCREASING: FUNCTIONAL GROOVES	6	SEVERAL SIDES INCREASING: FUNCTIONAL GROOVES	6	INTERNAL PLANE SURFACE AND/OR GROOVE	6	WITH GEAR TEETH: SPUR GEAR TEETH
7	FUNCTIONAL CONE	7	FUNCTIONAL CONE	7	INTERNEL SPLINE (POLYGON)	7	WITH GEAR TEETH: BEVEL GEAR TEETH
8	OPERATING (MOVING) THREADS	8	OPERATING (MOVING) THREADS	8	EXTERNAL AND INTERNAL SPLINES AND GROOVES	8	WITH GEAR TEETH: OTHER GEAR TEETH
9	OTHERS > 10 FUNCTIONAL DIAMETERS	9	OTHERS > 10 FUNCTIONAL DIAMETERS	9	OTHERS	9	WITH GEAR TEETH: OTHERS

Figure 4

OPITZ CLASSIFICATION AND CODING SYSTEM (ROTATIONAL COMPONENTS)

of component classification system. There are a number of good classification systems in existence today, Mitrofanov's in Russia, that of either Opitz or Gildemeister in Germany, that of Brisch and Partners in England and many others. (See Figs. 3, 4, 5, & 6). The best coding system is one which is adopted specifically to the industry or plant where it is used. To insure this, a company can devise its own classification system based upon either standardized systems or some other tailor-made systems. In order to facilitate grouping of parts, the system must be both design or form oriented and also production or process oriented. Care must be taken in formulating the process code so that the system can accommodate future change in technology which may produce entirely new methods of processing the parts in a family.

To understand clearly the classification and coding system, let us take an example of our home address system. Fig. 7-a illustrates a common classification system used by us all. The situation created here starts with the U.S.A. as a whole, then by progressive sub-divisions is able to locate a particular individual anywhere in the country. Our own unique identity is in fact our code number, just as a classification system allots a similar identity to each component produced within the company. Fig. 7-b shows a very simple method of breaking down the total component range within a company in similar sub-divisions.

As an example, a code number for a part using the Opitz code is shown as follows:

IDENTIFICATION	CLASSIFICATION		INFORMATION	
004711	01102	2200	01	22

COUNTING NUMBER
FORM CODE
ADDITIONAL CODE
DRAWING FORMAT
QUALITY DIRECTIONS

The second set of digits (classification digits of parts) are further separated into two groups, one for information about the shape of the part and the other conveying data about production processes required. The third set of digits carries additional information that can be directed to specific users, or dropped if not considered necessary. (Cont'd — Philippine Metals Vol. III No. 1)

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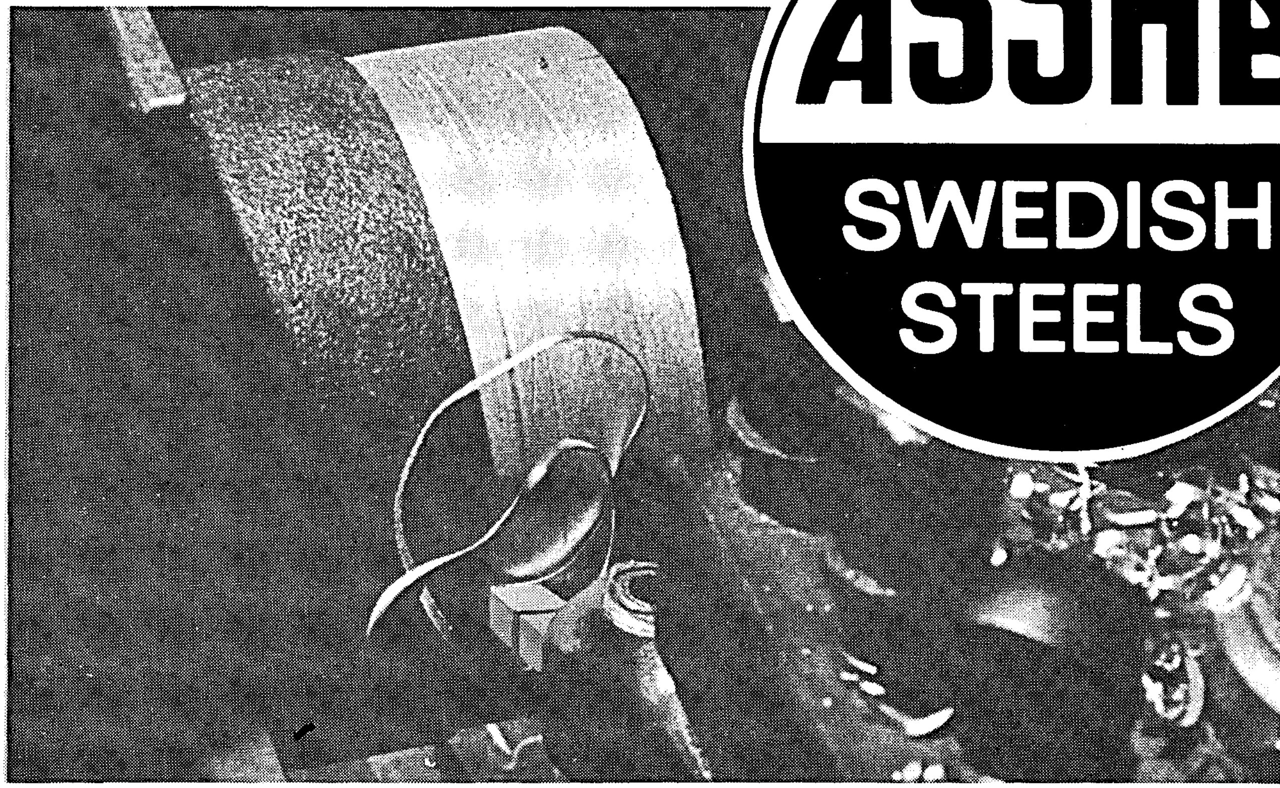

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ADAPTIVE USES OF THE QUALITY CONTROL CHARTS IN THE METALS INDUSTRY

PART II

by

Dr. Bernardo F. Adiviso

IV. Computational Matrix of the Control Charts

A. ILLUSTRATION MODEL FOR CALCULATING THE MEASUREMENT

Chart Control Limits

1. **The Sample Problem:** A machine setup had just been completed for the production of studs having a cut-off length specification of 5mm. $\pm$ .010 mm. About 200 studs are produced daily. Samples of three were taken each hour for quality appraisal as follows:

	Readings		
Sample 1:	5.05	5.06	5.01
Sample 2:	4.99	4.97	5.01
Sample 3:	4.97	5.00	5.00
Sample 4:	5.05	5.04	5.00
Sample 5:	5.02	5.02	4.99
Sample 6:	4.99	5.03	5.01
Sample 7:	4.97	5.00	5.00
Sample 8:	5.03	5.02	5.04

Compute the control limits of the daily control chart based on these samples at 95 per cent confidence level.

2. **Procedures:**

Step 1: Compute for the averages and ranges of the samples. Referring to sample 1, the three readings are:

$$\begin{array}{r} 5.05 \\ 5.06 \\ \underline{5.01} \\ 15.12 \end{array}$$

Using formula (1):

$$\overline{X} = \frac{15.12}{3} = 5.04 \text{ mm.}$$

Range:

$$R = 5.06 - 5.01 = 0.05 \text{ mm.}$$

Similar calculations may be done for the other samples. The results can be entered into the tabulation as shown in Table 3.

Table 3
CUT-OFF LENGTHS OF 24 SAMPLES OF STUD

Sample		1	2	3	4	5	6	7	8		
Readings	1	5.05	4.99	4.97	5.05	5.02	4.99	4.97	5.03		
	2	5.06	4.97	5.00	5.04	5.02	5.03	5.00	5.02		
	3	5.01	5.01	5.00	5.00	4.99	5.01	5.00	5.04		
TOTALS		15.12	14.97	14.97	15.09	15.03	15.03	14.97	15.09		
	$\overline{X}$	5.04	4.99	4.99	5.03	5.01	5.01	4.99	5.03	=	40.09
	R	0.05	0.04	0.03	0.05	0.03	0.04	0.03	0.01	=	0.28

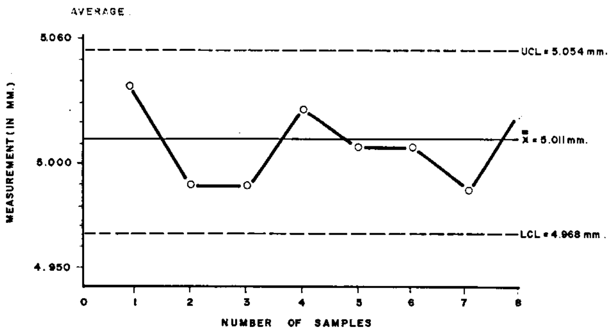

Figure 1a

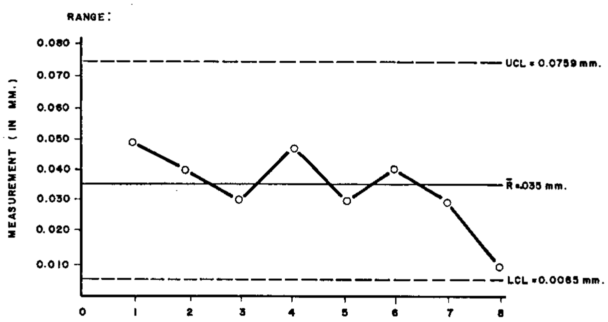

Figure 1b

Step 2: Determine the Grand Average and the Average

Range: Using formula (7b):

$$\bar{\bar{X}} = \frac{40.09}{8} = 5.011 \text{ mm.}$$

Using formula (8b):

$$\bar{R} = \frac{0.28}{8} = 0.035 \text{ mm.}$$

Step 3: Compute the control limits at 95 per cent confidence level (or five per cent probability of defectives).

Averages:

Substituting formula (7a and 7c) and using Table 1 for the value of $f_3 = 1.232$ when the sample size $n = 3$:

$LCL = 5.011 - 1.232\,(0.035) =$ 4.968 mm.

$UCL = 5.011 + 1.232\,(0.035) =$ 5.054 mm.

Ranges:

Substituting formula (8a and 8c) and using Table 1 for the values of f_1 and f_2 when the sample size $n = 3$

$LCL = 0.18\,(0.035) = 0.0063$ mm.

$UCL = 2.17\,(0.035) = 0.0759$ mm.

Step 4: Construct the Control Chart ($\bar{X}$ R Chart)

Step 5: Evaluate the constructed chart.

Use the limits to analyze sample results.

It can be deduced from Figure 1 that not even one sample measurement is found out of control (or outside the control limits). It can be recalled here that all these calculations were based on a 95 per cent probability of having "good" items using Table 1. Admittedly, the number of samples should have been more, say, covering a period of one week, or one month. Such a result would have been more valid for predictive and/or for control purposes. (The example here is actually an illustration model).

The more important things to note in the use of the $\bar{X}$, R chart are trends that are cyclical or shifting, in addition, to those readings found outside the control limits (called outlyers). These are actually the real problems of the quality control analyst, to know and isolate the sources of quality disturbances for corrective action.

B. ILLUSTRATION MODEL FOR CALCULATING THE PER CENT DEFECTIVE CONTROL LIMITS FOR 100 PER CENT INSPECTION.

1. **The Sample Problem:** In the final inspection of LPG cylinder manufacturing, the following data were recorded in one week:

	Day	No. of Units Inspected	No. of Defective Units (c)
	1	1001	40
	2	990	60
	3	1005	75
	4	1000	55
	5	995	40
	6	1015	45
TOTAL	6 days	6006 units	315 defectives

Compute for the per cent — defective control limits at 95 per cent confidence level.

2. **Procedures:**

Step 1: Compute for the average sample size n.

$$n = \frac{\text{Total units inspected}}{\text{No. of days}} =$$

$$\frac{6006}{6} = 1001 \text{ units}$$

Step 2: Compute for the daily percentage of defective. Referring to the results of the first day inspection, the per cent defective is computed as:

$$\frac{\text{No of daily defective}}{\text{Daily total unit inspected}} \times 100 = \frac{40}{1001} \times 100 =$$

$$= 3.99\%$$

Similar calculations may be done for the rest of the inspection results. A consolidation can be prepared typical of the one presented in Table 4.

Table 4
GO AND NO-GO INSPECTION RESULTS

Date	Inspected	Defective	% Defective
1	1001	40	3.99
2	990	60	6.06
3	1005	75	7.46
4	1000	55	5.50
5	995	40	4.02
6	1015	45	4.43
Total	6006	315	

Step 3: Compute for the (a) average per cent defective and the (b) standard deviation. Use formula (2) and (5), respectively.

(a) $\bar{p} = \frac{315}{6006} \times 100 = 5.24\%$

(b) $6\ \bar{p} = \sqrt{\frac{5.24(100-5.24)}{1001}} = 0.704\%$

Step 4: Compute for the Control Limits. Use formula (9) at five per cent probability of having defective, $u = \pm$ 1.96 — sigma as derived from Table 2.

$\bar{p}$ Central Limits:

LCL = 5.24 − 1.96 (0.704) = 3.86%

Center Line = $\bar{p}$ = 5.24%

UCL = 5.24 + 1.96 (0.704) = 6.62%

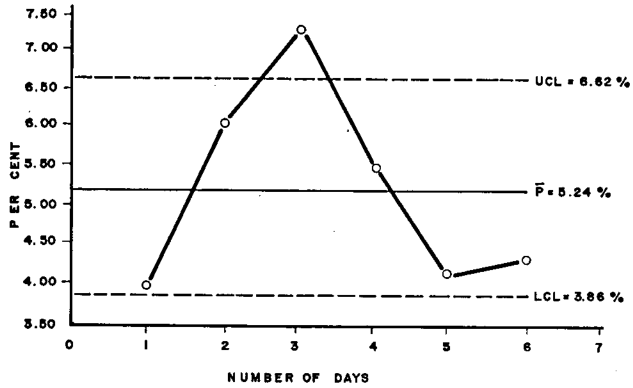

Figure 2

The average fraction-defective is the decimal value of $\bar{p}$. Compute the control limits by using formula 10.

Step 5: Construct the per cent — defective control chart.

Step 6: Evaluate the per cent-defective chart. Use the limits to analyze the results.

It can be gleaned from Figure 2 that the third day has exceeded the upper control limit. In terms of chance, there is the chance of having five times out of 100 cases as based on the theory of probability. With the few number of sampling days in this example, the result does not warrant a very reasonable basis of drawing conclusion as to how good or satisfactory is the behavior of the production process or the production quality as a whole. To be more exhaustive, this illustration model would have covered, at least, a period of one month to yield a more objective picture of the entire situation. Also, a quality control chart form must be devised reflecting the nature and requirements of the particular product or industry for ease in administration such as in recording, analyzing, and plotting of the sample results.

V. Conclusion

In the metals industry, the application of the above types of control charts cannot be ignored. Their uses vary from the control of metal elements and properties during smelting, slabbing, rolling, casting, tinning, plating, parts manufacturing, assembling, servicing, to special process studies.

In passing, this article does not claim to have treated the totality of the control charts but has attempted to present the practical approaches needed in accelerating their uses in the Philippines, especially in the metals industry.


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THE DEVELOPMENT OF FOUNDRY TECHNOLOGY

By EGON GLADH

Egon Gladh, a foundry and metallurgical expert, is a United Nations Development Program (UNDP) consultant to MIRDC. He is Vice-President of the Swedish Foundrymen's Society. While Foundry Manager for Scania-Vabis steel foundry, he introduced the pouring of steel in green sand instead of dry sand. As production manager in ASEA, he was responsible for the handmoulding and machinemoulding shops, the foundry for cast iron, the nonferrous foundry and the die-casting shop, the pattern shop and handled the planning office.

INTRODUCTION

The term foundry technique means designing of metallic materials by pouring the material while in molten state to fill a mould cavity and allowing it to solidify.

Foundry technique is one of the oldest methods of designing metal. It dates back as far as 4,000 years.

Foundry technology includes the metallurgy and metallography of cast metals, melting techniques, mould material knowledge, methods of moulding and core making, fettling methods, mechanization of foundries, etc.

The development of the foundry industry had gained momentum in the last 30-35 years when significant progress and renewal of the foundry techniques were made. New moulding methods, better melting furnaces, mechanical materials handling facilities, ventillation techniques, etc. have been developed.

The foundry industry is important for a country's industrialization because it is a basic workshop for many mechanical and engineering industries. Car manufacturing companies need a lot of components made of cast metals; manufacturers of machine tools require cast iron components; and, steel plants need ingot moulds. Also, a lot of cast steel and non-ferrous metal components are needed in the industry.

* **Derived from the speech delivered by Egon Gladh before the officers and members of the Philippine Foundry Society (PFS) during the tour to the MIRDC shops in Bicutan, last September 22.**

METALLURGY

Gray iron has a limited tensile strength, depending upon the shape and size of the free graphite in the structure. It has a relatively low tensile strength.

The basic theory behind increasing the tensile strength in gray iron is to change the graphite to nodular form. Metallurgists in the United States and England discovered that if a small portion of cerium or magnesium alloy is added to the molten iron, the form of graphite changes to a spheroidal shape, thus giving the material higher tensile strength. This new material is called ductile iron.

The dominant alloy in the treatment of the melt to make ductile iron is magnesium. There are different methods of doing this treatment, the simplest of which is to add NiMg or FeSiMg in the ladle. After treatment with Magnesium, it is necessary that inoculation be carried out.

Inoculation of gray iron and ductile iron is a key to structural control of the castings. The principle behind this is that adding a number of alloys to the melt will assist in the nucleation of eutectic cells. It will help to minimize chill in all compositions of gray and ductile iron and to promote uniformity between thick and thin sections of castings, thus reducing section sensitivity and at the same time, increasing the tensile strength. The most common material for this is 75 per cent ferrosilicon, but there are a lot of commercial inoculation materials available of different compositions. The technique in inoculation is important to have the desired effect.

FURNACE

For melting of cast iron, the cold blast cupola is still the widely used furnace, but hot blast cupola used in combination with an induction furnace for holding is common in many countries. This duplex melting has several advantages such as:

1. Less coke rate and cheaper charge materials.
2. Possibilities to make adjusment of composition.

Electrical induction furnace of the high and main frequency types is used more and more now for melting in foundries because of its advantages, such as easy charging, better control of the melt, possibility to make adjustments and control of the composition and temperature of the melt. The furnace is used for all cast metal as cast iron, steel and nonferrous.

MOULDING FACILITIES

In the past, the most common method of making moulds was by hand. These hand moulders had a lot experience and were well trained. Today, it is difficult to get these people, so that most of the moulds are made by machines.

The development of moulding machines has gone a long way from very simple jolt squeeze machines to fully automatic machines. The latest is the high-pressure moulding machine which has extremely high pressure of up to 20 kp./cm^2 compared to 6-7 kp/cm^2 of a common machine. This machine demands pattern made of metal because of the high pressure involved in the operation.

Moulding machines for flaskless moulding have also been developed. These machines have very high efficiency and capacity. The cycle time is short, only 10-20 seconds. Such large casting as motor blocks, cylinder heads, etc., can be produced with these machines.

Shell moulding is common in many foundries today and the shell moulding machines are getting more automatic. Shell moulding however, has its own limitations. With this method, castings of up to 100 kg. only can be produced.

This technical development in moulding machines is needed to meet the customer's demand for better quality, closer dimension at tolerances and lower prices of castings.

In the coremaking field, new methods were also developed such as hot box, cold box, and shell core methods. For large cores, air setting methods which are based on a new binder of resin type is gaining importance. The large cores can be produced with a continuous mixer and the core does not need drying in an oven.

QUALITY AND CONTROL

To manufacture and deliver quality castings are not as easy as they seem to be.

Many foundries do not have the facilities to control every step in production process. Most foundries only exercise controls at the end of the process by which time it is already too late to make the necessary correction. It generally pays to have a good control organization. Control work has to start as soon as the foundry gets the drawing from a customer. One should try to find out if the drawing can be modified so that it can be easier to cast and check also if the specifications of the metal is accurate. Defective castings could start while still in the drafting stage.

A schedule for a general control of the various steps in the production process is important. Pattern, flasks, sand preparation, mould hardness, the melt, etc. must be controlled in fixed intervals. Raw materials must be purchased after specifications and delivery must be closely controlled so that it will be in accordance with the given specifications.

SAFETY

A factor that foundrymen must take into consideration now is the control of air pollution from the foundries. Many countries in Europe and the USA have strict regulations concerning dusts escaping in the atmosphere. They have regulations also about the internal safety in the foundries because today a lot of chemicals are being used by the industry.

FUTURE DEVELOPMENTS

It is known in the metallurgical field that many countries are undertaking intensive research work in order to produce better and stronger metallic materials. A lot of materials can be developed with a hardness that will be impossible to machine. The only way to design this material will be by pouring. The melting process will be automatic and pouring should be done directly from the furnace.

New moulding material and binder are being developed as a result of the continued research in the chemical industry. Moulding and coremaking machines are already automatic, but they will eventually be a fully automatic process, which can be computerized.

Jobbing foundries are needed in the future, but these foundries must not only be better organized and more flexible in the melting operation but also develop new and faster methods for core and mould making and fettling. It is important to have good quality control and correct accounting system to make the price of castings reasonable.

OBSERVATIONS AND COMMENTS

The use of the molding floor and wood material as the flasks is "Filipino ingenuity". A lot is saved in the flask material cost but machining cost is doubled. As a result, the degree of porosity and other defects of the product are also affected.

Another observation is the existing competition with each other in the foundry industry. Emphasis has been made here on the price war, overlooking the fact that the products must be of superior quality. The Filipino competitors are not EEI, AG & P, Marsteel Corporation nor Atlas. The real competitors are Japan, Taiwan, Singapore, Australia and Red China.

Another is the Filipino concept of secrecy of operations. Very few have been to the various foundries in the country. This practice has led to specialization on certain operations, not on an integrated basis. Some are doing well in the pattern making aspect, some in molding, some in melting, some in finishing and some in heat treatment. If only there is an exchange of ideas among those engaged in metal casting, then an improved foundry industry will be realized.

The Philippine Foundry Society is one tool that can help in the improvement of the foundry industry.

The counterpart of the Philippine Foundry Society in Sweden has devised a means of costing each operation of the casting process. Each plant manager fills up a form and regularly submits it to the association. During monthly meetings, members bring to everybody's attention a progress report. Those who are at the top are congratulated while those who failed to make it are frowned upon — to signify disapproval.

There are other means of activating and uplifting an association — more imaginative ones to improve it.

men in the metals industry

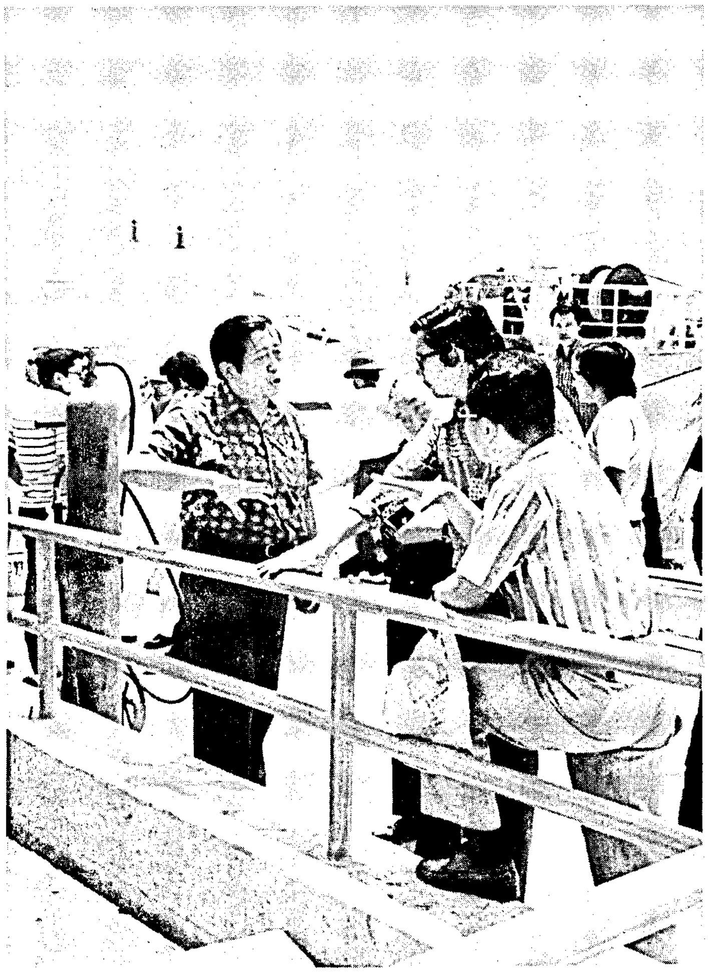
VICTOR G. GUEVARA

A top executive, an inventor, an expert in housing cooperatives, a farming enthusiast — a truly versatile businessman. He is Victor G. Guevara, Director of the Board of the Maria Cristina Chemical Industries, Inc. (MCCI), the nation's first carbide and ferroalloy plant and Executive Vice-President of Mabuhay Vinyl Corporation, the only producer of polyvinyl chloride resins in the Philippines.

Guevara, a mechanical engineer graduate from the University of the Philippines, has tried his hand in almost all fields of business worth venturing in, and somehow managed to make the most of it, excelling in a good number of endeavors. In 1947, for example, he played a key role in clearing the forest regions and the big landed estates in Tarlac and Pangasinan which had been abandoned as a result of the last war. Also in the same year, he pioneered in the wide scale production of onions in several Pangasinan barrios. This agricultural activity helped minimize the additional expenditures of the government in the importation of onions from other countries.

Realizing the importance not only of food but shelter, Guevara initiated the establishment of the first housing cooperative for MCCI employees. He personally supervised the construction of houses made of hollow blocks, complete with modern toilet facilities.

Victor G. Guevara, explaining to the members of the Board the operation of the plant.



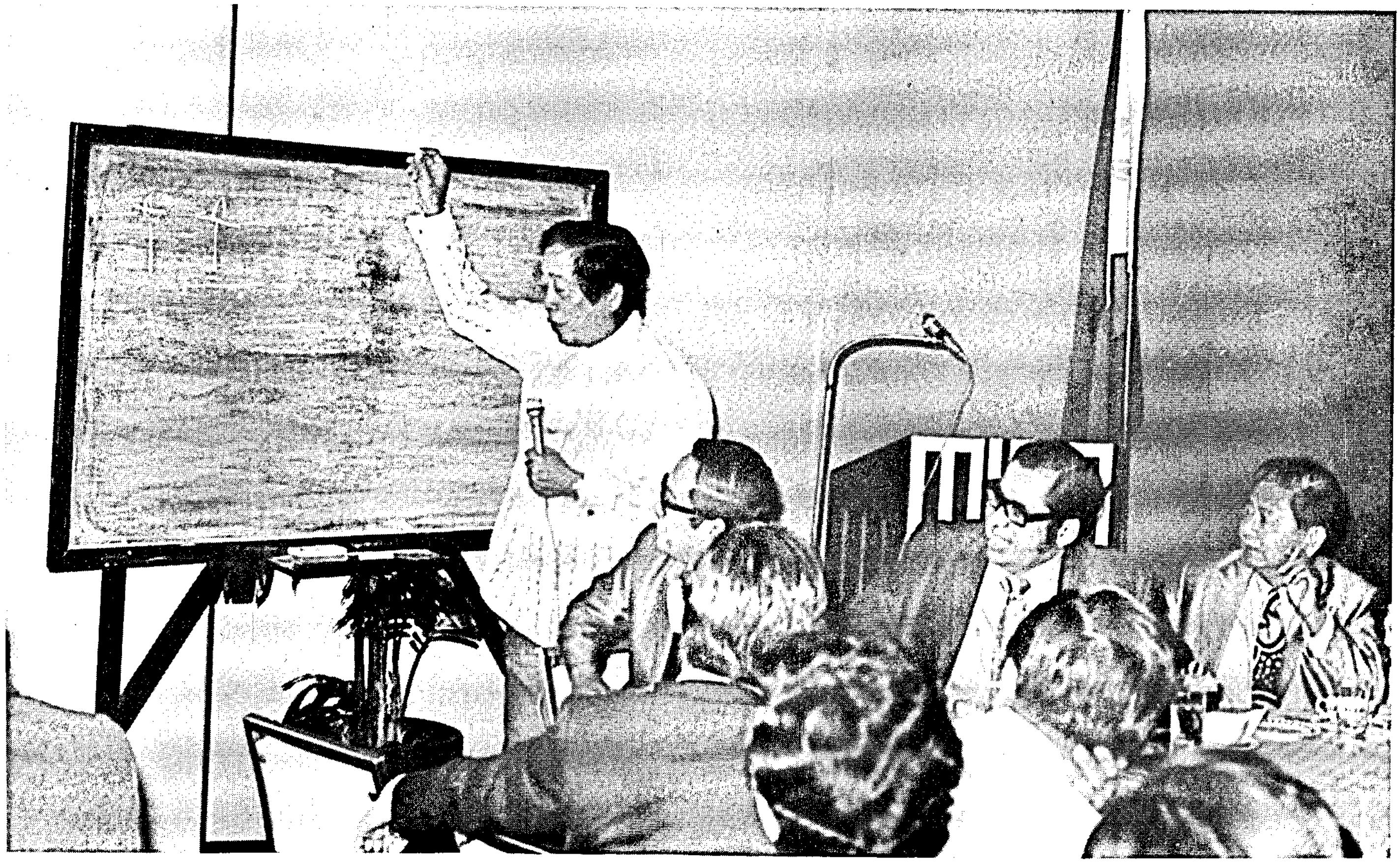
During the unloading of Vinyl chloride monomer from Japan last August 12, 1972; Monomer is the raw material used in the production of polyvinyl chloride resin.

In 1962, he invented together with Mr. Pancrasio Bawagan of the Forest Products Institute, University of the Philippines as co-inventor, a process of briquetting charcoal.

Victor Guevara, it is interesting to note, is the worthy son of an illustrious father — retired Judge Guillermo B. Guevara, former member of the Code Commission which drafted the country's Revised Penal Code. Of late, the father was spotlighted on the national scene for his proposed Code of Crimes, more particularly for his espousal of the socially dangerous theory, in relation to criminal and male-factors in society.

Father and son, very close to each other, possess and not surprisingly, the same attributes common to captains of industry: foresight, versatility and indefatigability. At 51, Victor Guevara is the President of the Management Association of the Philippines, and is also an active member of the following organizations: the Mindanao Development Authority, Knight of Columbus, Council for Economic Development, the Rotary Club of Iligan City, UP Alumni Foundation, Inc. and the Philippine Chamber of Industries. He is chairman of the Business Advisory Committee of the Metals Industry Research and Development Center (MIRDC). This committee is the duly constituted authority of the private sector, in relation to the metals and allied industries.

The range of Guevara's aptitude is truly formidable. In his undertakings, employees and associates alike are quick to single out his professional facility. Surely one can not but remark that the range of his abilities cuts across almost all fields. In case you're thinking, "Jack of all trades . . . ," you're wrong, he's master of all his trades.



Guevara delivering a lecture during the second day of "The First Private Sector and Metals Industry Development Center Workshop Seminar" last February 12, 1972.

Members of the Japanese Economic Mission touring the Mabuhay Vinyl plant in 1969 with Guevara leading.

Firm Feature

PHILIMCO–PHUMACO FOUNDRY OPERATIONS

The foundry department shows various molds ready for pouring. Metal-coke ratio attainable is 16 to 18 based on coke carbon content of 90 to 92 per cent. The cupolas and blowers shown in background were designed and built by PHUMACO.

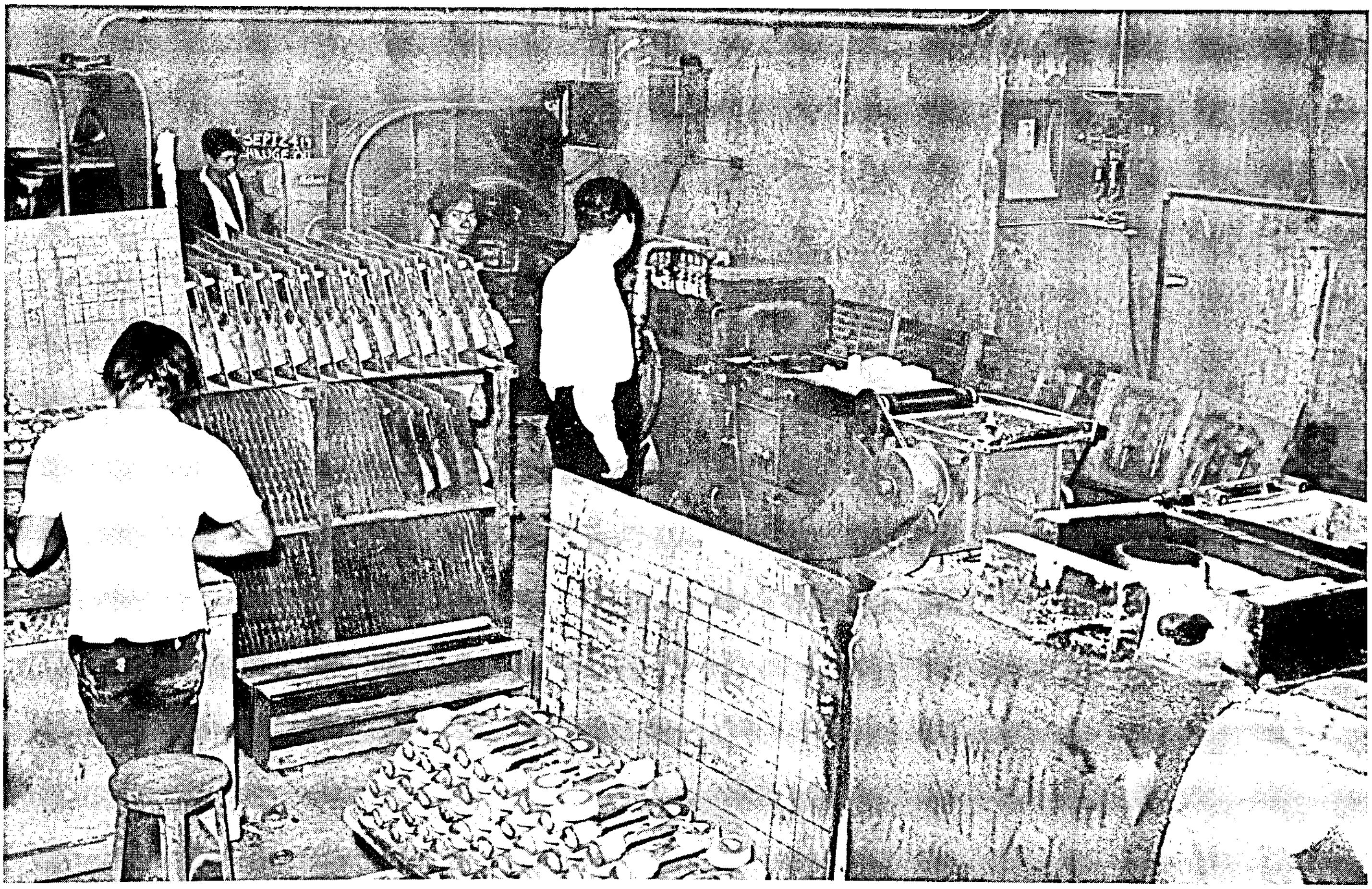
A—The shell core and shell molding section of PHUMACO shows automatic core and molding machines in operation.

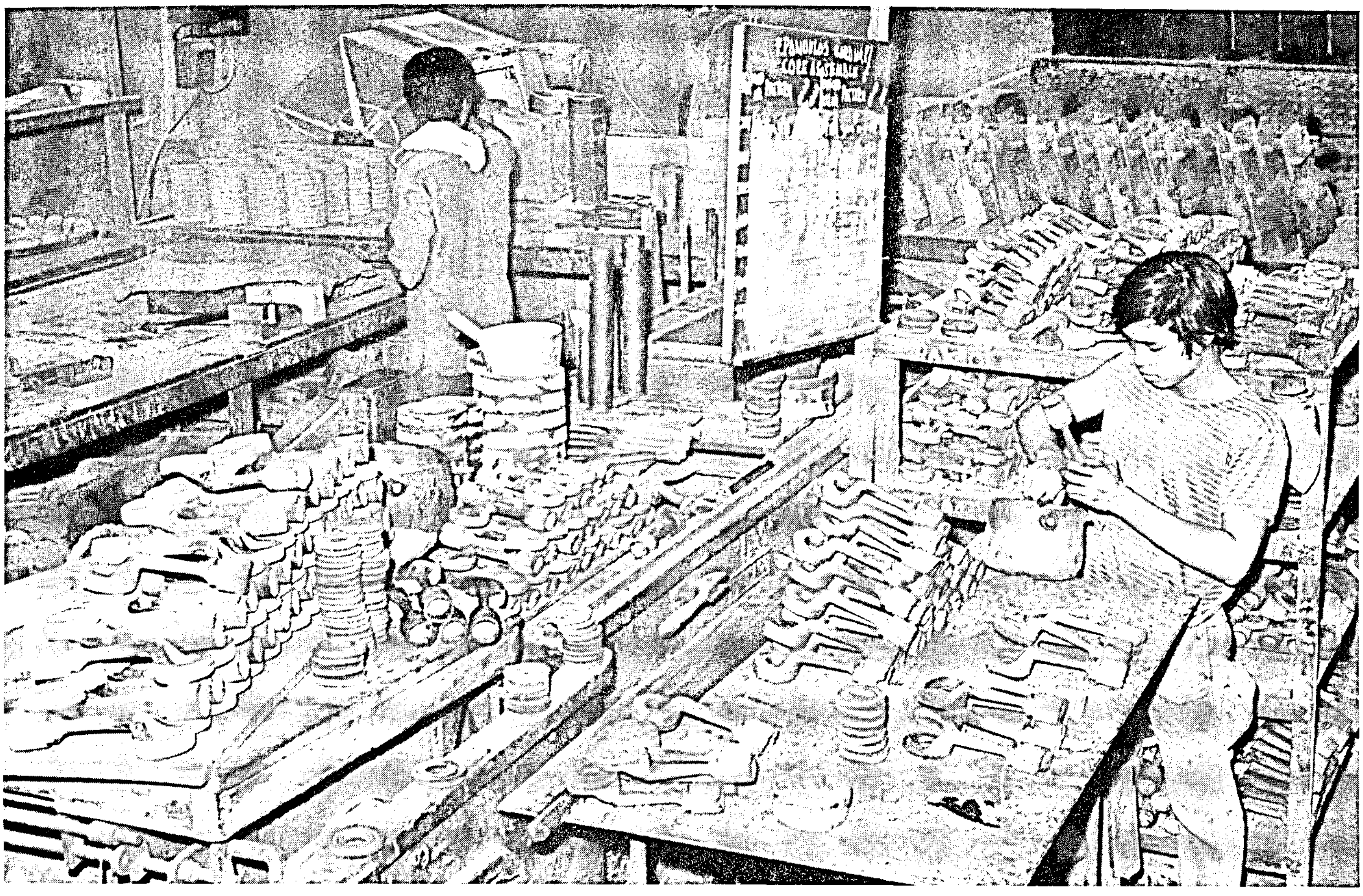
B—Shell cores are shown being produced and inspected.

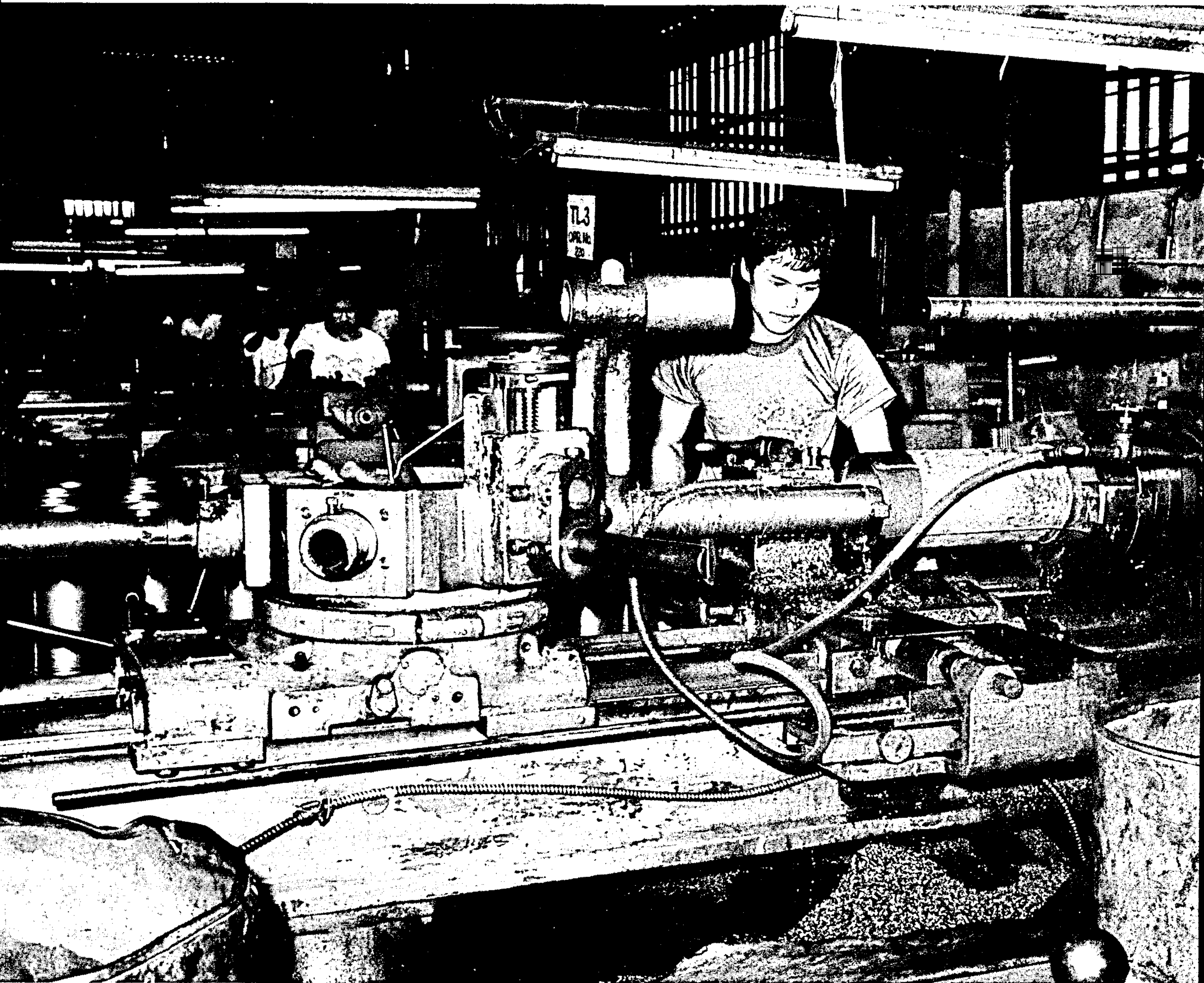
The Philippine Iron Manufacturing Company, Inc. (PHILIMCO) was founded in 1951 by Mr. L. C. Young to manufacture durable goods for household use and cast iron products for industries. Starting with capital assets of ₱100,000, the assets is now valued at ₱6.8M. The early history of this company was characterized by considerable pioneering spirit of Mr. Young who became particularly interested in a household product which at the time was mainly an imported item — the charcoal flat iron. Other foundries were producing soil pipes, frying pans, grates, large cooking pans, gray iron castings for rice mills, sugar centrals and others. In spite of the initial technical difficulties encountered in the production of flat iron which is mainly attributed to the orientation of the product in which the bottom has to be reasonably thick while the sides has to be very much thinner so as to keep the weight and physical size just right for the users who are mostly women, upon employment of technical consultants, the company was able to successfully produce the product with rejects drastically cut, its market acceptance and sales improved, thus paving the way up for the company.

It can truly be said that the early history of the Philippine Iron Manufacturing Company, Inc., is the history of the charcoal flat iron production in the Philippines. Today, PHILIMCO flat irons supply about 90 per cent of the domestic market and these can be found even in the remotest barrios of the country. The success in flat iron paved the way to the production of other essential products such as cooking pots, frying pans, sewing machines and parts, coffee or corn mills, meat grinders and ice shavers. Recently, added to the product line are electric flat iron, gas flat iron, gas lamp, liquified petroleum gas stoves and industrial sewing machine stands which are produced on job lot orders, as well as deep-well piston pump. Sewing machine stand and component parts have been exported to other Asean countries.

In view of the desire of the PHILIMCO President and General Manager to produce castings needed by local industries such as mining, agriculture, transportation and construction industries, he organized in 1965 the Philippine United Foundry and Machinery Corporation (PHUMACO). Two cupolas with a nominal melting capacity of 8 tons per hour and the complimentary heat treatment and machining facilities







Machining of a cylinder sleeve using a horizontal turret lathe.

were installed. This company was started with a capital asset of ₱200,000. Presently, the value of its machinery and equipment which includes complete nonferrous casting facilities, two arc-furnaces and a steel converter amount to ₱1.83 M.

PHUMACO specializes in the manufacture of automotive parts which constitute about 60 per cent of its sales revenue. Other essential products being produced include irrigation and household pumps, tractor parts, cylindrical liners for all types of engines and castings for agriculture, mining and manufacturing industries. Among the more recent products produced on continuing job lot order basis are various types of LPG burners and grates which used to be imported in large quantities. Cylindrical liners and exhaust manifold of grey marine engines for local fishing boats are also being produced as ordered thus also contributing in no small measure to the local fishing industry.

ORGANIZATION

The organizational structure of the Philippine Iron Manufacturing Company, Inc. (PHILIMCO) and the Philippine United Foundry and Machinery Corporation (PHUMACO) are similar. Mr. L. C. Young is the President and General Manager of these two companies. Since production operations are more or less the same, these two companies operate on identical policies. Directly reporting to the President is the Assistant General Manager for each of these two companies. The Assistant General Manager directs and coordinates the major functions of personnel, purchasing, finance, production and sales. Engineering and maintenance function is entrusted to the Production Manager whose main responsibility is to coordinate and direct the operations of the foundry and the machining departments. Consultants hired by the company develop systems analysis, productivity improvement, engineering designs and long range plans.

Mr. Young is ably assisted by Vicente S. David, Assistant General Manager of PHILIMCO, Robert Young, Assistant General Manager of PHUMACO, Joseph L. C. Young, Production Manager of PHILIMCO, Jose Ong, Production Manager of PHUMACO and Vicente Decipeda, Engineering and Management Consultant and PHUMACO Director.

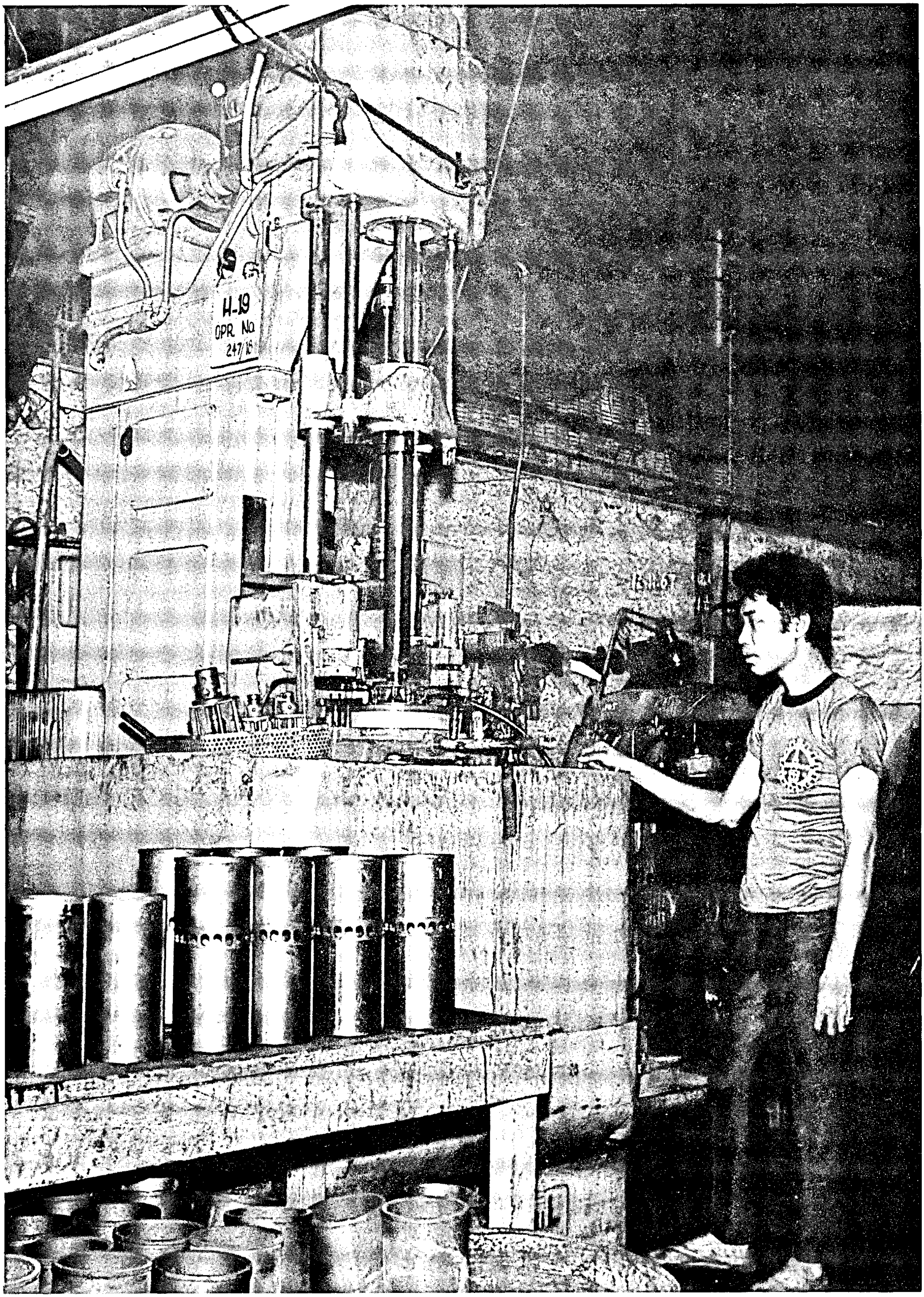
MANPOWER

Through the company's on-the-job training and incentive programs, its unskilled workers were able to acquire the art and skill required in pattern making, sand molding, core preparation and the correct operation of shell mold and shell core machines. At present, both plants have a total of 126 foundry workers and 191 machinists and fabrication workers. Office force totals 36 employees so that for the two plants the total manpower is 353.

PLANT DESCRIPTION

The Philippine Iron Manufacturing Company, Inc. (PHILIMCO) is located at the corner of 8th Avenue and J. Teodoro Street, in Grace Park, Caloocan City. It has a floor area of approximately 5,500 square meters. Finishing, assembly and testing of sewing machines, LPG stoves, gas lamps and gas flat iron and also the administration office is in the second floor with an area of 400 square meters.

The Philippine United Foundry & Machinery Corporation (PHUMACO) is located in Barrio Balon-Bato, Balintawak, Quezon City. The plant has a total area of 8,000 square meters in which 2,500 sq. m. is for the foundry and the remaining area of 5,500 sq. m. is for the machine shop and storage.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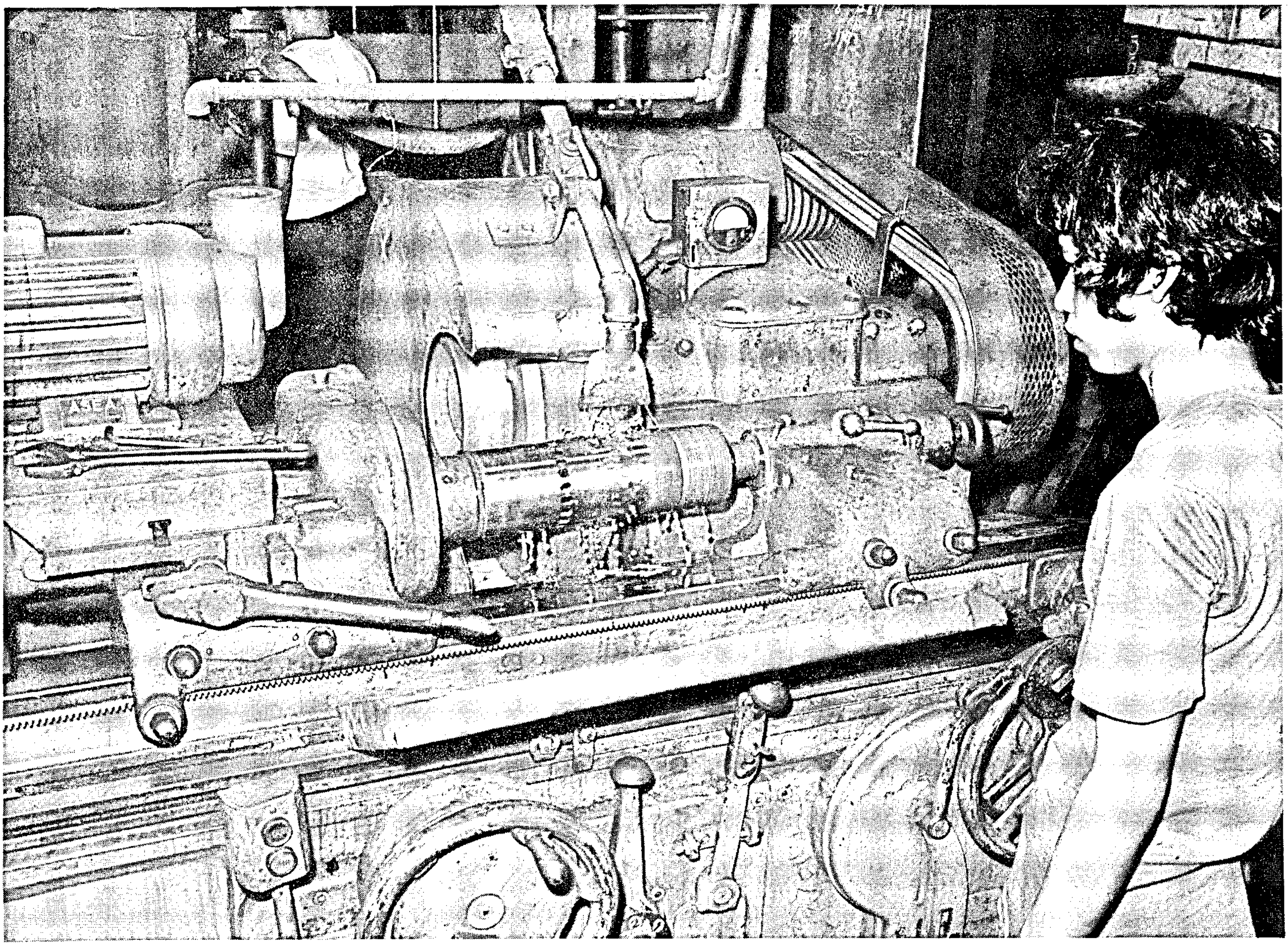
PRODUCTS

The Philippine Iron Manufacturing Company, Inc. manufactures mostly consumer products of PHILIMCO brand. On the other hand, Philippine United Foundry and Machinery Corporation specializes in the production of automotive parts. In order to broaden its profit base, PHILIMCO also manufactures certain components of producer goods like industrial sewing machine stands and parts on contractual basis. Industrial type fuel burners are also being manufactured.

PHUMACO not only makes automotive parts but also certain parts for tractors, grey marine engines and for industrial machinery and equipment. Various types of pumps are also produced on job lot orders from local marketing firms.

Presently, PHILIMCO manufactures a dozen different products most of which are replacement spare parts for motor vehicles, grey marine engines and tractors. Cylinder liners of various types for internal combustion engines are also being cast.

Below is the grinding of the outside surface of a cylinder sleeve using a cylindrical grinding machine while at left is honing of the internal surface of a cylindrical sleeve using horizontal honing machine.



It is quite evident that production is highly diversified. As has been mentioned earlier, it was the objective to broaden the profit base. Besides diversification has to be resorted to, so as to offer other parts when the market gets flooded with importation of surplus parts for jeeps and 6 × 6 trucks and increase utilization of installed capacity.

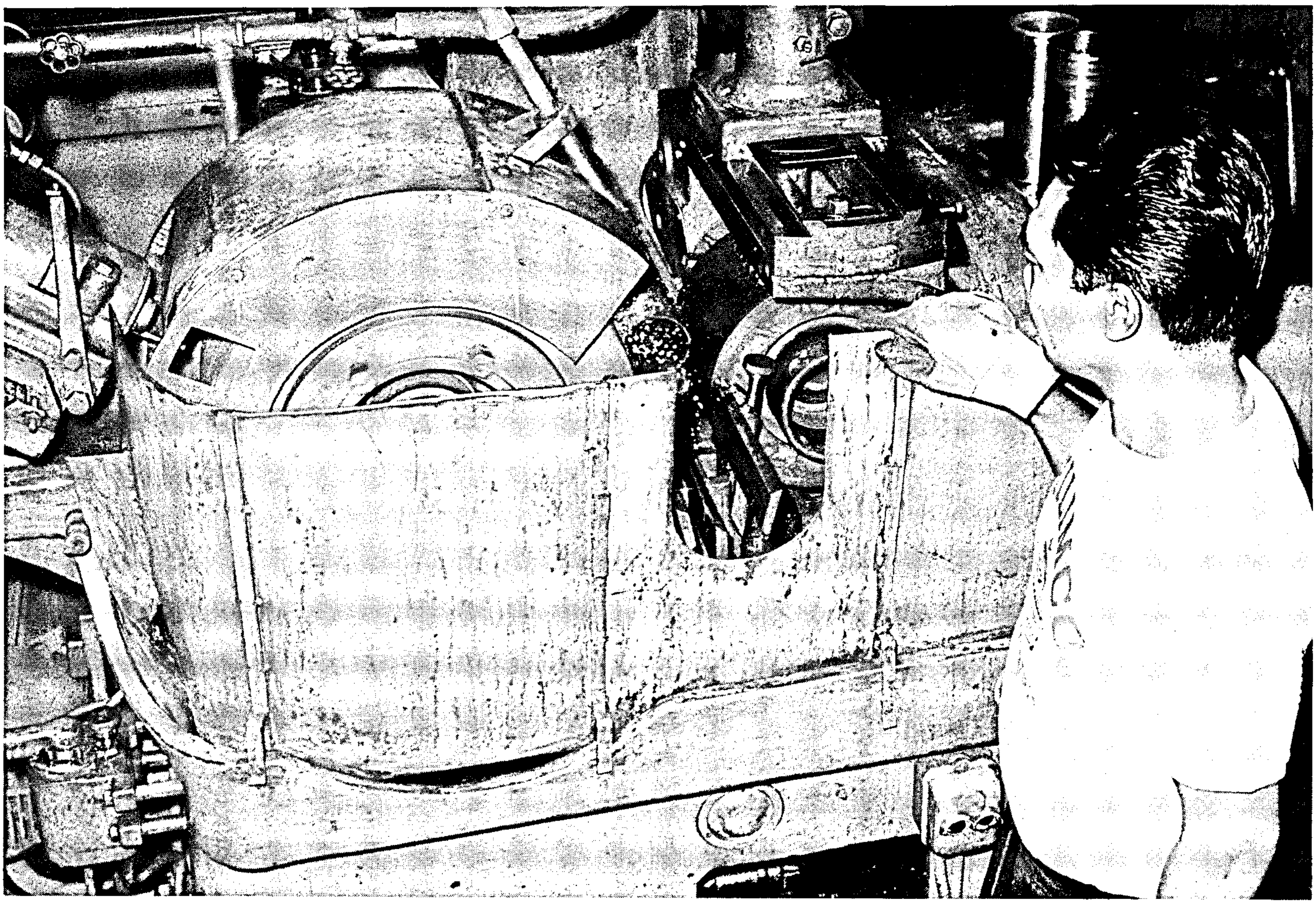
Products manufactured belong to the category of light castings. The weekly average output is about 50 tons of finished products requiring from 90 to 100 tons of liquid metal. In terms of quantity, about 50,000 units of various products are produced weekly. The installed cupola capacity of 12 tons per hour is presently utilized to the extent of only about 30 per cent. It is expected however that with the Progressive Car Manufacturing Program and a more reasonable tariff protection for local products, the capacity utilization can be considerably increased. Besides it is planned to produce medium castings such as ingot molds and parts for heavy construction machinery which are not yet being produced locally.

MARKET DEMAND SITUATION

The demand for household metal products produced by PHILIMCO is predominantly income elastic. This is believed to be so because there has been no significant increase in sales despite the fact that prices has increased only very slightly from the pre-floating rate period. The present wholesale price of charcoal flat iron is only ₱78 per dozen as compared with ₱50 in 1951. In 1951, an imported charcoal flat iron was valued at ₱75 to ₱100 per dozen.

The consumers of PHILIMCO products are the great masses of people mostly in rural areas. However, in the case of the more recently manufactured products such as gas flat iron, gas lamp and gas stoves, the market is primarily in towns and urban areas. Demand for these items is price elastic in general. When purchased as standby for electric appliances, the demand tends to become price inelastic. It is expected that the demand will continue to grow at a faster rate since more and more people both in urban and rural areas are becoming accustomed to

Grinding of the outside surface of small cylinder sleeves using a centerless grinding machine.



the use of liquified petroleum gas. PHUMACO supplies at least 80 per cent of cast iron base of electric irons.

PHUMACO automotive parts are produced for the replacement market. At least 70% of the production are earmarked for jeeps of all types, most of which however are the MacArthur and Willys models. The balance of 30 per cent are replacement parts for 6 X 6 trucks, tractors and for certain makes of passenger cars and also cylinder sleeves for engines.

The demand for most of these items is increasing at the rate of at least 10 per cent yearly.

RAW MATERIALS

Iron castings require such direct raw materials as foundry pig iron, scrap iron, ferroalloys, foundry coke and limestone. Indirect materials include silica sand, sandbinder, thermosetting resins, refractories, sodium silicate, CO_2 gas and packaging materials. With the exception of pig iron, foundry coke and certain types of ferroalloys, the other materials are locally available. In the immediate future, it is expected that all materials required can be purchased locally.

Scrap iron constitute from 75 to 100 per cent by weight of the total cupola charge. Imported pig iron is from 10 to 25 per cent whenever necessary. In the cupolas being used which were all of local design and fabrication, the requirement for foundry coke to metal ratio averages 1:16. When using a good quality coke of 90 to 92 per cent the ratio can still be higher.

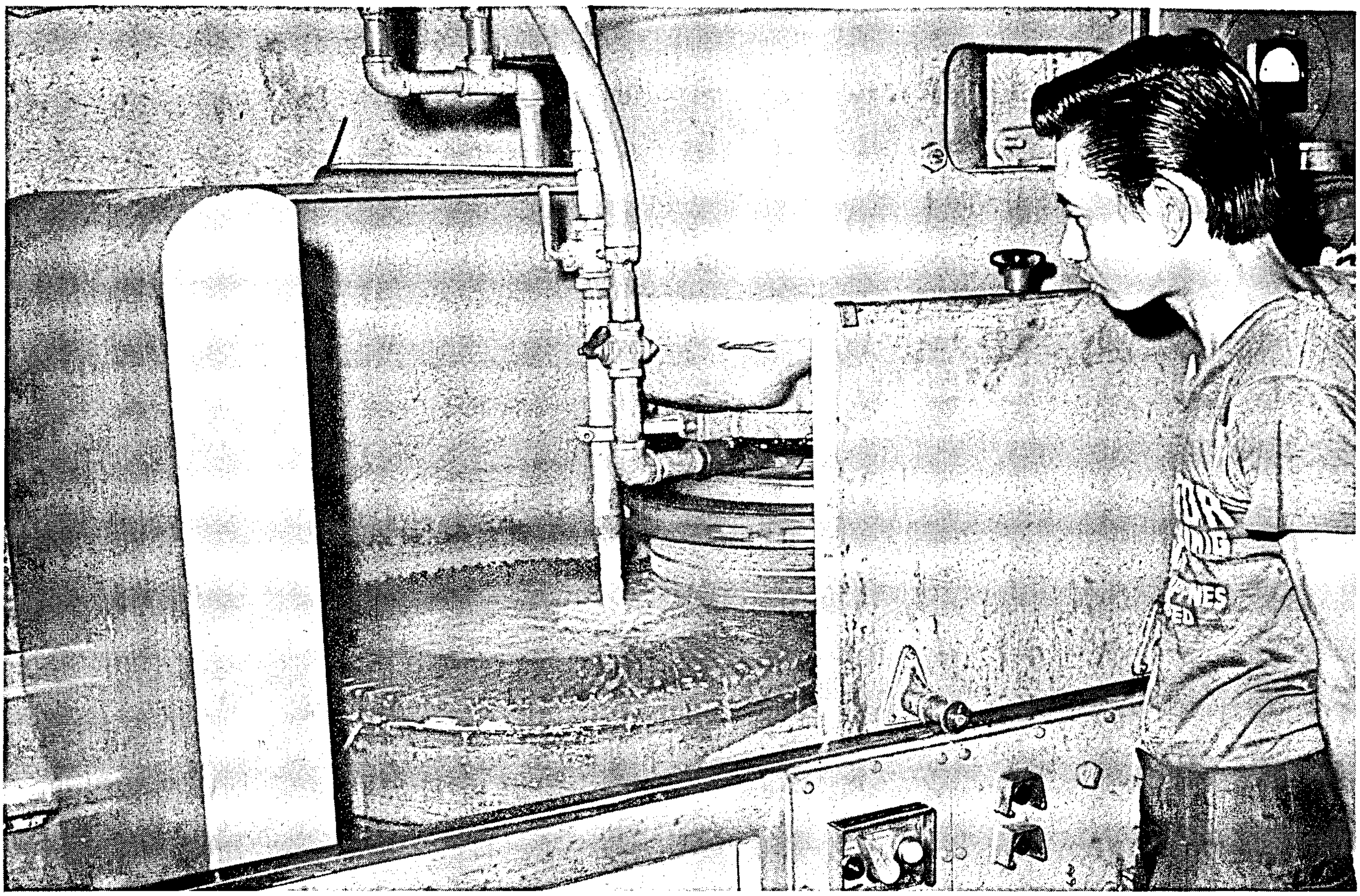
Based on the utilization of installed melting capacity to the extent of only about 30 per cent, raw material requirement on an annual basis is more or less 1,300 tons pig iron, 3,900 tons cast iron scrap, 50 ton ferroalloys and 420 tons foundry coke.

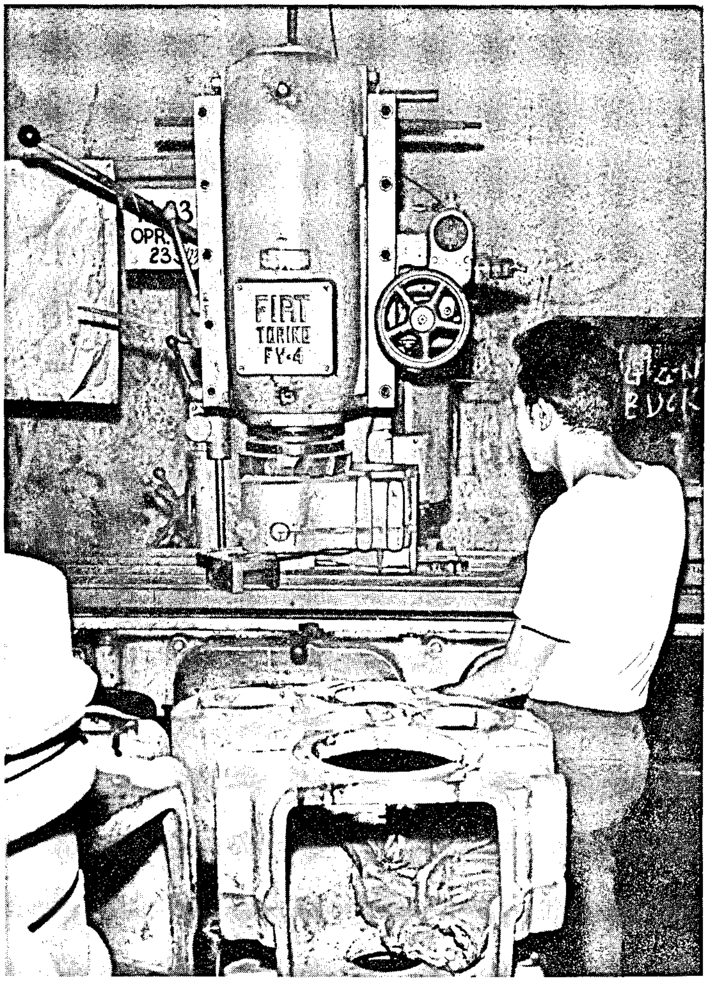
Imported materials usually come from Japan, Taiwan or Australia.

MANUFACTURING PROCESS

The manufacture of cast iron products follows the conventional methods and procedures that are generally used throughout the world. It is only in foundry

A chrome alloy white cast machine part being ground to high polish using a 34" Blanchard Surface Grinder.





A transfer case of 6 × 6 truck undergoes surface finishing using a vertical milling machine.

practice, in certain aspects of quality control, heat treatment and machining that procedures could differ.

At PHUMACO, the basic manufacturing process involves the following steps: preparation of all materials and supplies needed including the properly designed patterns, cores, moulding sand, shell moulds, cupola charge, etc. sand molding; cupola charging and melting of charge; pouring liquid metal inoculated or not into the moulds; shakeout, cleaning, inspection, grinding; heat treatment when necessary; machining; final heat treatment when necessary, finishing, inspection, gaging, assembly and testing when necessary; application of surface protective coating; and then finally the product is sent to the finished product storage.

In shell molding and shell core operations, PHUMACO-built shell mold and shell core machines are being used. Clean dry silica sand is used mixed with thermosetting binder. The pattern is mounted in the machine and the operation is automatic starting from the heating of the pattern to a predetermined temperature and duration to the introduction of bonded sand which adheres to the pattern and finally to the stripping of the shell with the aid of a parting agent. Shells and cores produced are stored ready for use whenever required.

After shakeout and removal of gates, risers and metal flushes, the castings in groups of a particular product are passed through the wheelabrator grit blast machine for thorough cleaning. Those without defects are sent to the machining department or to the rough castings storage as required.

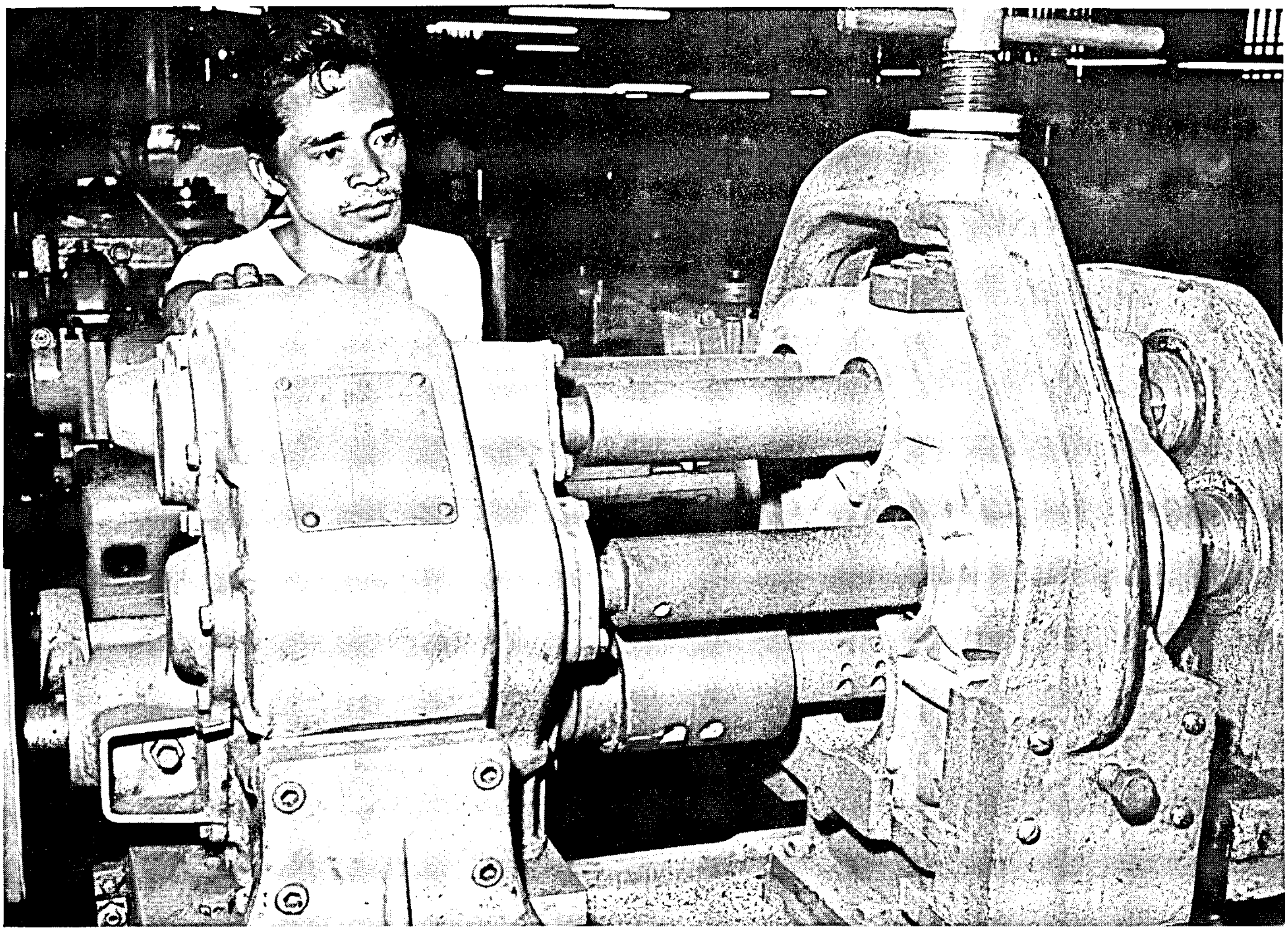
In view of a wide variety of products being manufactured and a limited volume required for most of the products or parts, machining process for certain groups of products was developed. On each and every item of casting to be machined, a route chart has been prepared. The route charts and machining drawings for all items were analyzed to determine similar or identical machining operations needed. The basic tooling for such identical or similar operations is developed to fit into the machine tools where machining will be performed. All items in a particular group are machined in accordance with pre-established schedules such that each item even of different shape and orientation can pass the same machine for the particular machining operation using the same jig or fixture and tools. If a modification of the jig becomes necessary, it is usually minor and the entire set-up need not have to be changed. Thus the economies of large scale operation is achieved, even if the volume per product or part is small.

QUALITY CONTROL

Quality control in PHUMACO and PHILIMCO foundries covers the control of metal composition for specific group of castings, control of molding sand quality and control of melting and pouring conditions. For castings of certain weight range, thickness variations, strength, hardness, density and surface finish, a definite ratio of a specific kind of scrap iron to pig iron is established. Besides pouring temperatures are varied accordingly. The correct metal charge ratio and pouring temperature have been established based on many years of practice. In order to insure adherence to established ratios, a complete record of cupola charges including weights of foundry coke, limestone and ferroalloys used are regularly submitted for review as well as a report of the quantity of good castings and rejects produced for a particular pouring day.

In order to pinpoint the prevalent causes of cast-

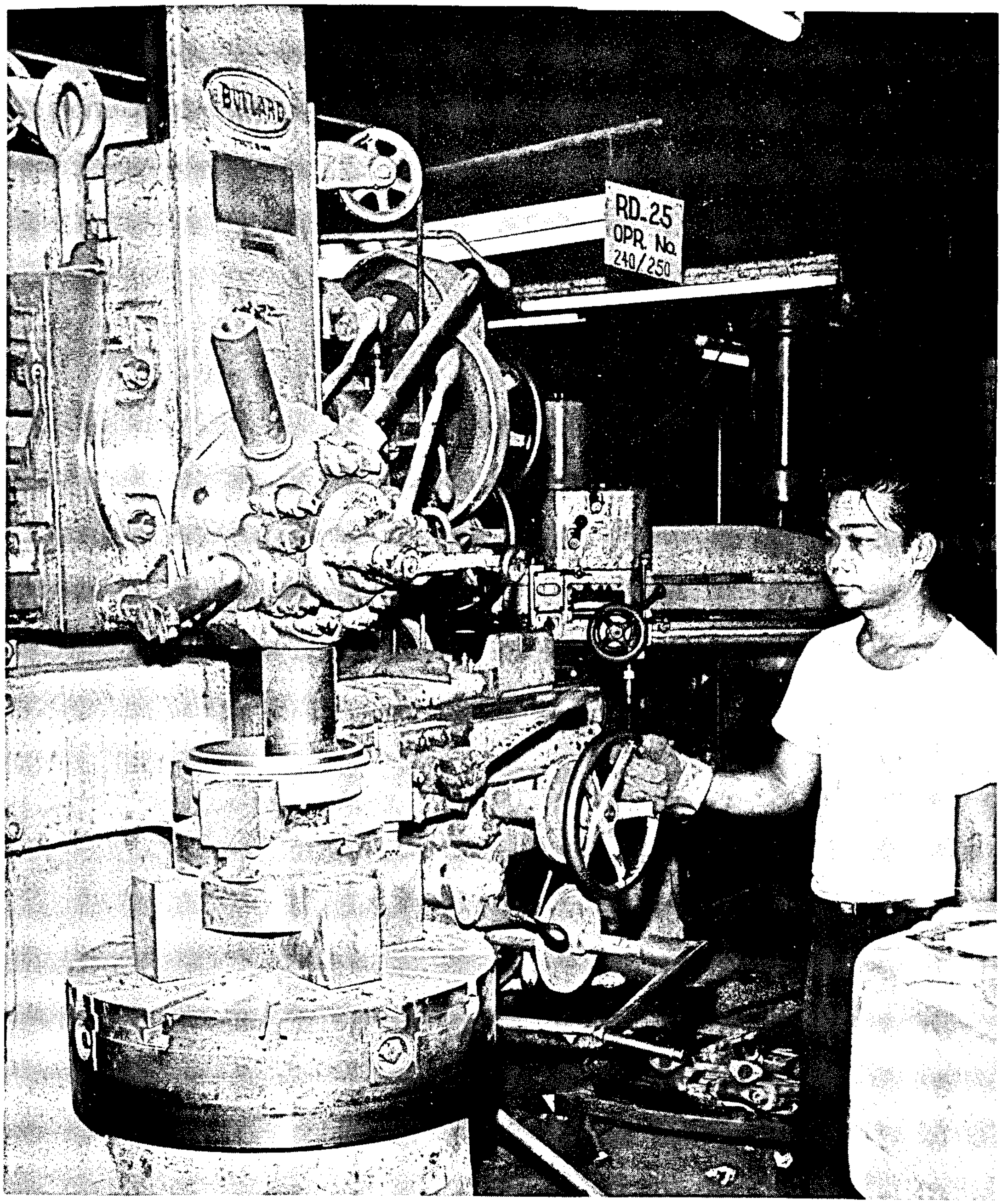
Boring a transfer case of a 6 × 6 truck using four spindles operating simultaneously. This special machine was designed and built by PHUMACO.



ing rejects, a clear description of defects observed by the quality control inspector is reported by him and corrective steps are immediately taken by the foundry superintendent to prevent recurrence.

Chemical composition of castings for certain groups of products has been established based on the chemical analysis of the sample by the Metals Industry Research and Development Center. The chemistry which has brought about acceptable mechanical properties is used as the basis in the standardization of metal charge ratios for different castings. With slight variations, PHUMACO castings are produced to conform with SAE standards for cast iron specified below:

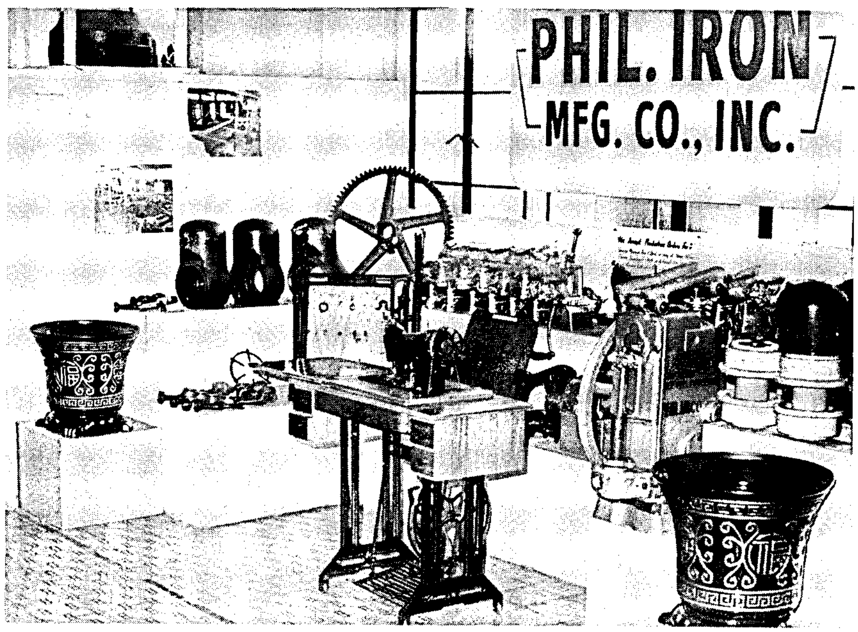
Brake drum being machined using a vertical turret lathe.

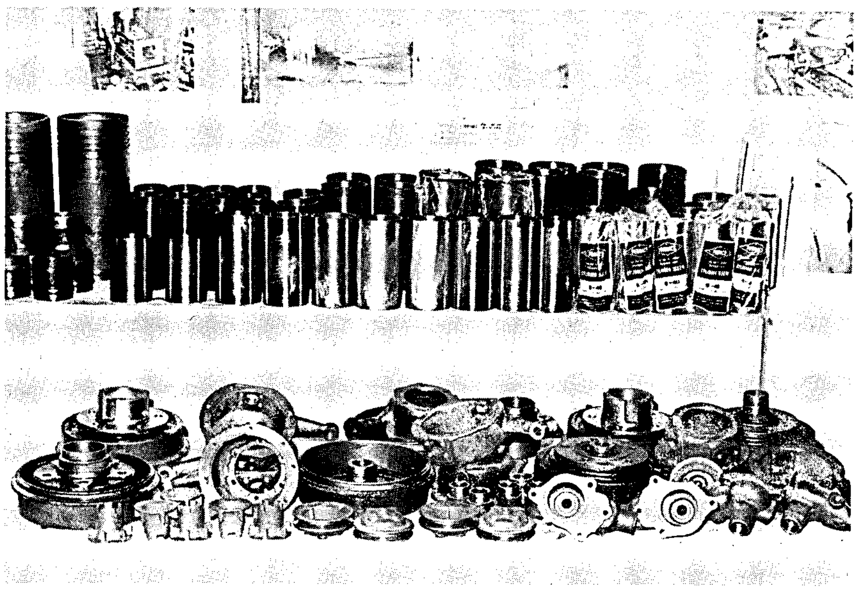


Product or part	SAE No.	T.C.	Si	P	S	Mn
Flat irons & LPG Burners	111	3.23-3.50	2.00-2.30	0.20	0.15	0.60-0.90
Brake drums, C.I. Automotive parts, Bell housing	120	3.20-3.40	1.90-2.20	0.15	0.15	0.60-0.90
Cylinder Sleeves	(121)	3.10-3.30	1.80-2.10	0.12	0.15	0.60-0.90
	122	3.00-3.20	1.80-2.10	0.10	0.15	0.70-1.00

After the castings have passed grinding, grit blasting and inspection, these are sent directly to the machining department. Some castings undergo stress relieving and/or annealing before delivery to the machine shop for machining operations.

Shown on display are some of the many products of the Philippine United Foundry and Machinery Corporation and Philippine Iron Mfg. Co., Inc.





A close check of the castings being machined is made and those with internal porosity, cracks and other defects discovered at any stage of the machining process are rejected and returned to the foundry for remelting. The quality of machining operations such as surface finish, precision and completeness are analyzed and compared with the blue prints and product sample by the machining inspectors. This is done usually on each product. Inspection jigs for most products have been developed to facilitate the inspection process. Appropriate pressure tests and/or balancing are also applied on certain products as part of the quality control procedure. Finally, before the products are delivered they are inspected for proper surface coating and packing.

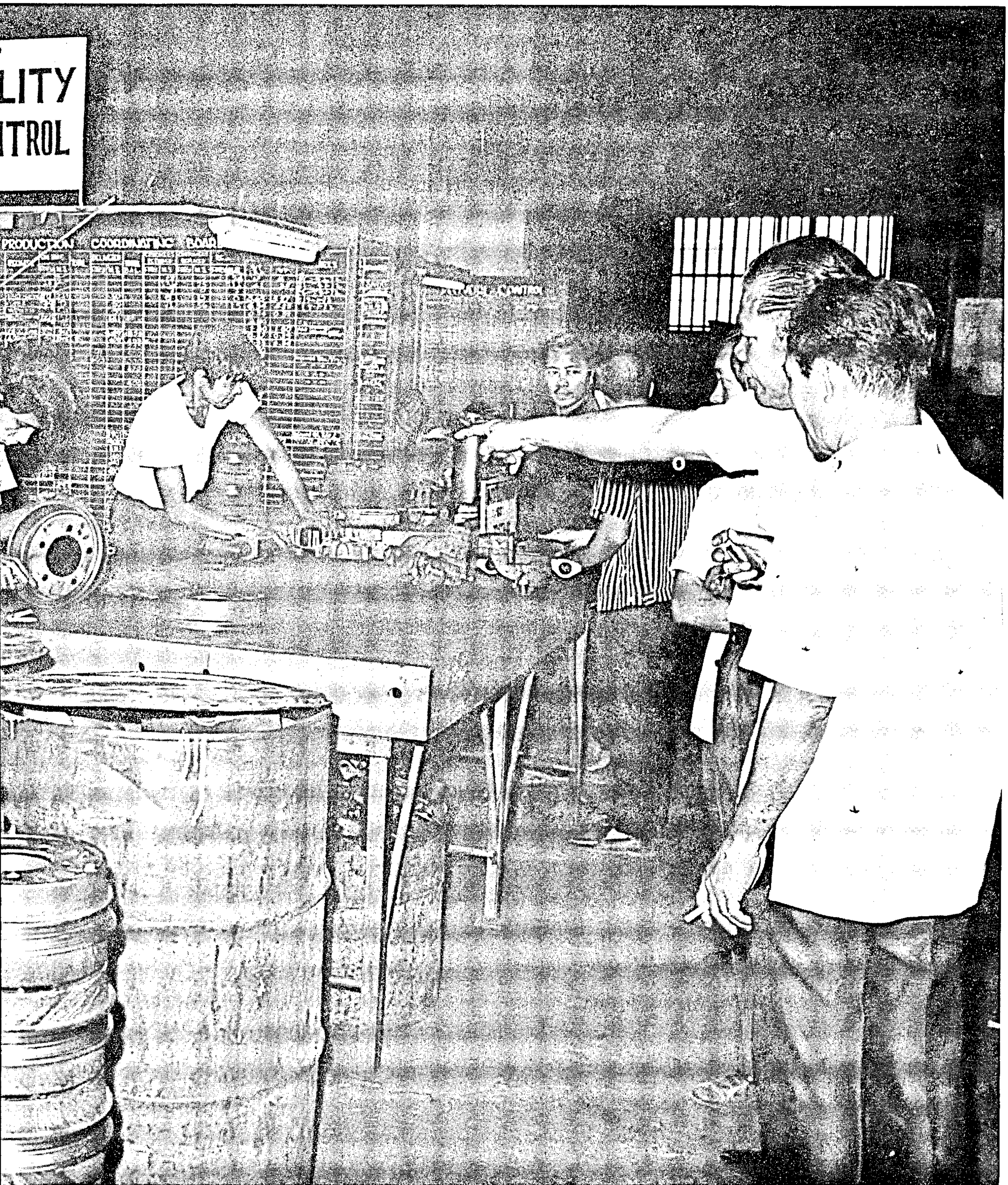
PROBLEMS OF THE INDUSTRY

Some of the problems of the local metal working industry are as follows:

1. Lack of operating capital to finance inventories and receivables and undertake a more vigorous product development and expansion program.
2. Lack of available trained manpower, so that expensive training of personnel has to be undertaken by the company itself eating up a sizeable portion of working funds and restricting the rapid improvement of productivity.

PROSPECTS

The bright side of this industry lies in the plan of the government to accelerate the development of the local tool and engineering industries. The Progressive Car Manufacturing Program and similar programs in the near future will certainly give the much needed encouragement and stimulation to the local metal working industry. Since such programs give due recognition to the existence of production facilities and knowhow that are not fully utilized, the industry will surely respond by getting actively involved in such programs and contribute effectively to their success. In this connection, PHUMACO is an industrial member of the Car Parts Producers Association, Philippine Automotive Parts Manufacturers Association, Philippine Foundry Society and the Philippine Iron and Steel Institute. On the other hand PHILIMCO is a contributing member of the MIRDC and a member of the PCI.



The quality control section conducts final inspection of products being manufactured. In most cases inspection jigs are used.

FOREIGN EXPORT PRICES

Table I
CONTINENTAL STEEL EXPORT
Monthly Price Averages September to December 1972
(In US $ Per Metric Ton)

	September	October	November	December
Billets	—	—	—	— +
Reinforcing rounds (a)	111.2+	111.2+	114.0+	116.0+
Merchants bars	120.3+	121.0+	122.5+	126.0+
Joists, channels (Brit)	—	—	—	—
Channels (US)	133.4+	—	—	141.0+
W.F. (Univ. beams)	142.6+	143.2+	145.5+	149.0+
Wire rods	134.7+	136.0+	136.0+	138.5+
Hot rolled strip: 1 in.	—	—	132.0+	—
Tube strip	128.5+	130.0+	132.0+	—
Heavy plates (c)	127.4+	127.2+	128.0+	134.0+
Medium plates (d)	128.0+	126.5+	129.0+	135.5+
Universal plates	128.9+	127.0+	172.0+	133.0+
Chequer plates	131.0+	130.9+	134.0+	138.0+
HR sheets: 16 g. & up	—	—	—	—
HR coil (dry)	—	—	—	—
CR sheets: 17-20g.	152.7+	153.1+	155.5+	166.0+
Galv. coils: 17-20g. (b)	196.6*	200.0*	200.0*	200*
Bright wire	144.0	144.6	148.5	148.5
Black annealed wire	161.0	161.3	163.5	163.5
Galv. wire: 5-16½ g.	166.5	165.4	165.0	170.0
Barbed wire	196.0	197.8	204.5	204.5

Source: Metal Bulletin
+ 2½ percent exporter's commission incl. *less $5; corrugated extra $2; flat sheets $5.
(a) Usual deformed bar premiums; structural $2; intermediate $3
(b) 4-ton coil
(c) over 8 mm.
(d) 3-8 mm.
(e) Some markets quoted on cost and freight basis
MB's appraisal Continental (ECSC) mills' basis (net unless stated)
FOB export prices, ordinary Thomas Commercial quality. Markets, sizes, quantities, delivery, etc. can affect prices shown.

Table II
JAPAN MONTHLY AVERAGE DOMESTIC PRICE
(In US $ Per MT unless otherwise indicated)
September-December 1972

Iron and Steel Products	September	October	November	December
Round Bar 9mm	111.20	113.95	114.04	115.94
16-25 mm	116.96	119.09	119.72	124.59
Flat Bar, 6 × 50 mm	133.15	134.15	134.54	138.53
Equal Angle,,6 × 50 mm	119.47	120.94	121.35	126 35
10 × 90 mm	124.56	126.22	126.62	130.82
Channel, 6 × 65 × 125 mm	158.91	162.16	163.55	169.10
H-Shape 9/14 × 250 × 250 mm	163.41	166.17	170.05	175.60
Hot Rolled Sheet (3 × 6) 1.6 mm	160.60	161.84	162.74	171.27
Cold Rolled Sheet (3 × 6) 1.2 mm	161.53	162.25	162.34	166.12
Medium Plate 3.2 × 3 × 6	153.00	154.36	157.67	173.84
Plate 6 × 4 × 8	151.38	153.23	156.05	166.26
9 × 4 × 8	152.60	153.23	154.83	158.82
Gas Pipe (Black), 15A (½ inch) (per kg.)	0.18	0.18	0.18	0.19
Water Pipe (White),. 15A (½ inch) (per kg.)	0.26	0.26	0.27	0.28
Galvanized Sheet				
(plain) 0.30 mm	189.12	189.39	191.56	193.05
(corru.) 0.25 (per sheet)	0.62	0.62	0.62	0.62
Colored Sheet				
(one side, plain) 0.30 mm	259.74	259.74	260.55	261.50
(one side, corru.) 0.25 (per sheet)	0.79	0.79	0.79	0.79
Wire Rod, 5.5 mm	133.93	133.93	133.93	134.51
Round Nail, 100 mm (4 inches)	183.44	182.99	182.63	183.50
Iron Wire, No. 8	163.56	163.56	163.56	164.51
Annealed Iron Wire, No. 8	165.58	165.13	164.77	164.05
Galv. Iron Wire, No. 8	191.96	191.96	191.96	192.05
Barbed Wire, No. 14	254.46	254.46	254.46	254.55
Tinplate,,90 L (0.257) mm	322.84	322.84	322.84	322.95
Wire Netting, 20 × 15 mm (one roll)	6.41	6.41	6.41	6.57
Welded Steel Netting (1 sq. meter)				
No. 4 (6 × 150 mm)	0.77	0.77	0.77	0.77
No. 8 (4 × 100 mm)	0.58	0.58	0.58	0.58
Special Steel				
Constructural Carbon Steel (SC)	160.73	161.26	161.26	164.67
Stainless Steel (per kg.)				
SUS 24 (18 CR)				
Sheet (2-6 mm)	0.71	0.71	0.71	0.71
SUS 27 (18-8)				
Sheet 0.3 mm	1.40	1.40	1.41	1.41

Non Ferrous Metals				
Electric Copper	1124.41	1109.03	1065.34	1029.49
Electric Zinc	409.39	409.09	408.69	408.35
Electric Lead	352.42	353.08	353.08	353.15
Tin	3920.82	3916.40	3861.61	3825.85
Antimony	1611.20	1611.20	1607.14	1607.25
Nickel	4155.84	4155.84	4155.84	4155.95
Selenium	24431.82	24431.82	24431.82	24887.16
Bismuth	9577.92	9577.92	9577.92	9578.05
Cadmium	6582.79	6599.03	6599.03	6952.27
Mercury	6493.51	6493.51	6655.84	6655.95
Aluminum	637.17	637.17	637.17	637.25
Rolled Copper & Brass				
Copper Sheet, 2.0 mm	1553.52	1553.03	1542.21	1536.85
Copper Tube, 50 × 5 mm	1642.56	1645.02	1642.32	1639.77
Copper Rod, 25 mm	1544.67	1547.62	1536.80	1531.45
Copper Wire, 0.9 mm	1493.99	1493.51	1485.39	1482.75
Brass Sheet, 2.0 mm	1233.77	1233.77	1222.94	1217.65
Brass Tube, 50 × 5 mm	1361.18	1363.64	1363.64	1363.75
Brass Rod, 25 mm	1066.02	1055.19	1033.55	1022.73
Brass Wire, 6 mm	1222.45	1226.55	1222.94	1212.17
Rolled Aluminum				
Sheet (99 percent) 1.0 mm (400 × 1,200)	957.79	957.79	957.79	957 79
Circle 1.0 mm	1079.55	1079.55	1087.66	1087.66
Steel Scraps				
Special for Electric Furnace	42.78	43.59	44.12	44.89
Pig Iron Scrap	60.25	61.69	62.09	63.77
Copper Scrap				
No. 1 Copper Wire (Berry)	1062.35	1031.57	987.83	951.57
No. 2 Copper Wire (Birch)	1016.45	986.92	928.98	889.07

Source: Japan Metal Bulletin.

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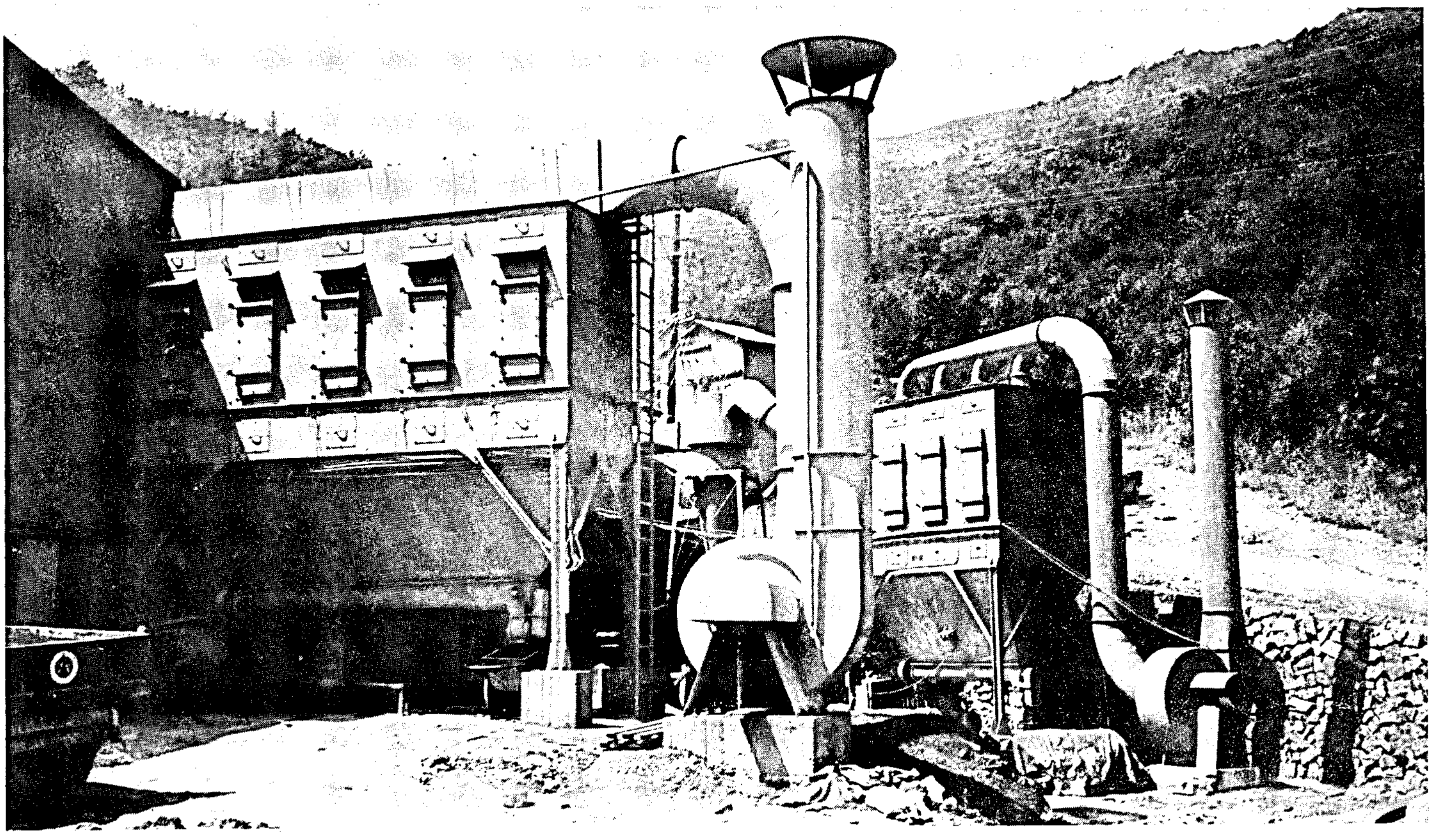

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ALUMINUM

The aluminum industry has been very up-to-date in the improvement and development of new products and markets. The 1971 statistics recorded the following major outlets of aluminum products:

	Per Cent
Building and Construction	26.6
Transportation	17.2
Containers and Packaging	14.6
Electrical	13.7
Consumer Durables	9.3
Machinery and Equipment	6.2
Exports	5.4
Others	7.0

Even with the up-and-down trend of supply and demand in these industries and other economic factors, the price of aluminum has remained stable in years. In 1960, the price of primary metal was quoted at 23.88 cents; this increased at a slow rate until it reached a peak of 29 cents in 1971. In 1972, however, producers decreased the primary metal price to 25 cents due to excess capacity and the onset of a seasonal summer slow down.

Price of aluminum is predicted to remain steady in the near future although a slight increase or decrease may occur as a result of imbalances between supply and demand.

COPPER

The price for copper is not likely to remain stable until the US economy improves to the point that it will stimulate the economies of other countries. The CIPEC nations which account for the major portion of the Free World Copper export trade have made plans to stabilize copper prices but no action has been made regarding this.

It has been the practice that when demand and prices slowed down, producers curtailed production. Because of this and the recent strikes in the US copper mining and processing industries, a world surplus in 1971 is not likely to develop. Until the year 1971, copper supply remained adequate for the demand.

Prices of electrolytic copper increased from 47 cents a pound in 1969 to 57 cents in 1970, dipping to 51 cents per pound in 1971 and remaining at 52 cents in 1972.

The Copper Development Association, Inc. (CDA) has launched an extensive program for the development of the copper market. The target markets for each industry included in the CDA program follows:

INTERNATIONAL METAL MARKETS

	Per Cent
Electrical and Electronic Products	28.5
Building Construction	23.2
Consumer Products	19.6
Industrial Machinery & Equipment	16.0
Transportation	12.7

With these developments, it is predicted that improvements in price will likely occur in the near future.

NICKEL

The price of nickel was held at 128 cents per lb. in 1969 as a result of a 35 per cent wage boost in Canada. In 1970, the price was further increased to 133 to compensate for financial losses resulting from the floating rate of the Canadian dollar. This price remained stable until 1972 although a price increase is expected in early 1973.

In short supply in late 1969, nickel was in free supply in 1971. By 1972, the nickel consumption has grown at an average rate of seven per cent.

Nickel will be in free supply in 1972 unless a strike develops in Canada. There will be an increase in production costs but stainless steel consumers will still be willing to take the price boost. Possible substitutes for nickel is likely to occur but this will be at a higher cost.

This metal has a great diversification of applications. As such, future world growth will depend on availability, prices and world economy.

LEAD

In terms of industrial consumption and domestic mine production, the year 1971 was a significant one in the United States. Mine production of recoverable lead in that year amounted to 573,377 short tons – the highest level recorded in 41 years.

Even with the decrease in the industrial applications of lead in 1970, new markets like ammunition and batteries showed phenomenal growth resulting in a price peak of 15.60 cents a pound. In 1971, stocks declined and the dock strike in the United States continued which resulted in a price decrease of 13.50-14.00 cents a pound and remaining at the same level until the end of the year. In 1972, when producers had covered most of their consumer needs, the price was quoted back at 15½ cents a pound. Any increase in price is not expected in the near future.

Continued growth in the lead market is expected despite the increased competition from plastics and other materials and the government's drive to phase out the use of lead in gasoline to prevent air pollution. To cope with this trend, the industry is expanding sales promotion efforts and researches are being conducted to develop markets for new products.

TIN

In spite of a slow down in economic activity in most industrialized countries, the level of consumption of tin was not affected as anticipated. On the contrary, consumption of primary tin metal rose by 2.5 per cent in 1971 over the 1970 figures. This could be attributed to the unexpected growth in Japanese consumption and the relative stability in consumption in the USA, France and West Germany.

The surge in price in 1970 was caused by a balance in the supply and demand figures. In 1971, production increased more than consumption which resulted to the decrease in price. Thus, the average New York price of tin in 1971 was around 167 cents per pound – a decline from 174 cents in 1970.

The 1972 published price of tin was reported at 175 cents per lb. Improvements in consumption of leading industrial countries brought about this increase. This price is expected to remain in 1973.

ZINC

The cost-price squeeze in the zinc-producing industry was the major cause in the loss

METAL PRICES
(Cents Per Pound)
1967-1972

	METAL					
Year	Aluminum Ingot	Copper Electrolytic	Lead Common	Zinc Electrolytic	Tin	Nickel Refined
1967	24.98	38.23	14.00	14.35	153.40	94
1968	25.57	41.85	13.21	14.00	148.11	103
1969	27.18	47.53	14.93	15.15	164.43	128
1970	28.12	57.70	15.69	15.82	174.13	133
1971	29.00	51.43	13.89	16.14	167.34	133
1972	25.00	52.00	15.50	18.00	175.00	133

of almost one-fourth of all U.S. slab zinc smelter and refinery capacity. Several plants were closed during 1971 and even the electrolytic zinc refinery of Anaconda Co. is scheduled to cease operation by mid-1972. Preliminary estimates recorded the use of slab zinc in the United States for 1971 at 1,260,000 tons — a six per cent increase over that of 1970. This however, is well below the 1,300,000 tons of 1969.

The 1971 automotive industry showed substantial improvements although appliance manufacturing and construction activities increased at a slower rate than expected.

Together with this trend in industrial activities, prices of zinc increased from 15 cents per pound in 1970 to 16 cents per pound in 1971. A further increase to 18 cents per pound was noted in 1972 and this is expected to increase by 1973.

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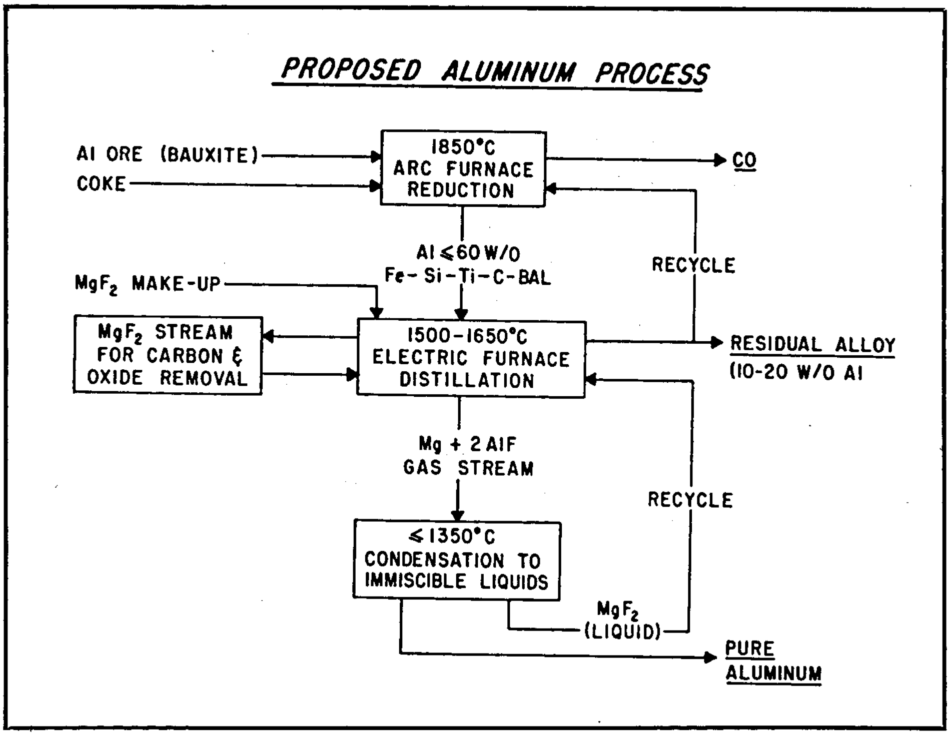
technical abstracts



REVERSAL OF FE-NI-C MARTENSITE BY RAPID LARGE SHEAR

The conditions for reversal of martensite to austenite during large and rapid applied shear are discussed and evaluated experimentally pierced hole. Although the large transformation strain of reverse martensite formation could conceivably couple with the applied shear stress to provide a large energy aiding the reversal, such extensive coupling is not experimentally found to be important. Rather the important engineering qualities to consider are the chemical stability of the martensite, the strain heating of the austenite and diffusion of heat from the shear zone. **Metallurgical Transactions, September, 1972.**

ALUMINUM EXTRACTION FROM ARC-FURNACE ALLOYS

A considerable amount of research has been conducted over the years attempting to replace the Bayer-Hall process as a method for producing aluminum. The principal approach has been based on carbothermic or direct reduction of Al_2O_3 containing ores in an arc-furnace. Alloys containing up to 70% Al can be produced in this fashion.

Refining of the raw alloy is required before any commercial utility can be found for it. In the past decade, major programs have been conducted by Alcan, Pechiney-Ugine, and Reynolds Metals Co.

A promising new method for extracting Al from carbothermically reduced alloys has been examined on the laboratory scale. It involves reacting the alloy with molten MgF_2. Vapors of AlF and Mg result. If the vapors are cooled out of contact with the alloy, a purified Al and MgF_2 are produced. These products are immiscible above the melting point of MgF_2 (1265°C) and can be separated. **Light Metal Age, April, 1972.**

A NEW LOOK AT THE BAUSCHINGER EFFECT

During plastic deformation the mechanical properties exhibit a dependence on the direction of previous deformation. This effect, viewed in terms of the yielding and flow characteristics of metals is generally referred to as the Bauschinger effect. Because of the complexity of the effect a number of theoretical and practical problems associated with it remain unsolved. In this paper a new interpretation of the Bauschinger effect is outlined and the possible use of this in investigating some of the outstanding problems is discussed. **Metals Australia, September, 1972.**

CONTROL OF MACHINES BY NUMERICAL CONTROL

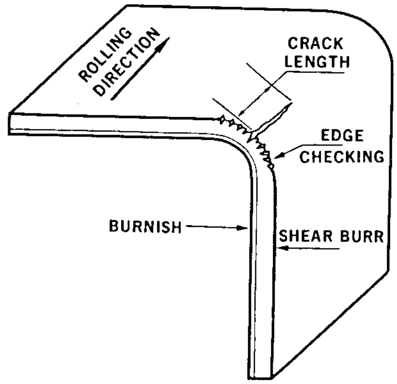
Numerical control has become an ever more dominant means of controlling machines and processes in today's factories. As the name implies, numerical control provides for the automatic machining or processing of parts and material using quantitative input data.

The numerical control system usually provides for the control of the machine tool spindle (s), tool turret (s), and miscellaneous functions, in addition to control of the principal axes of motion of the tool (s) or work piece.

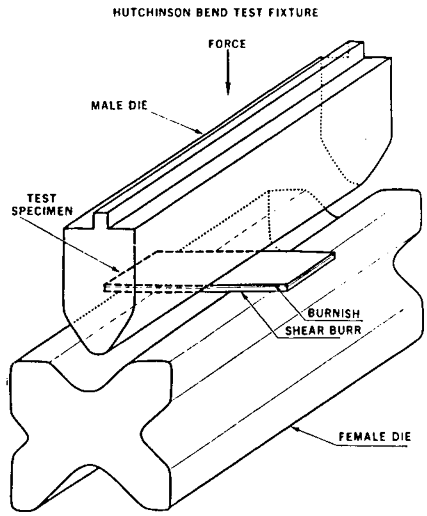
This paper deals with the types of numerical control systems available in today's market place, the functional organization of these controls, the types of components used to implement the basic functions, how these components and the means of packaging them have changed over the first 25 years of numerical control evolution, and also mentions some of the industry and international standards that have helped guide N/C through these first formative years. **Mechanical Engineering, August, 1972.**

SHEARED EDGE BEND TEST

A bend test using sheared rather than machined edges has been developed to evaluate the brake press formability of high strength steel plates. Specimens, taken perpendicular to the rolling direction of two hot rolled steels and a heat treated steel with different degrees of stringering of non metallic inclusions were tested by the Hutchinson bend test and the standard ASTM bend test. The tests showed that the Hutchinson bend test is more sensitive than the standard ASTM bend test in differentiating materials of different propensities for crack propagation. The test appears to be useful in the evaluation of the brake performance of high strength steels. **Journal of Materials, March, 1972.**



A typical bend test specimen after completion of the Hutchinson bend test.



Position of the bend test specimen between the male and female dies prior to testing.

A NEW PROCESS FOR CLEANING HIGH CARBON STEELS

Cleaning high carbon steels prior to chemical plating or electroplating can be difficult, particularly when a carbon-free surface is required. A process developed by Union Carbide Corporation Nuclear Division uses the steel as an anode in a water solution of orthophosphoric acid, a flouride ion, and a wetting agent. Applying an overvoltage to obtain copious (sparging) amounts of oxygen leaves the surface clean, free of carbon, and uniformly etched including the crystal boundaries. **Industry Week, June 19, 1972.**

NODULAR CAST IRON WITH MEDIUM SILICON — A NEW WEAR-RESISTANT MATERIAL

Ferritic nodular cast iron alloyed with 4-5% Si has high strength at room and sub-critical temperatures, superior elasticity, high oxidation resistance and good structural and dimensional stability below 700°C. Laboratory and service trials have revealed a new property of this material; excellent wear resistance under both lubricated and dry frictional conditions.

Tests on piston rings in internal combustion engines at elevated temperatures show that ferritic nodular cast iron alloyed with 4-5% Si and 0.35-0.60% P is superior to unalloyed or complex-alloyed flake graphite cast irons and to pearlitic nodular cast irons, as far as wear-resistance, elasticity and structural stability are concerned. Piston rings cast from this alloy improved engine operation, virtually doubling the service life and reducing oil consumption to 1/3 or 1/2 of the normal consumption. **AFS Castmetals Research Journal, March, 1972.**

OPTIMUM CHEMICAL COMPOSITION OF PIG IRON FOR BASIC OXYGEN STEELMAKING

The variation in chemical composition of steelmaking pig iron in BOS shops was analysed in five southern plants during 1966-1968 and it was found that there was a relationship between these variations and the consumption of charge materials, the yield of good steel, and certain other technical and economic operational factors pertaining to the shops. A frequency distribution of the chemical composition (Si, Mn, S) is presented for four shops before and after the mixer in 1969. The sulfur content after residence time in the mixer undergoes a certain increase

British Steel Corporation's 5 stand tandem mill at Port Talbot as seen from the control pulpit.

which must be prevented by the addition of lime and by removing the mixer slag. With a large scrap consumption (up to 300 kg/t of steel) the pig iron should contain 0.60-0.90% Si. The melting of low-manganese pig iron improves the performance of the blast furnace but notably reduces the efficiency of the converter. The pig iron should contain 0.9-1.2% Mn. Measures must be taken to reduce the variations in the chemical composition of the pig iron. **Steel in the USSR, November, 1971.**

HIGH-TENSILE STAINLESS STEELS CONTAINING BERYLLIUM

The structure of steels with nominal contents of 8% nickel and 0.2% beryllium and chromium contents of 12, 14 and 16% in various conditions of heat treatment have been studied using thin-foil, extraction replica and x-ray diffraction techniques. The precipitate responsible for the hardening of these alloys has been identified as NiBe by electron diffraction from extraction replicas and selected areas of the thin-foil. A decrease in the peak hardness with increasing chromium content has been observed during aging and attributed to an increase in the volume of reverted austenite with increasing chromium content. The kinetics of formation and the morphology of reverted austenite, and the relationship between observed structures and mechanical properties is discussed. **Journal of the Iron and Steel Institute, July, 1972.**

EFFECT OF MATERIAL PROPERTIES ON OPERATION OF NICKEL ALLOY SPRINGS

The paper attempts to make the designer aware of the effects of environment, primarily temperature, on the mechanical properties of nickel alloys in spring applications. Nickel alloys are classified by major chemical elements into nine basic groups. Three of these groups supply the bulk of the alloys for use as springs.

Some guidelines and check lists are furnished to assist in giving full consideration to the end-use requirements of springs. Examples are given to illustrate spring behaviour as the alloy properties vary from changing temperature. A list of proprietary trademark alloys is included to assist designers in locating sources of application information for high temperature alloys. **Mechanical Engineering, August, 1972.**

ON-LINE IDENTIFICATION OF A TANDEM MILL

The paper describes measurements and on-line identification carried out on a tandem steel mill as a part of a project to develop an improved computer control system for the mill. The paper does not dwell on theoretical points, but presents a view of how a difficult modelling problem can be handled in practice with rather simple means. It is hoped that the paper would be of value to those who are planning similar modelling experiments. An on-line correlator was found to be particularly useful to identify responses under difficult experimental conditions, and to tune the feedback control systems on the mill. The mill and the experimental conditions, are described. **Journal of the Iron and Steel Institute, August, 1972.**

TEMPERING OF STEEL

Tempering of martensitic steels involves the segregation of carbon, the precipitation of carbides, the decomposition of retained austenite, and the recovery and recrystallization of the martensitic structure. Because these several reactions overlap and occur on such a fine scale, it is only recently that knowledge of the resulting structures has become reasonably complete. Present understanding of the processes involved in the tempering of iron-carbons martensites and how they are affected by alloying elements is reviewed. **Metallurgical Transactions, May, 1972.**

CO_2 PROCESS AND RECLAMATION BY MEANS OF AN AIRLESS SHOTBLAST MACHINE

One of the more original concept in recent years is the reclamation of sand during the process of shotblasting, the sand and shot being separated and recirculated for subsequent use. The author shows how his company has taken this technique and developed it to a high degree of efficiency. One of the outstanding aspects is the use of boxless moulds made from CO_2 Process sand. This means that moulds and castings can be transferred directly into the shotblast unit. **Foundry Trade Journal, May 1972.**

Rows of boxless moulds made from CO_2 Process sand, clamped ready for pouring.

THE REMOVAL OF PHOSPHORUS, USING IRON OF DIFFERENT COMPOSITIONS

Several features of phosphorus removal are examined, using experimental heats in a laboratory converter charged with pig iron of various compositions. Kinetic curves were obtained comparing the extent to which phospborus and carbon are oxidized during the blow-using pig iron with various silicon and manganese contents. It was observed that when blowing iron with a low manganese content, the adverse effect of silicon on dephosphorization is particularly marked. In the experimental blows of iron containing more than 0.9% Mn, the best performance as regards dephosphorization was achieved in cases where the iron had a somewhat higher silicon content. The optimum relationships between managanese and silicon in the iron were determined, compatible with the most favorable conditions for slag formation and good dephosphorization. **Steel in the USSR, June, 1971.**

STEELPLANT RETRACTORIES IN THE SEVENTIES

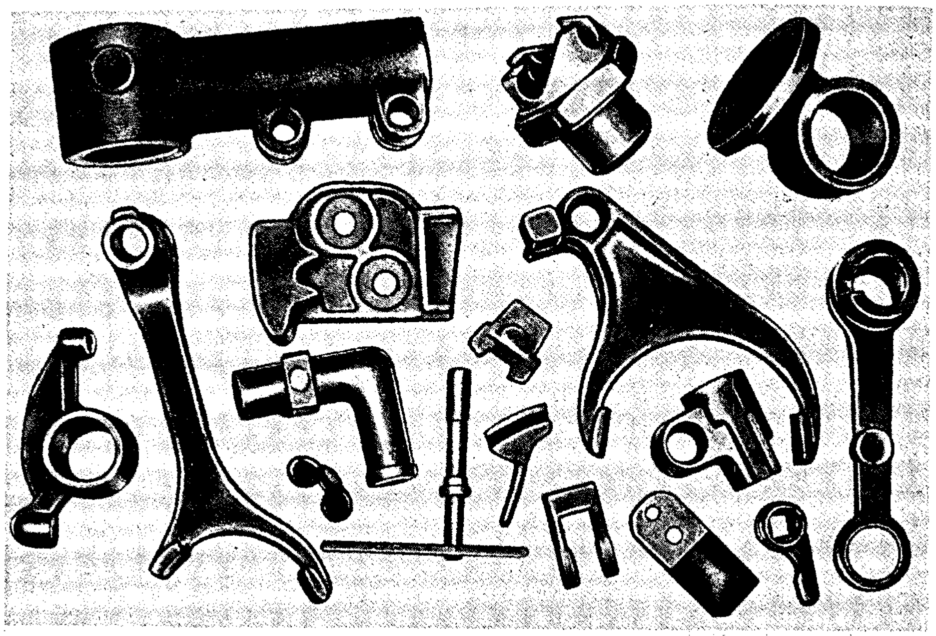
The patterns of refractory use in different steel plant processes in the Seventies will essentially follow the evolutionary trends initiated in the Sixties. The rapid and extensive conversion from refractories based on natural raw materials to ones made from synthetic materials that has occurred in the past 15 years will taper off as the need for synthetic basic, high-alumina and zirconia refractories nears end-use saturation. In the future, greater emphasis will be placed on using the specific properties of individual refractories to full advantage in carefully designed refractory structures. No longer will composition be the dominating force in refractory development. Installation techniques will play an increased role in the economics of refractory utilization. Improvements in refractory use can be expected through 1980 for ironmaking, steelmaking, metal casting and metal forming. **Ceramic Society Bulletin, July, 1972.**

ISOLATION AND ABSORPTION OF MACHINERY VIBRATION

The problem of isolating machinery vibration from both rigid and non-rigid foundations is considered, and reasons why predicted levels of force transmissibility are often exceeded inpractice are discussed and illustrated by representative samples. Both one-and two-stage mounting systems are analyzed. The machinery and the intermediate mass of the two-stage mounting system, may sometimes be supported on rubber antivibration mounts by multiresinant flanges or feet, which are represented here by short shear beams. **Mechanical Engineering, August, 1972.**

EXPANDING EXISTING CASTING OPERATIONS

At some point in time, virtually every casting producer either has to increase the capacity of his plant or modernize to meet quality requirements economically. When that time comes, he must decide whether to build a new plant and vacate the existing one, to build a new plant and continue to operate the existing one, or to expand existing facilities. For those who decide on an expansion, the article provides valuable insights on how to complete the project with maximum efficiency and minimum disruption of current operations. It is followed by several brief case histories of recent expansions. **Foundry, August, 1972.**



Typical Soviet investment castings.

FACTORS AFFECTING THE LIFE OF DROP FORGING DIES

Record of the lives of several hundred forging dies, used to make forty-one different parts on hammers and presses, were examined to determine which of the factors that can be measured and recorded have a significant effect on die life. Previous evidence that the weight of the forging is of predominant importance was confirmed. Two other factors, over which the forger has some control, are the flash land area (which should be high) and the amount of metal thrown as flash (which should be small). In addition, there is a clear superiority of 3% Ni – 30% Mo steel over no. 5 die steel. Finally, for similar parts, a better die life is obtained when they are made on hammers than when they are made on presses. These measurable factors account for only part of the variation in die life; much is due to random effects, including the skill of the operator. **Journal of the Iron and Steel Institute, July, 1972.**

CHEMICAL TREATMENT OF WASTEWATER FROM MINING AND MINERAL PROCESSING

The common chemical methods used to control waste discharges are neutralization, oxidation, reduction, coagulation, precipitation and ion exchange. Practically any type of mineral processing waste can be treated by chemicals. A variety of treatment processes may be required in a large plant to achieve the best over-all results, and the decisions as to the methods to be used should be based in part on feasibility studies that include tests to determine responses of the waste to the treatments planned. In addition, there should be an investigation of equipment, control devices, area requirements and labor needed for operation and maintenance of the facilities to be installed. All of these factors have to be evaluated in the light of the effluent quality required to meet regulatory statutes. **E/MJ, April 1971.**

AUTOMATED INVESTMENT CASTING IN THE USSR

Soviet development of automated investment casting is highly advanced. In one automotive investment foundry, 80% of all operations are automated, including pattern material preparation, slurry preparation, pattern-making, ceramic moldmaking, dewaxing, firing of shells, embedding the shells in back up sand, pouring, cooling, cleaning, and cut-off. As a result of automation like this, up to 1,000 investment cast parts are used in automotive applications. **Foundry, August, 1972.**

CONTACT PRESSURE BETWEEN AN ELASTIC SPHERICAL SHELL AND A RIGID PLATE

A theoretical analysis for the determination of the contact pressure between a uniform elastic spherical shell and a rigid plate is developed. The results are directly applicable to the theory of applanation tonometry which is concerned with the measurement of intraocular pressure. Numerical results are presented for a shell having a radius of thickness ratio of 30. **Mechanical Engineering, August, 1972.**

A FATIGUE CRACK INITIATION DETECTOR

An instrument which detects the initiation of a fatigue crack in the head of a bolt by measuring the change in relative position of the two ends of the double shear test joint at the maximum of the cycle load as the crack propagates, has been developed. Increase in relative displacement of 0.00002 in. (0.0005 mm) can be reliably detected using the output of linear variable differential transformer (LVDT). Detection of the initial head fillet crack should be a more reliable fatigue failure criterion and should result in less experimental scatter than catastrophic failure of the bolt. A detailed description of the instrument and examples of its use and performance are given. **Journal of Materials, March, 1972.**

THE LIMITING STRENGTH OF WORN METAL SURFACES

The limiting strength of metal and alloy surface strained by wearing with a blunted trepanning tool have been estimated by microhardness measurements. The relationship of the limiting strength to the low strain flow stress of the materials depends on the metallurgical structure. The stress and strain distribution below the surface have been determined with microhardness measurements as a function of depth and by observing the displacement of foils in a laminated specimen. The recrystallization characteristics of the highly strained surfaces have also been investigated, and it has been found that the strain-aging characteristic in 70/30 brass is removed and that the softening temperature is not decreased by a very high strain. It is suggested that the limiting process is fracture and the stress system imposed by the wear process inhibits the onset of fracture so that the fracture strain and stress are higher than in conventional deformation process. The limiting strength results are discussed in terms of the metallurgical structure. **Metallurgical Transactions, September, 1972.**

SELECTING MELTING EQUIPMENT

The lowest possible cost of melting metals for either ferrous or nonferrous foundries must, today, be the first priority in the total studies made by management when considering their corporate plans to manufacture and market a product. It is from the money made by a successful and profitable operation than an acceptable return on the capital invested will be achieved. Just as selection by a craftsman of a right type and quality of tools will go a long way to produce a finished high-quality product and a successful business, so it is the case for management to select the right type of melting plant for a foundry. **Foundry Trade Journal, May 1972.**

GOLD PLATING IN THE BUBBLE PHASE

The author describes a method of gold plating accomplished by using a controlled foam as the electrolyte and plating in the foam or bubble layer. The plating system uses a surface active agent dissolved in an electrolyte to produce a foam. The foam, consisting of the plating solution and nitrogen gas, does the work of the electrolyte in a standard liquid plating system. With this "bubble plating" system, bright and thick deposits of 24K gold in very short periods of time were obtained. **Metal Finishing, August 1972.**

THE MINICOMPUTER AS A CONTROL TOOL FOR MACHINERIES

Given is a general overview of some of the reasons for the rapid growth of the industrial applications of the minicomputer. The cost and market growth of the minicomputer and its role in the hierarchical computer system is presented.

The advantages and disadvantages of assembly language and high-level minicomputer programming is discussed along with the future trend of minicomputer software and its relationship with hardware. A summary of Frigidaire minicomputer machine control experience is presented. **Mechanical Engineering, August, 1972.**

A MICROSCOPIC STUDY OF STEEL SURFACES EXPOSED TO A HUMID SO_2-CONTAINING ATMOSPHERE

Electropolished and etched steel samples have been exposed to a humid, sulfur dioxide – containing atmosphere under controlled conditions. The surface structure of the samples and the distribution of the points of attack after exposure have been studied with a scanning electron microscope. **Corrosion Science, July 1972.**

AUTOMATIC INDUCTION HARDENING OF SURFACES

To achieve the desired metallurgical results in induction hardening, all factors must be accurately controlled and repeatable. Thus, the part must be heated each and every time to the same depth, same temperature, at the same rate, and in the same area. Then, it must be quenched at the same rate by using the same quenchant at the same temperature and pressure and at the same length of time. If an operation simply loads and unloads a part which is hardened in such a manner, the process is defined as "semi-automatic". If, on the other hand, the parts are loaded and unloaded without benefit of an operator, the process becomes "full-automatic". **Metals Engineering Quarterly, August, 1972.**

RECLAMATION OF CHEMICALLY BONDED SANDS

The principal techniques employed for the reclamation of chemically-bonded stands are outlined and the mechanical method of treating sand by means of a pulverizer equipped with multi-hammer heads are examined. The reclaimed material can be used for the preparation of further mixes of moulding and coresand bonded with the original binder which could either be furane resin, sodium silicate, or cement. In the case of furane resins, superior results are claimed for the treated sand compared with new material at the same level of binder addition. **Foundry Trade Journal, May 18, 1972**

RADIATIVE HEAT TRANSFER IN BLAST-FURNACE STOVES

A more accurate and scientifically based method of evaluation of heat transfer between the fluid and the solid in blast-furnace stoves has been devised. This method accounts for non-uniformity of temperature in the stream of the fluid, absorption of radiant energy by the fluid and partial reflection by the brick. A wide range of conditions, from relatively pure gases to those containing large quantities of solid particles, like in combusted carbon, are covered. Only the knowledge of physical constant of materials, the nature of flow and the temperature of the brick is necessary to use this treatment in evaluation of the heat transfer by radiation. **Journal of the Iron and Steel Institute, July, 1972.**

COLD ROLLING OF TUBES IN MILLS

In the investigations described, it was established that the reserve of plasticity is not fully utilized in cold rolling, owing to splitting of the tube ends; this is due to a considerable extent to their deformation characteristics in the return stroke of the working stand. The use of mills with a fixed working stand for producing cold-rolled tubes of steels and alloys that are difficult to work ensures the possibility of increasing productivity substantially, improving quality, and widening the range of products. **Steel in the USSR, June, 1971.**

ON THE ELECTROCHEMISTRY OF POROUS ZINC ELECTRODES IN ALKALINE SOLUTIONS

Porous zinc electrodes were discharged galvanostatistically in aqeous potassium hydroxide solutions. The morphology of the zinc oxide film formed was investigated with a scanning electron microscope. The current distribution in the porous electrode, and its dependence on current density, was determined by miscroslicing the electrode after discharge and chemical analysis. The oxide film had a porous, "carpet-like" structure, consisting of long needle crystals with occasional sidearms. The formation of this kind of film can be explained by a dissolution–precipitation mechanism. The current distribution in the porous electrode, and its dependence on current density could also be explained, based on a model of oxide film consisting of a thin, high resistance compact film, beneath the porous oxide. **Journal of the Electrochemical Society, September, 1972.**

TECHNIQUES OF PROCESS ANALYSIS IN EXTRACTIVE METALLURGY

The study of process metallurgy should include the theory of heat, mass, and momentum transfer and also the techniques of process analysis and design which have made chemical engineering an indispensable partner of the chemical science. The analytical tools which can be used in a particular situation depend entirely on the ingenuity of the metallurgist and his willingness to adapt and utilize the existing methodology. Various techniques of process analysis are exemplified by the author. **Metallurgical Transactions, August, 1972.**

PHOSPHATING AND CHROMATING OF METALS

Phosphate and chromate processes comprise a major part of the field covered by the term "conversion coatings". This is a relatively old industry, but development of new processes and applications make it quite a dynamic one.

Most commercial processes involve a number of stages of aqeous solutions to convert a greasy, possibly scaled, metal surface to an inert, inorganic coating. Many metals are involved, with steel, aluminum and zinc the most common.

Phosphates of various metals such as iron, zinc, manganese and lead, and chromates are those most frequently met. Some coatings are crystalline, some amorphous. End uses include lubrication of machine parts and for cold forming of metal, adhesive bonding, paint adhesion, corrosion resistance. Type and weight of coating are dictated by the end use.

A major feature of commercial processes is their trouble free and simple nature from the view point of user control.

Anti-pollution measures are affecting these processes; technological change threatens some applications, but is opening up new ones. The result is that the industry remains one with development and growth likely from many years to come. **Metals Australia, September, 1972.**

PRODUCTION OF HIGH QUALITY BIMETAL TUBES

The principle on which a new method of obtaining bimetal tubes is based, are examined. In producing a strong diffusive bonding of the layers, the combined hot plastic deformation of two-layer semi-products is replaced by cold-working, followed by a thermal diffusion treatment. As a result of the elimination of hot-rolling and heating in an oxidizing atmosphere, and using as initial semi-product cold-worked tubes with the necessary predetermined properties, the new method enables tubes to be obtained with a high surface quality, with accurate dimensions and a strong weld of the layers. **Steel in the USSR, January, 1972.**

THE MECHANISM OF PHOSPHATING OF STEEL

A schema of the mechanism involved in the different steps during phosphating of steel is proposed. The effect of electrochemical activity as a function of surface finishing, metal microstructure and quantity of inclusions is discussed. Certain aspects concerning crystallization and crystalline reorganization of phosphate layers are defined. The distribution of iron and zinc in the phosphate layers formed by the treatment of steel in zinc phosphating baths was investigated. **Corrosion Science, July, 1972.**

POLLUTION-FREE METALLURGY; COPPER VIA SOLVENT-EXTRACTION

Solvent extraction clearly fits into the new group of copper winning processes, which might eventually lead the way to the development of "chemical smelters" with their attendant advantages in the fight against atmospheric pollution. Although limited to certain types of leach operations at present, sufficient work is being carried out at research organizations throughout the world to indicate that very real possibilities exist for the application of solvent extraction in combination with other techniques to the recovery of copper from those ores which can presently be treated by pyrometallurgical means. **E/MJ April, 1971.**

EFFECT OF VANADIUM ON CARBON

Classed as low-cost substitutes for alloy steels in many applications, C-Mn-B steels have lower resistance to tempering. This is considered a disadvantage because quenched C-Mn-B steels will be weaker by 10,000 to 20,000 psi if put through a tempering furnace adjusted for commercial low-alloy grades. Lower resistance to tempering also makes steel more sensitive to differences in tempering time, and leads to softening of heat-affected zones of weldments. This softening is undersirable because it reduces the endurance limit of weldments subjected to cyclic stressing. **Metals Engineering Quarterly, August, 1972.**

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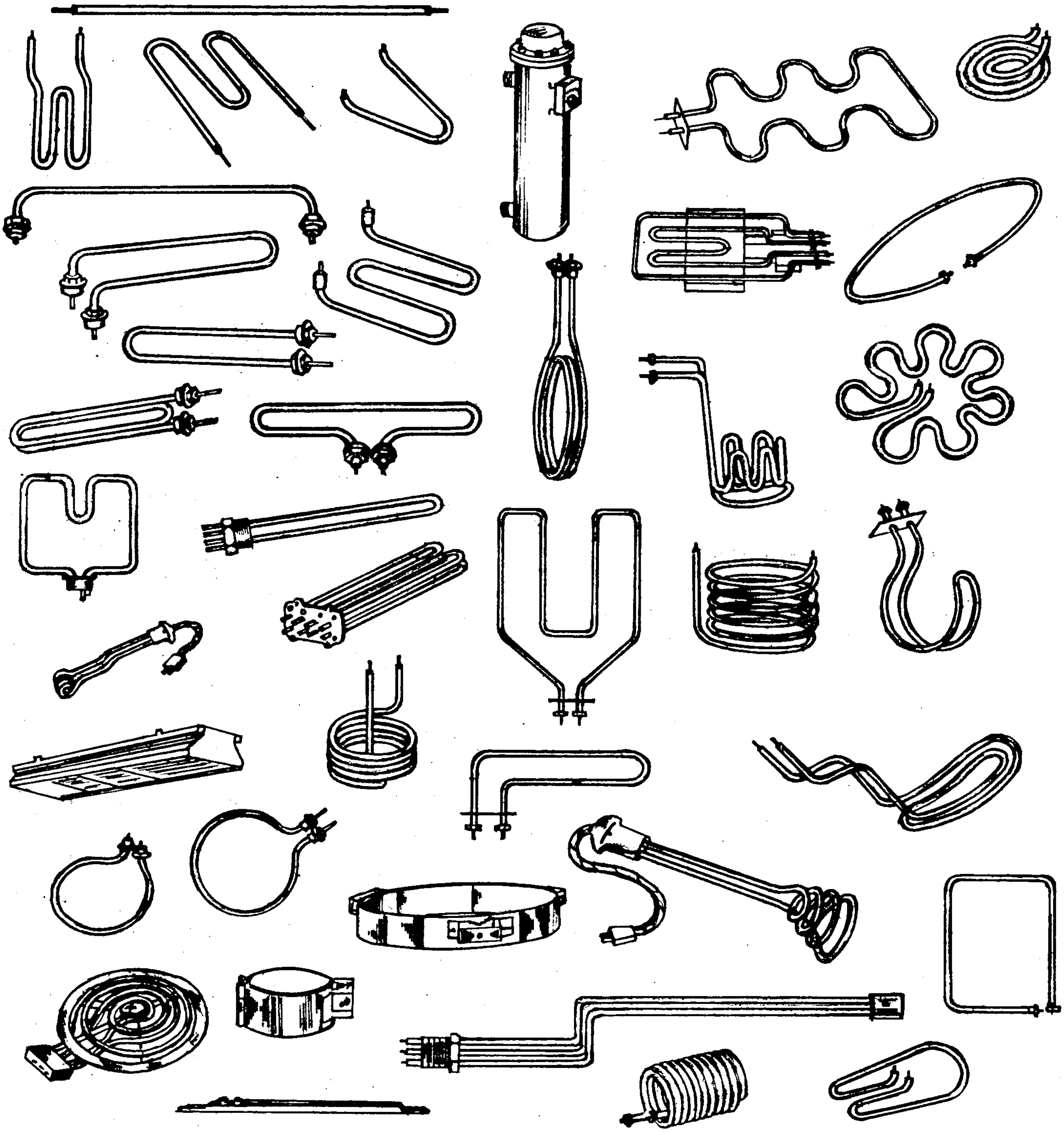

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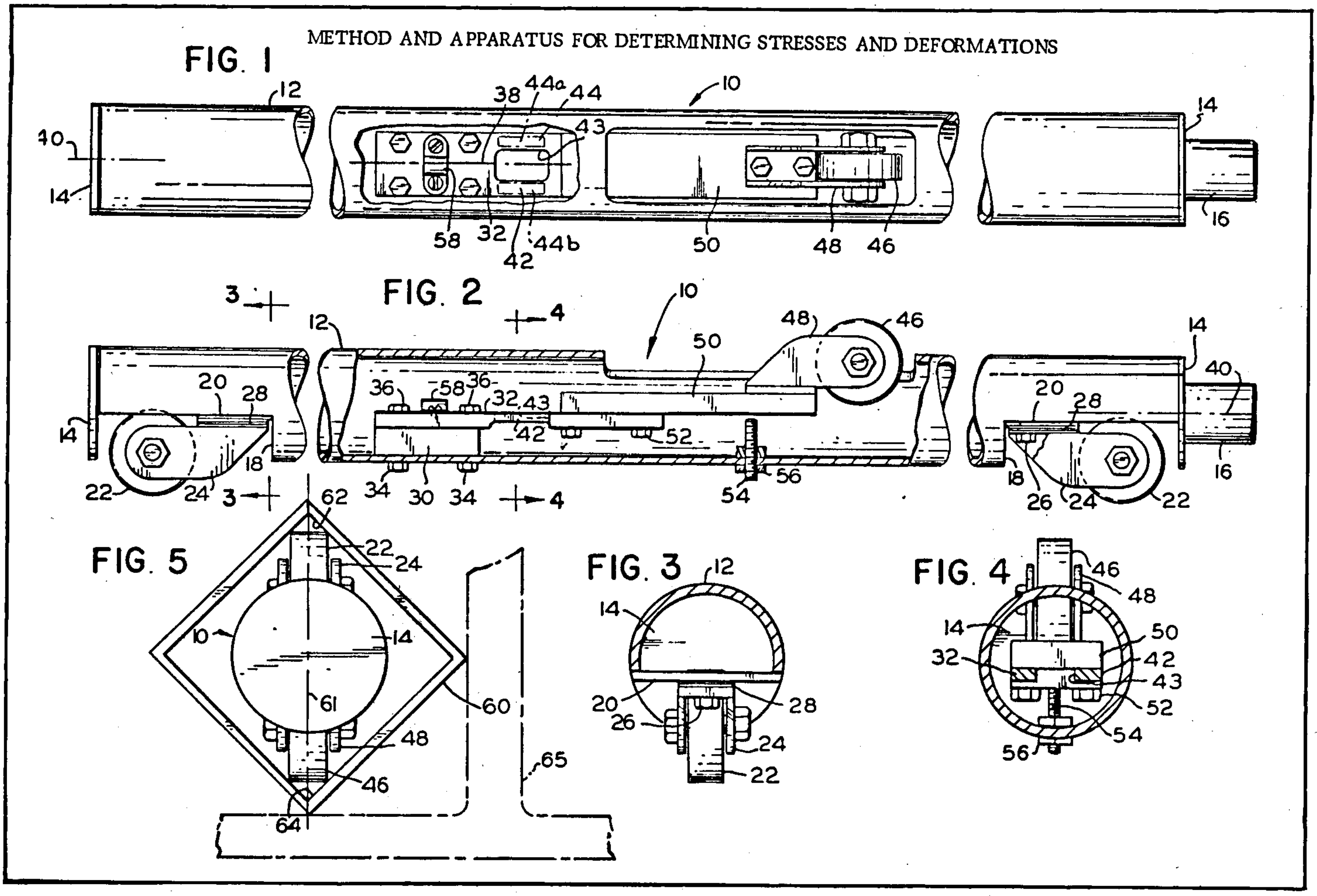


METHOD AND APPARATUS FOR DETERMINING STRESSES AND DEFORMATIONS

Harlan B. Smith, Albany, Oregon
Assignor to Cornell, Howard, Hayes and Merryfield, Inc. Corvallis, Oregon
Filed on September 28, 1968

This invention relates to the determination of bending stresses, particularly to a method and apparatus for determining such stresses in slender structural members such as beams, columns, slabs and piling. The method determines binding stresses in a structural member in which a square tube is attached to the member with a diagonal plane parallel to the plane of bending of the structural member, the tube being adapted to assume the curvature of the member during the bending thereof. A curvature meter is inserted in the tube. The meter has a tubular body and supporting rollers mounted at each end thereof. A third or sensing roller is mounted on a cantilever midway between the end rollers. The meter is inserted in the tube so that the end rollers ride in one apex thereof and the sensing roller rides in the opposite apex. Strain gauges mounted on the cantilever record the deflection thereof, which deflection can then be used to compute the stress in the structural member.

What is claimed is a method of determining bending stresses in structural member comprising: (a) attaching a square tube to said structural member with a diagonal plane of said tube parallel to the plane of bending of said structural member, said tube being adapted to assume the curvature of said structural member during bending thereof; (b) measuring the deflection if a first point along one apex of said tube with respect to the line drawn through two equidistant points along the opposite apex of said tube and on either side of said first point; and(c) computing the stress in said number as a function of said deflection. Another claim is the method of measuring deformations in a body comprising of inserting a square tube in said body with a diagonal plane of said tube parallel to the plane in which the deformation of said body is to be measured, said tube being adapted to assume the deformation of body; and measuring the deformation of one with the apices of said tube in said diagonal plane.

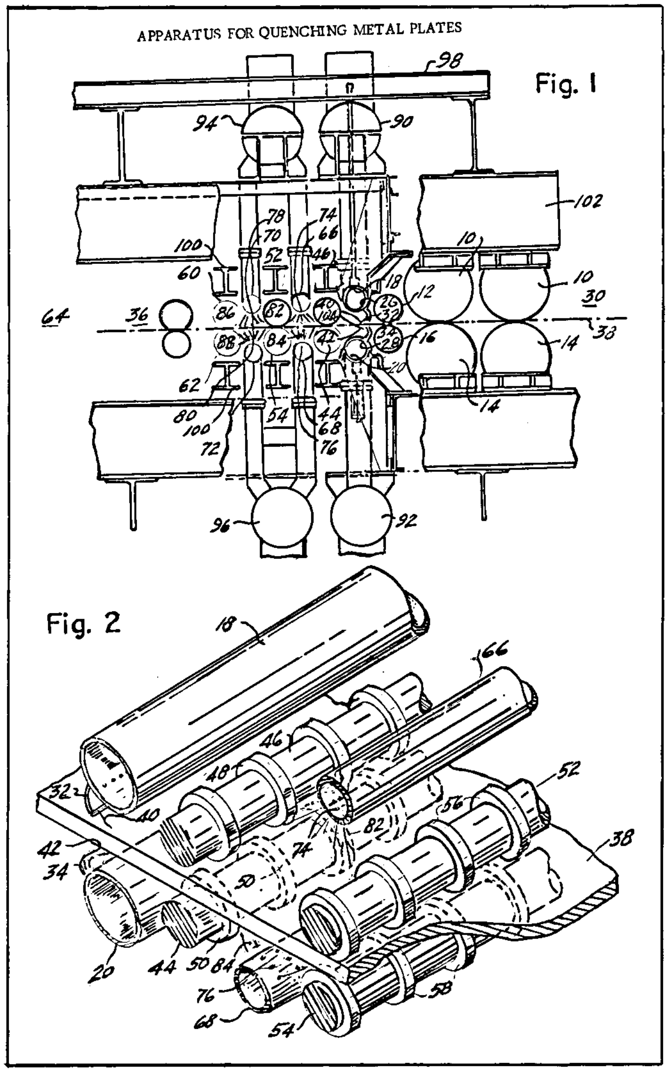
Figure 1 shows the plan parts with broken away of the curvature meter of the invention. Figure 2 is the sectional view showing the curvature meter inserted in a square tube and in position to measure deflections along a structural number attached to the tube.

APPARATUS FOR QUENCHING METALS PLATES

Franklin Charles Saffort, Robert Allyn Myrath and Edgar Lloyd Loveless, all of Pennsylvania, Assignors to Drever Co., of Bethayres, Pennsylvania, a corporation of Pennsylvania, U.S.A. Filed on November 25, 1966

This invention relates to a roller pressure high intensity quench system for quench reducing the temperature of metal plate to provide it with selected properties. It pertains to an apparatus in which directly opposed tired rollers engage plate at a temperature above the critical transformation temperature in which the metal plate moves along a predetermined path and is initially impinged angularly with a curtain of quench fluid in the top and bottom surfaces.

This apparatus produces a high intensity continuous quench system. A high velocity curtain of water or other suitable quench fluid strikes the work at an angle. This prevents the quenching fluid from reaching a point where the high velocity curtain of quench fluid strikes the plate. The angle also assists in forcing the quench fluid down the line through a plurality of staggered tired rolls used to restrain the metal plate while it is subjected to a severe quench. A subsequent spray pipe discharges quench fluid uniformly covering the area between two tired restraining rolls on both the top and bottom of the plate. The fluid also impinges the plate proximately where



the plate leaves the tired rolls whereby any dry spots caused by an interruption of the flow of quenching fluid along the plate surface are substantially eliminated.

The apparatus which provides a continuous high intensity uniform quench of a metal plate comprises:

a) means supporting and restraining the metal plate, forcing it to lie in a plane and moving it from a point of entry of the apparatus to an exit of the apparatus;

b) a pair of high intensity spray pipes positioned within the means supporting and having their longitudinal axes parallel, the spray pipes are spaced apart and each has a plurality of closely spaced holes longitudinally aligned along the length of the spray pipe, the holes face the between the spray pipes;

c) a curved deflector attached to each spray pipe adjacent the holes and extending along the longitudinal axis of the spray pipe, the curved deflector extends from the spray pipe toward the entry end of the apparatus and curves toward the opposite spray pipe, each curved deflector is positioned so that its free end is directed toward the other deflector and toward the exit end of the apparatus so that a tangent to the tip of each deflector forms an angle of 10-40° with the metal plate surface, the free end of each deflector is also positioned so that the quench fluid leaving the free end initially impinges the metal plate at a minimum distance from the preceeding supporting and restraining means; and

d) means supplying an initial quenching fluid under pressure to each spray pipe, the fluid leaves the holes and strikes the deflector which causes a high velocity curtain of liquid to initially impinge on the metal plate at an angle preventing any splash back in the opposite direction from which the metal plate is entering the apparatus, the fluid is directed along the metal plate toward the exit end of the apparatus.

EXTRUSION PRESS

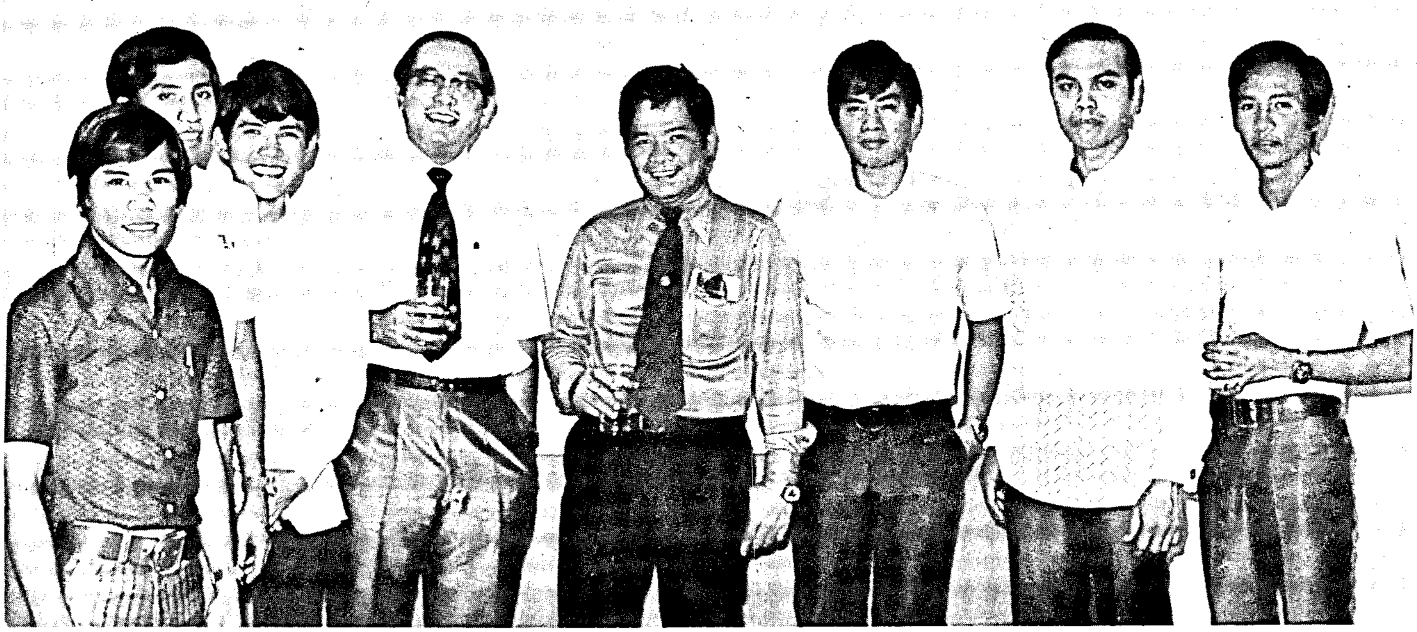
Daniel Jeremiah Cullen and John Anthony Merrill, both of Arizona, assignors to Reynolds Metals Co. of Richmond, Virgina, a Corp. of Delaware, USA

Application filed on July 6, 1962

This invention relates to an extrusion press for extruding hollow tubes or pipes. More particularly, this invention relates to an extrusion press for extruding tubes of varying wall thickness and varying diameters. This invention provides an extrusion press forming hollow tubes having thick end walls and a thin middle wall, which press is characterized in that the mandrel is secured to the ram for movement therewith and has substantially annular grooves spaced along its length, the spacing between adjacent grooves bring greater than the length of the grooves in the axial direction. The tubes produced by such a press have sufficient strength at their ends for forming strong welded joints. The hollow tubes formed by the extrusion press can have a substantially constant internal diameter, in which case the end tube parts are thickened externally and have outer diameters greater than the outer diameter of the thin middle part of the hollow tube. The extrusion press can also form hollow tubes having thickened parts at spaced positions along their length. It was claimed that the method of making a hollow metal extruded tube having a long thin tubular body and externally thickened walls at opposite ends thereof, by extruding a confined metal charge through an annular orifice between a die of fixed size and a substantially cylindrical mandrel extending through the bore of said die having an alternation, small mandrel portions, and terminal and inner large mandrel portions which are of equal height or diameter, to vary the orifice and control the wall thickness of the extruded product, which comprises extruding the charge through the orifice while advancing the mandrel to form uniform successive thick and thin adjoining parts of the extruded product by varying the internal configuration of the extrusion at the die, and includes the following steps successively: a) enlarging the extrusion orifice to form a uniformly and internally thickened wall, b) gradually reducing the orifice to form a tapered wall of decreasing thickness, c) maintaining the reduced orifice substantially constant to form a long thin tubular body, d) gradually enlarging the extrusion orifice to form a tapered wall of increasing thickness, e) maintaining the enlarged orifice substantially constant to form a second uniformly and internally thickened wall, and progressively filling the extrusion from confinement by the die, while advancing it relative to the mandrel outwardly of the die and radially expanding the first formed thickened wall over the terminal large mandrel portion to form a completed hollow extruded tube of uniform internal diameter throughout and having a long thin tubular body and externally thickened walls of substantially uniform thickness at opposite ends thereof, and having an externally thickened tapered wall intermediate each of said uniformly thickened end wall and said tubular body.

MIRDC corner

MIRDC TRAINEES ABROAD



MIDC Singapore trainees with MIRDC Director Dr. Antonio V. Arizabal and Domingo Toledo of AG&P. From left to right, Jose Girado Jr., Toribio Jamolin, Emmanuel Nolasco, Romualdo Publico, Marencho Rivera and Demosthenes Dar. Not in photo are Jose Sason and Fernando Seriña.

Jose S. Sason, metallurgical engineer from the University of the Philippines and team leader of the MIRDC trainees group, recently arrived after finishing a four-month training course at MIDC Singapore together with Demosthenes D. Dar, Jose D. Girado Jr., Toribio J. Jamolin, Emmanuel V. Nolasco, Romualdo Publico, Marencho G. Rivera and Fernando N. Seriña.

The group was trained under the direct supervision of ILO experts and members of the MIDC Singapore technical staff through lectures, demonstrations, plant visits, and actual application of theories, which the trainees supplemented with outside researches.

Their training included mechanical design, foundry techniques, tool and die design, tool and die making, metrology, quality control, heat treatment, electroplating and mechanical workshop practice.

MIRDC PARTICIPATES IN REGIONAL DEVELOPMENT CONFERENCE

Dr. Antonio V. Arizabal, Director; Estefanio M. Gacad, Senior Development Engineer and Virgilio V. Valin, Analyst, represented MIRDC at a two-day conference on "Regional Development Through Coordinated Action of Various Agencies" held at Davao City last November 16 and 17.

Other agencies who participated were the Board of Investments; Department of National Defense; Development Bank of the Philippines; Mindanao Development Authority; National Electrification Administration; National Power Corporation; Presidential Economic Staff; Sycip, Gorres & Velayo & Co., and the U.P. Institute for Small Scale Industries.

WILLIAM HOWELLS

HOWELLS — NOW WITH MIRDC

Another UNIDO expert has been added to the MIRDC group of foreign technical consultants. He is William Howells, an industrial engineer from New Zealand.

He studied at the Bristol University, England obtaining a Bachelor of Science in Engineering. He also studied part time at the Merchant Venturers Technical College, acquiring ordinary and higher national certificates, in Mechanical and Product Engineering.

Previous to his new assignment, he was the Chief of Project of the International Labor Organization in Jamaica. He headed a team of six ILO experts and ten short-term technical experts who assisted in the Jamaican government project of establishing the Productivity Centre and Industrial Services Division of the Jamaican Industrial Development Corporation (JIDC).

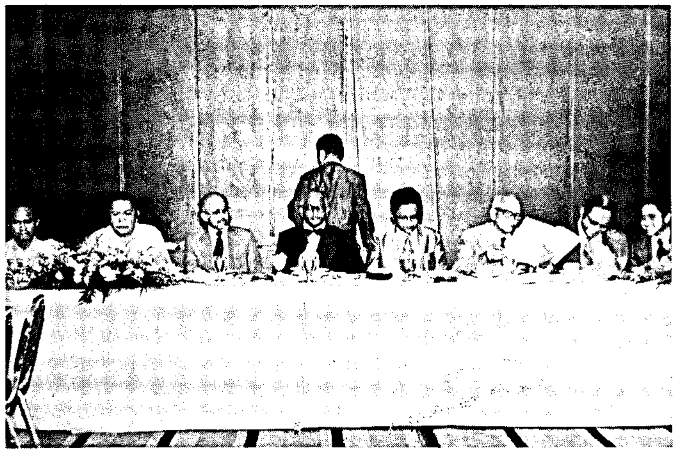
He has experience in brass foundries, tool and die shops, jobbing machine shops, wire and wire rope manufacture, and aluminum hollow ware manufacture.

While here in the Philippines, Mr. Howells will act as management consultant for MIRDC for a period of one year.

MIRDC, LIAISON FOR ECAFE SURVEY MISSION

Two ECAFE experts arrived in Manila last September 23 for a seven-day fact-finding mission.

V. M. Subramanian, Chief of the ECAFE Technological Section and R. D. Lalkaka, ECAFE/UNIDO Regional Adviser on Metallurgical Industries studied problems plaguing the local billet industry. They also looked into the feasibility of establishing a regional steel billet plant.



ECAFE billet experts R. D. Lalkaka and V.M. Subramanian are flanked by PISI members Vicente Decipeda, Daniel Mijares, Dominador de Jesus, Bernardo Abrera, ex-officio officer Dr. Antonio V. Arizabal and Jose Marcelo, Jr. at the Plaza on September 26.

The Metals Industry Research and Development Center (MIRDC) was designated official liaison group for the ECAFE team. Heading the list of the liaison panel was Beatriz D. Orinion, Chief of MIRDC's Information and Statistics Division.

The team consulted with the various government and private industry representatives on the proposed ECAFE mission which included the Board of Investments, (BOI); Presidential Economic Staff, (PES); Department of Commerce and Industry, (DCI); National Power Corporation, (NPC); National Economic Council, (NEC); Free Trade Zone Authority, (FTZA); Tariff Commission; Industrial Estate Corporation and the Department of Public Works.

The team's itinerary included Malaysia, Singapore, Indonesia and Thailand.

HORIKAWA'S SEMINAR:

Dr. Kazuo Horikawa, representative of the South East Asia Iron and Steel Institute, (SEAISI) gave a lecture on "Weldability of Newly Developed Low Alloy High Strength Steel" last October 13, Friday, at the Intercontinental Hotel in Makati.

The seminar was jointly sponsored by the Philippine Iron and Steel Institute (PISI) and the Philippine Foundry Society (PFS).

Dr. Horikawa is the Director of the Iron and Steel Institute of Japan and the Japan Institute of Metals. He gave the same lecture in Singapore, Australia and Japan.

new arrivals at the MIRDC library

BOOKS (Continued from PHILIPPINE METALS Vol. II No. 3):

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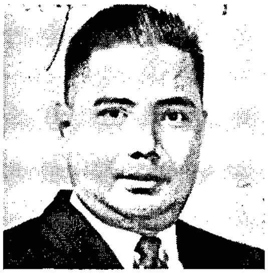
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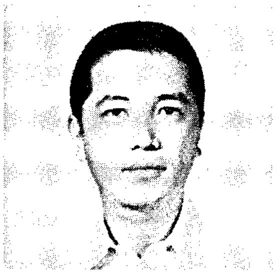
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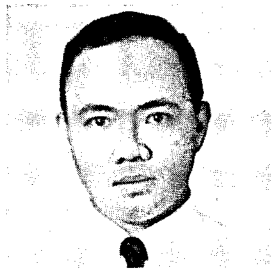
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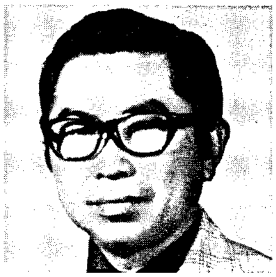
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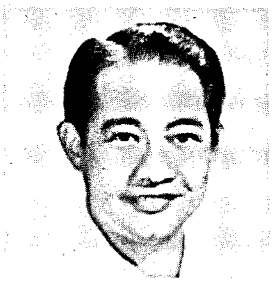
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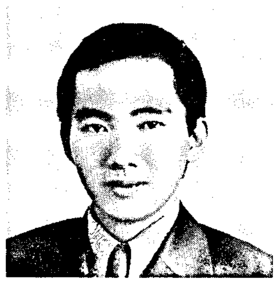

Robert Young

Starting with this issue, "PFS on Focus" shall be a regular feature of the Philippine Metals. This being the initial spread, the PFS officers and the organization's various activities are presented for the readers to know more about it.

The PFS hopes to work for the advancement of the metal castings industry, technologically and economically. More specifically, the organization is working for the improvement of the local castings market. These and other similar goals are the factors that make PFS a truly dynamic association.

PFS, SME, MIRDC SPONSOR SEMINAR

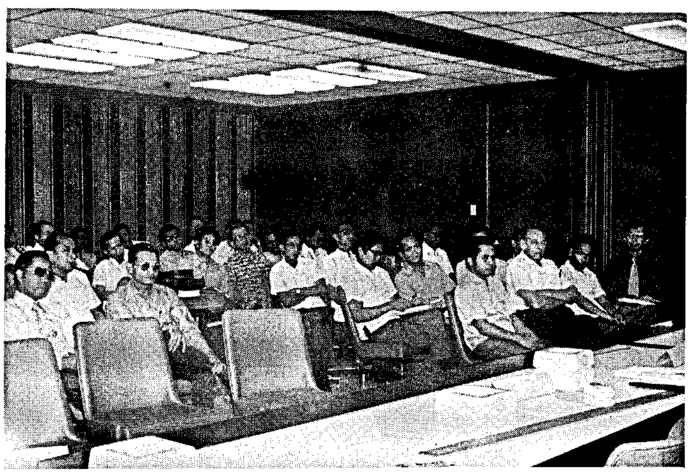
The Philippine Foundry Society (PFS), the Society of Manufacturing Engineers (SME) and the Metals Industry Research and Development Center (MIRDC) sponsored a seminar on "Machinability and Grinding Technology" on October 12, 1972. Invited to speak was Dr. Joseph Stanislao, an industrial engineering professor and Chairman of the Department of Industrial Engineering at the Cleveland State University.

The seminar, held at the BOI Training Room was followed by an open forum.

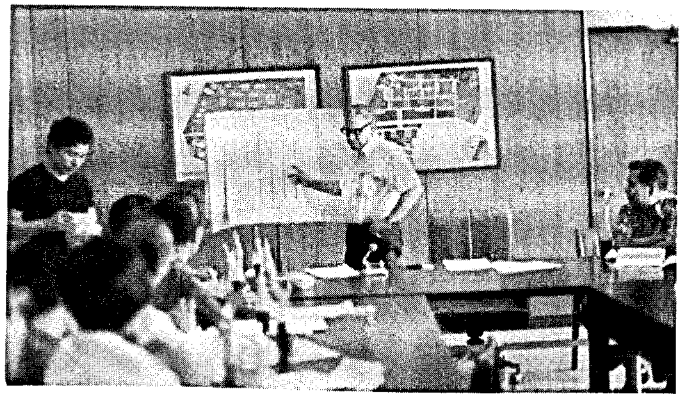
MIRDC Director Antonio V. Arizabal delivered the opening remarks, SME President Albino F. Maglalang introduced the guest speaker while PFS President Ernesto Patenia concluded the seminar. Some sixty PFS, SME members and MIRDC staff members attended the occasion.

The following are the elected officers of SME: Albino F. Maglalang of Wimpey International, Inc., Chairman; Juan S. Barrera of Machinery Steel Products Engineering, 1st Vice Chairman; Alfredo L. Sabra of Crims Manufacturing and Trading Second Vice-Chairman, Luis O. Maciano of Sandvik Philippines, Secretary, and Yu Mun of Overseas Hardware Co., Inc., Treasurer. Composing the Board of Directors are: Melecio A. Torres of Marcelo Steel Corporation, Rogelio H. Roxas of R. Roxas Machine Shop, Jose Ocariza of San Miguel Corporation, Ilustre D. Boado of Engineered Products Industries Corporation, and E.P. Angeles of Western Steel, Inc.

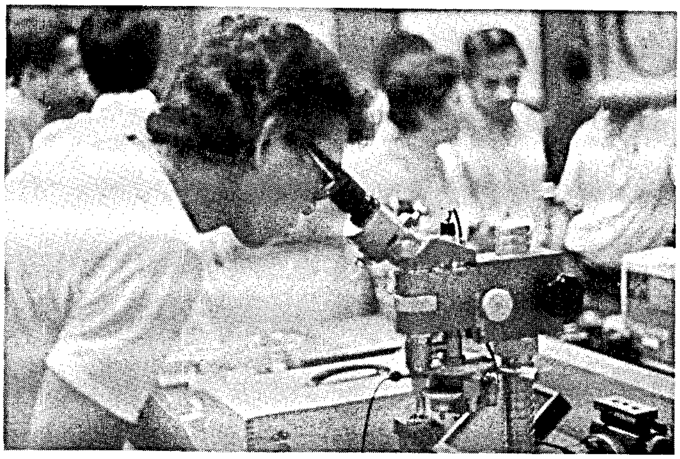
Dr. Stanislao entertaining questions from the audience.



A portion of the audience composed of SME and PFS members is shown in this photo.



UNDP foundry expert Egon Gladh discussing the foundry technology in other countries.



A PFS member looking through MIRDC's micro-hardness tester.

PFS VISIT TO BICUTAN

The MIRDC shops and laboratories in Bicutan were shown to the officers and members of the Philippine Foundry Society, (PFS) last September 22, 1972.

Facilities of the MIRDC were displayed, the operations of which were explained to the PFS members. The MIRDC shops have equipment which can be used in the testing of various materials according to standard specifications.

The tour was capped by a short talk from Egon Gladh, a UNDP foundry expert.

The laboratory tour marked the first of the many activities undertaken by the PFS. Officers of the PFS include President, Ernesto M. Patenia of Atlantic Gulf & Pacific Co. of Manila, Inc.; Vice-President, Antonio Abastillas of Marsteel; Corporate Secretary, Ernesto C. Ignacio of Warner Barnes Co., Ltd.; Treasurer, Servillano Lim of Master Steel Products, Inc.; Auditor, Abraham S. Averilla of Honiron (Philippines), Inc.

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metals NEWS

BOI Chairman Vicente Paterno inducting into office the officers of the Car Parts Productions Association, Inc.

CAPPA HOLDS INDUCTION, DEFINES OBJECTIVES

The Car Parts Producers Association, Inc. (CAPPA) had their induction of officers last September 29, 1972 at the Ball Room of the Hotel Intercontinental, Makati.

Board of Investments (BOI) Chairman Vicente T. Paterno, also the guest speaker, inducted them into office. The officers are Felisberto Veranc, Jr., President; Rolando A. Reyes, Vice-President; Francisco Lopez-Tan, Secretary; and Eduardo H. Torres, Treasurer. Rafael Fineza is the CAPPA Executive Secretary.

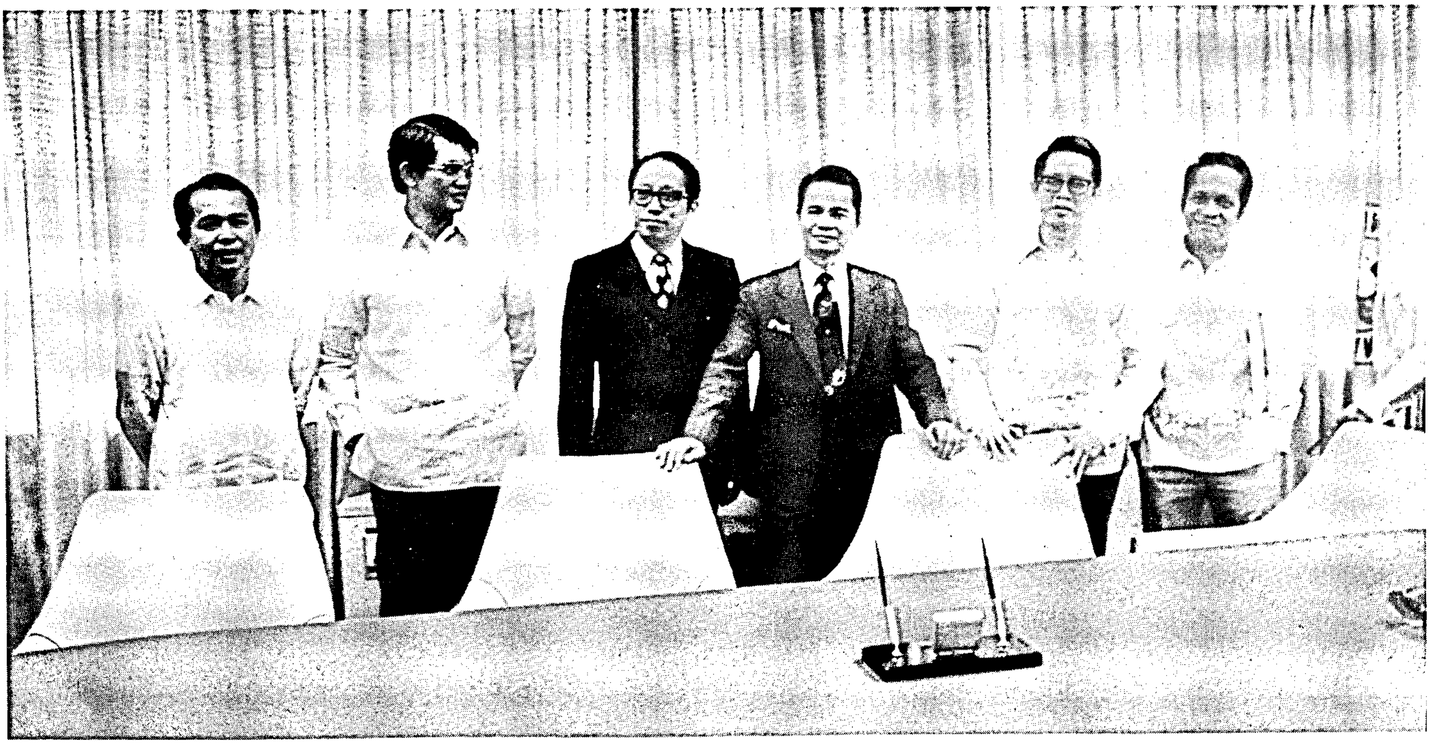
Jose Concepcion, Jr., Antonio Portillo, Jose Masangkay, Vicente Decipeda, Norberto Rafer and Gabriel Velisano are the members of the Board.

CAPPA, an organization representing the entire automotive parts industry aims to promote and assist the various agencies of the government involved in the Progressive Car Manufacturing Program and related projects. It also hopes to discourage the importation of automotive parts or components already being manufactured domestically in sufficient quantity, acceptable quality and at competitive prices. Lastly, CAPPA aims to upgrade the production and business standards of the automotive industry and resolve through united efforts, the problems of the industry.

EEI PROMOTIONS AND APPOINTMENTS

Jaime V. Ongpin, president, Engineering Equipment, Inc. announced recently the promotion of Francisco M. Vargas to the position of General Manager of the Construction Division.

He replaced Manuel P. Arriola who recently retired and who is now acting as Construction consultant for the company. Vargas holds a bachelor's degree in Mechanical Engineering from the University of Santo Tomas. He also is a graduate of the Philip-



Maria Cristina Chemical Industries, Inc., manufacturer of calcium carbide and ferroalloys, took a step towards integration by mining and producing its own semi-anthracite by operating the Butong Coal Mines in Zamboanga del Sur. Financed by the National Investment Development Corporation (NIDC), the project saves the country some $500,000 annually, the cost of petroleum coke otherwise to be imported. After signing the ₱1.785 million loan agreement, photo shows from left: Dominico M. Romero, MCCI Senior Accountant; Eduardo L. David, MCCI Finance Manager: Ricardo P. Guevara, MCCI President: Eusebio D. Villatuya, PNB President; Mario Y. Consing, NIDC Senior Vice-President and Mario M. Zaballero, NIDC Manager, Credit Implementation.

pine Military Academy and served as an officer of the Armed Forces of the Philippines prior to joining EEI.

In his present position, Mr. Vargas will be responsible for all the operations of the Construction Division of EEI.

Other promotions and appointments were also announced by Mr. Ongpin. Promoted were: Mr. Lorenzo S. Calderon, to Treasury Group Manager; Mr. David S. Son, to Treasury Manager; Mr. Eduardo F. Torroba, to Sales Manager for Petroleum Equipment, Machinery Division.

Appointed sales managers were: Mr. Porfirio S. Perfecto, to Industrial Safety and Materials Handling Depts., Machinery Division; Mr. Sergio D. Villanueva, to Construction Division; and Mr. Antonio G. Balibrea to Foundry Division.

MARCELO STEEL CORPORATION ENGINEERS TO CANADA

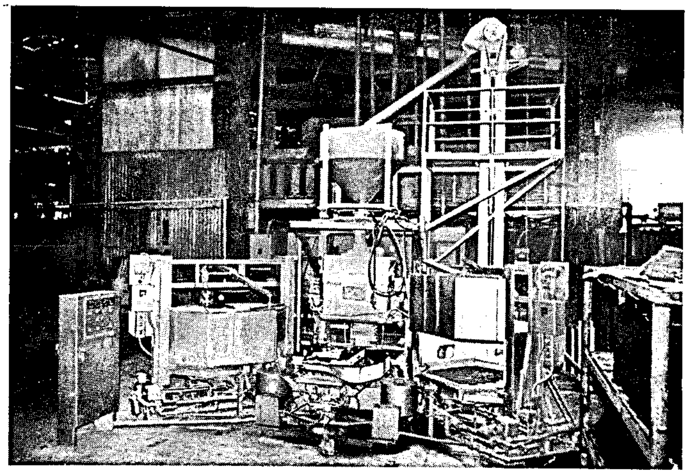
A delegation of engineers from Marcelo Steel Corporation (MSC) recently left for Canada in connection with a three-month study mission of certain techniques of operations of machinery being utilized by the Canadian Steel Mills which will be eventually used locally for the Marcelo Steel Mills.

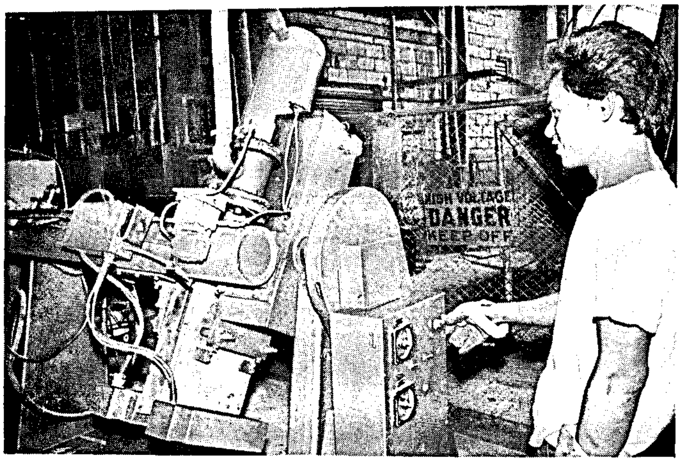
The project is a part of MSC's development program which includes rearrangement and renovation of plant facilities and buildings and personnel development program organization.

Just recently, a mechanical engineer from MSC's rolling mill division has completed training on merchant bar mill operations, roll-pass design for merchant bars and steel plant engineering. The training scheme which was sponsored by the South East Asia Iron and Steel Institute at Kaohsiung, Taiwan lasted for three months .

PACIFIC OXYGEN WELDING INSTITUTE SPONSORS WELDING SEMINARS

The Pacific Oxygen and Acetylene Co. (POACO) Welding Institute is offering training courses in weld-





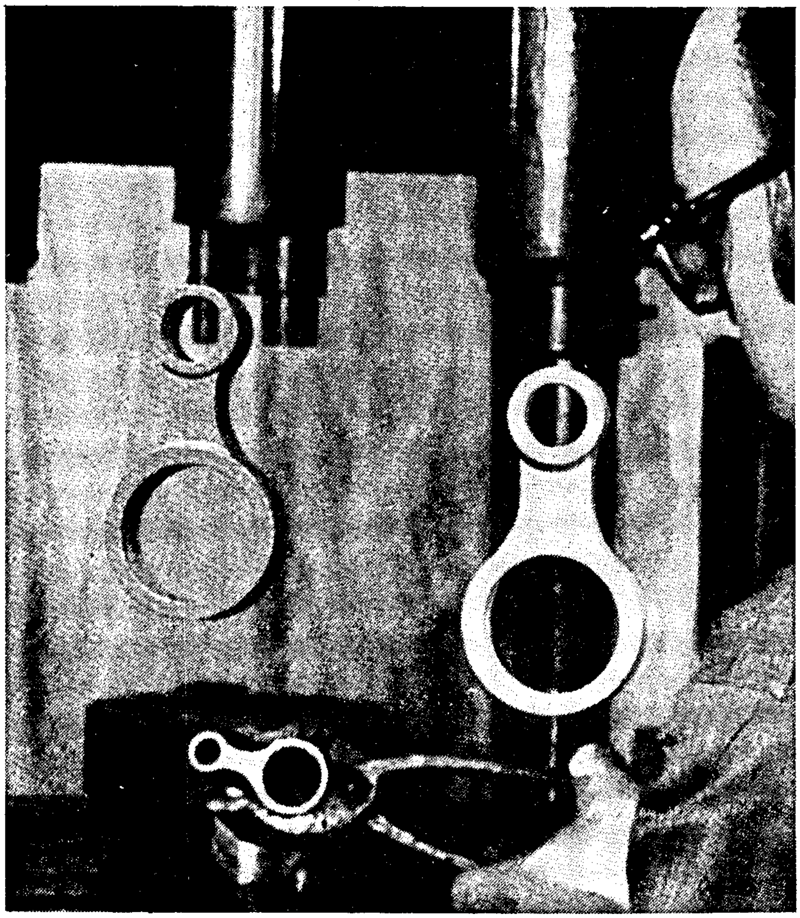
The EEI Foundry Division recently increased its capability to produce castings of high quality by acquiring new shell molding equipment. These are: a shell molding machine, a shell core blower machine (shown above) and a shell bonding machine. (shown below).

ing to meet the need for well trained welders for rapidly developing industries. The objectives of the course are to equip the participants with the basic principles, methods and practices of modern welding, to enable the experienced welder to increase his knowledge and to train the participants in assimilating correct welding and cutting techniques.

The course, which started last November 11, 1972, is open to all high school graduates and experienced welders. Training courses are being conducted in cooperation with Welding Industries of the Philippines and Union Carbide Philippines, Inc. Training comes in the form of lectures, practical laboratory works, film showing and field trips.

POACO products include gas and liquid oxygen, gas and liquid nitrogen, CO_2 fire extinguishers, and welding and cutting equipment.

Foreign news



One stroke of the press and a sintered aluminum powder metallurgy preform (left) becomes a high strength precision aluminum P/M part (right).

ALUMINUM P/M FORGING PROCESS YIELDS PARTS WITH IMPROVED STRENGTH

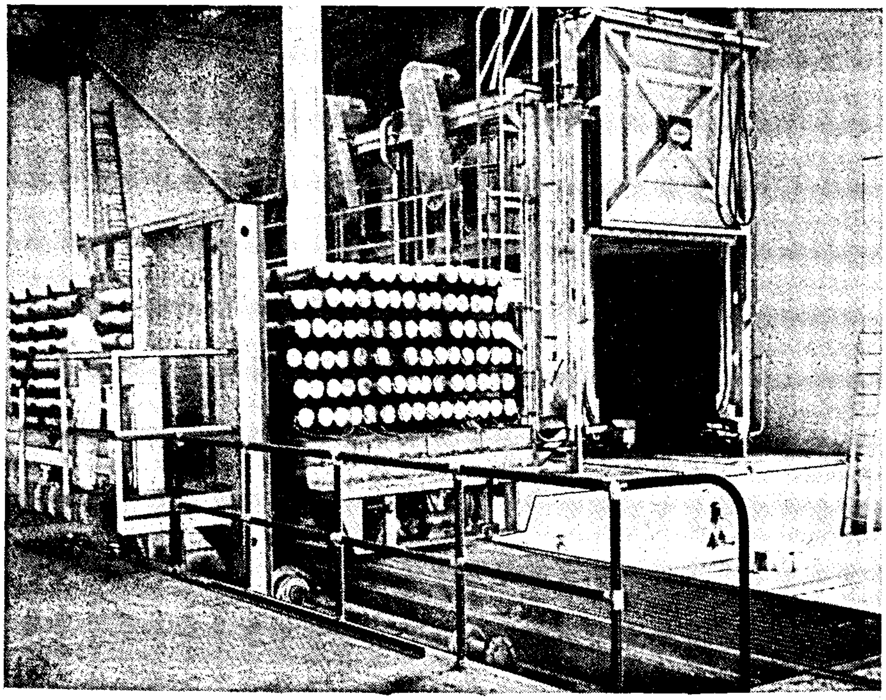
Two significant advances in aluminum powder metallurgy technology were recently revealed in a technical paper prepared for the ASM Conference by Alcoa research engineers K. E. Buchovecky and M. R. Rearick.

Aluminum P/M forging technology makes it possible to combine powder metallurgy precision and economy in forged parts having fatigue limits of 17,500 psi and strengths in the 66,000 psi range. The process involves three steps. First, the powder is compacted into preform shape. Next, it is sintered in a controlled atmosphere, which metallurgically bonds the powder particles. Then the aluminum part is hot-forged to final shape in one step in a confined die.

REFRACTORY PRICES UPPED

Higher prices on a number of major refractory products including fire clay brick and fireclay, have been put into effect by Harbison-Walker Refractories Co., USA, the leading producer.

This company's new prices on highly duty fireclay brick and shapes have been raised $13 per 1,000 bricks (nine inch equivalent) for the high duty grade and $15 a thousand for the super duty grade. Further, the price of ground fireclay, in bulk, has been raised $2 a net ton. Increase on silica brick are $14 for 1,000 and on silica fireclay in bulk, $4 a ton.



Homogenizing of aluminum logs is accomplished in a rapid cycle through effective design of the air recirculation system of this car-bottom furnace.

RAPID HOMOGENIZING OF ALUMINUM IN CROSSFLOW CAR TYPE FURNACE

Sunbeam Equipment Corporation of USA has designed, built and installed a unique furnace system for the manufacture of aluminum ladders and other extruded products where homogenizing is done in a new reversing cross flow car bottom type aluminum furnace.

Unique in the system design are completely automatic two-point temperature control, fans and baffle. Side mounted recirculating fans and the baffle arrangement improve the air recirculation to shorten the overall heat treat cycle time. The cycle is based on running the air stream temperature at 1125°F; the log temperature not to exceed 1100°F.

The system is presently used by the plant of R. D. Werner of Greenville, Pa., USA.

FERRODYNE FORMED TO PRODUCE FERROUS DIE CASTINGS

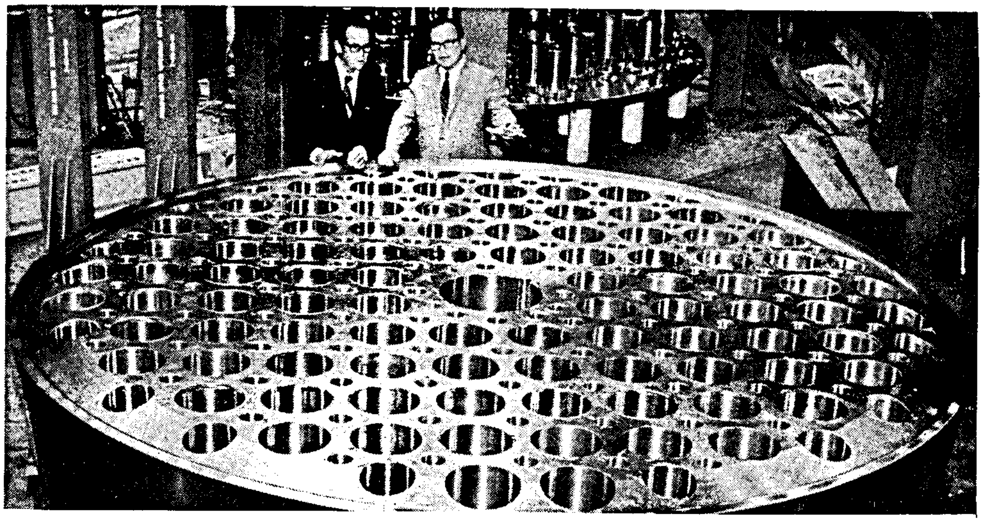
Ferrodyne Corporation, of Cleveland, USA has been organized recently to make ferrous die castings for industry as an outgrowth of research and development activities of General Electric Co. which will hold a substantial interest. Initially, Ferrodyne will start operations with a number of die casting machines, with capacities ranging up to 400 tons. Other equipment include four induction melting furnaces and trimming and finishing equipment.

Ferrous die casting applications are expected to be in builders hardware and in marine and chemical hardware.

GE CREATES MINING PRODUCT SECTION

The establishment of a mining product section and realignment of United Kingdom sales has been announced by General Electric Co.

The new mining product section will have responsibility for mining tool sales, mining tool engineering, mining metal sales and market development and customer service. Mining tools and mining metals are marketed by the department under the brand name "Carboloy".



The largest nudear forging, made by US Steel from a 95-inch type 304 stainless steel ingot weighing 294,000 pounds and machine-finished for a nuclear power plant reactor lower core support at Westinghouse Electric Pensacola division plant.

LARGEST NUCLEAR FORGING

From a 95-inch Type 304 stainless steel ingot weighing 294,000 pounds, the largest ever poured, was made by U.S. Steel to a nuclear forging machine-finishing for a power plant nuclear reactor lower core support at Westinghouse Electric's Pensacola division plant. The forging weighed 110,000 pounds, was 152¼ inches in diameter and 20¼ inches thick when completed.

SPRAY SYSTEM FOR COATING IS MARKETED

A new heavy duty flame spray system that reportedly brings greater process control to applying wear resistant metal coatings is being marketed by Metco, Inc. of New York, USA.

Major components of the new Metco type 6PT Thermospray System are a spray gun powder feeder and air jets.

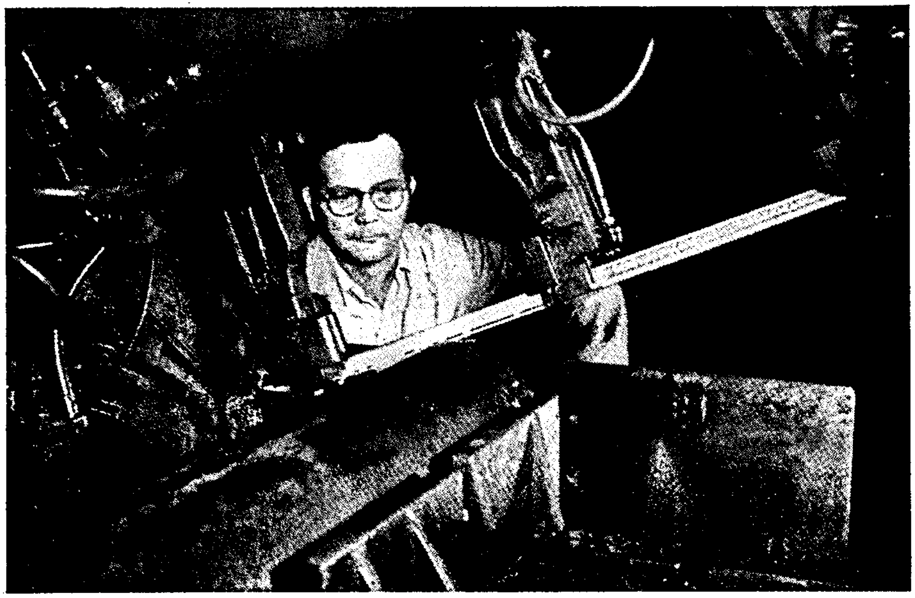
The gun is modular in construction so that it can be automatically or manually operated. The powder feeder has fingertip veneer-type controls that can be preset to give the precise powder flow needed to produce the desired type and quality of coating.

Type 6P system is currently available in three models. Type 6P is machine mounted and manually-operated, type 6P-H is hand-held and manually-operated. Type 6P-A is machine-mounted and automatic.

METAL INSERTS TO PREVENT TUBE EROSION

A new Metal Insert Corporation, has been formed in Clinton, Connecticut to produce aluminum brass, aluminum bronze, cupronickel and stainless steel inserts designed to prevent erosion in condenser and heater tubes.

The metal inserts, measuring about 7 inches in length and 3/4 inch in diameter are expanded into each condenser tube. They are said to prevent erosion caused by a phenomenon called Vena Contracta.



Effectiveness of welds on the high speed band saw blade is being checked after production by new welding and annealing method.

NEW TECHNIQUE REDUCES BREAKAGE ON HIGH SPEED STEEL BAND SAW BLADES

"Di-Arc", a new method of welding and annealing high speed steel band saw blades has been developed and now used by the Disston Division, H.K. Porter Co., Inc. to reduce the frequency of breakage at welds on endless bands.

Types of materials cut with the blades include metals such as ferrous and nonferrous titanium, and all grades of stainless.

The blades are produced in regular and lancer tooth patterns in one-inch widths, welded to lengths as specified and individually packaged in protective containers ready for shipment.

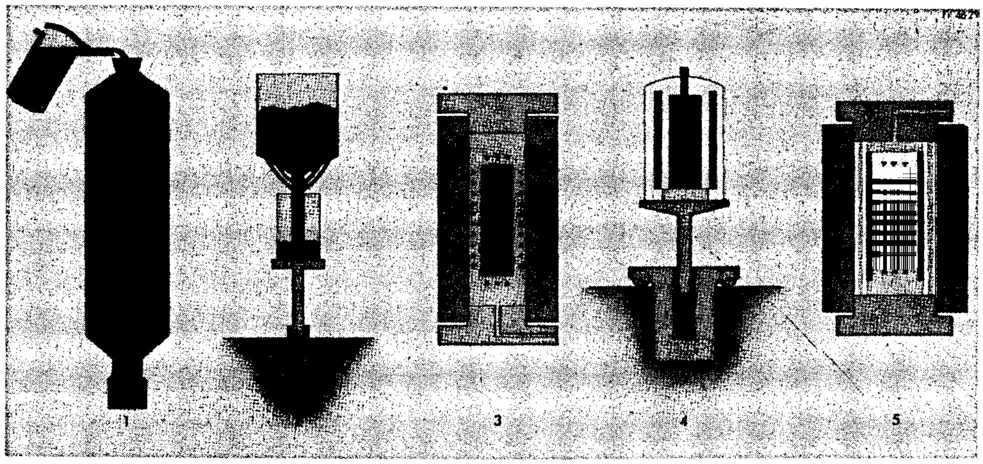
KAWASAKI TO START OPERATING SECOND TINPLATE MILL

Kawasaki Steel Corporation of Japan will soon be operating its second tinplate mill with a monthly capacity of 15,000 tons at the Chiba Works.

At present, Kawasaki Steel is operating its No. 1 tinplate mill with a monthly output of 10,000 tons.

BRITISH STEEL CORPORATION COMPLETES TRIALS

British Steel Corporation (BSC) has successfully completed a second series of blast furnace trials at East Moors Works (General Steel Division) on formed coke produced by the USA's Food Machinery Corporation (FMC) at its Kemmerer Works. The furnace operated smoothly and at good output during the trials, which used 3,000 tons of material. The trials, together with those conducted earlier this year on briquettes produced by West Germany's Bergbau Forchung, form part of BSC's programme to reduce its dependence on coking coal.



Schematic diagram showing the different steps in the ASEA-STORA Process:
1. Atomisation to powder
2. Encapulation
3. Cold isostatic compaction
4. Preheating and evacuation
5. Hot isostatic compaction

THE ASEA-STORA PROCESS FOR THE PRODUCTION OF HIGH-ALLOY STEELS

A new process of making large billets without segregations or separations of the alloy elements have been jointly developed by two Swedish companies, ASEA and Stora Kopparbergs Bergslags AB. Steel produced using the ASEA-STORA process have a uniform distribution of fine carbide grains, which leads to an increased life of tools manufactured from the new steel. In addition, hot working is simplified and the grindability improved.

U.S. STEEL GETS NEW SYSTEM FOR HARDENING RAIL HEADS

An automatic, semi-continuous system for hardening the heads of steel mills, using electrical induction heating, has been installed in two major rail mills of United States Steel Corporation.

This new patented system, said to produce more wear resistant rail, is the result of a research program started by the company about 10 years ago.

In addition to longer life, it is said to minimize the need to straighten heat-treated rail and to provide accurate and consistent heating control.

About 90 percent of the rails made in the US are not heat-treated for extra hardness and extended life. Most commonly, rails are merely hot rolled from 2,350°F and "control cooled". Such rails have a hardness of about 250 to 260 Brinell.

STEEL PIPE OUTPUT CAPACITY TO UP 82% BY 1975

The five major steel pipe producers–Nippon Steel Corporation, Nippon Kokan K.K., Kawasaki Steel Corporation, Sumitomo Metal Industries, Ltd. and Kobe Steel, Ltd., have begun preparations for raising production capacity up to a total of 12,674,000 tons per year by 1975, an increase of 82% compared to 6,962,000 tons at the end of 1971.

The expansion programs of steel pipe producers are based on their demand estimates of the products in the future and will be centered around the large and medium size pipes.

IRON SPONGE MILL at Hitachi Metals' Yasugi Works.

HITACHI IRON SPONGE MILL OPENS

Hitachi Metals, Japans' leading specialty steel firm, unveiled its long secret sponge iron mill which has been successfully operative on the basis of Swedish and Hitachi Metals' own patents at Yasugi, some 350 miles west of Tokyo for about ten years behind closed doors.

Hitachi's Yasugi Works originated in 1899 for the initial purpose of preserving the district's tradition in cutlery steel. Cutlery steels share in Yasugi Works dwindled year after year to 20 to 30 percent. Sixty to 70 percent of Yasugi's products today are high speed and other high grade tool steels and about 10 percent superalloys.

Hitachi Metals Yasugi Works today operate at about 80 percent of its monthly capacity rated at 7,000 metric tons. Sponge iron is normally blended with iron yielded by eight small electric furnaces plus other elements.

Q-BOP: THE SCRAP-HUNGRY NEW STEELMAKING PROCESS

Q-BOP is a modern version of the old Bessemer converter, which gave way to the open hearth steel producing furnace, in turn replaced largely by today's swift BOFs (basic oxygen furnaces). The Bessemer had air blown-in from its bottom. It is said to be faster, better and more economical than present BOFs.

Unlike conventional BOFs however, new Q-BOP units are described as scrap-hungry. They are far from the scrap-gobbling open hearths and electric furnaces. Nevertheless they consume more recycled material than regular BOFs, perhaps 20 per cent more per ton of steel produced.

NEW HOT-TOPPING SYSTEM FACILITATES PRODUCTION AND INCREASES INGOT YIELD

Foseco, Inc. of Cleveland, Ohio has developed a new type of steel ingot hot-topping system that promotes more consistent metallurgical structure while increasing ingot yield by minimizing "pipe". The systems utilizes four fibrous ceramic liner boards and a high-refractory gasket ring which is soft enough to form a gasket under pressure, flexible enough to eliminate breakage and refractory enough to withstand the high temperatures of steel making.

"Basta alam kong ang aking Ford "D" Series trucks ay magaling sa akyatan, magaling sa hakutan, 'di na magastos sa gas, 'di pa magastos sa piyesa. Wala na akong mahihiling pa. We use Ford on all roads in Luzon and under all conditions. Para sa akin, talagang everything is alright with Ford."

Mr. MAX MADRIDEJOS
President
Arrow Forwarding Corporation

Mr. MAX MADRIDEJOS

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- **MONTECARS** Bacolod City
- **NSB CORPORATION** Roxas City

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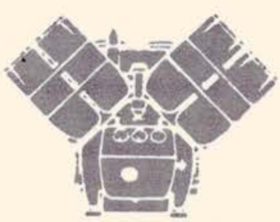

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