Iron and Steel

By F. E. Brantley [1]

The year started with cautious optimism in the domestic steel industry and raw steel [2] production continued to exceed that for 1970 during the first few months. By July it was evident that production had been buoyed up by stockpile buying against a possible strike on expiration of the labor contract July 31. Agreement was reached August 1 on a new 3-year pact, leaving stocks to be worked off. This, combined with record imports of 18.9 million short tons, resulted in diminishing orders for mill products, from which the market did not fully recover by yearend. Domestic raw steel production totaled 120.4 million tons, down 8.4 percent from that of 1970. However, apparent consumption of steel products, adjusted for imports and exports, was up 5.6 percent.

A general steel recession in the free world was evident as total world production decreased approximately 2 percent from that of 1970. Hardest hit of major producers was the United Kingdom, down 14.6 percent, followed by West Germany with a reduction of 10.5 percent, and Japan with 5.1 percent. The U.S.S.R. increased its production by 4.4 percent, and for the first time exceeded U.S. production, by a margin of 10.7 percent.

Prices continued to advance in most countries, as pollution control and currency adjustments became increasingly important factors to be dealt with. Capital spending by U.S. steelmakers was slightly over $1.6 billion for 1971. Environmental quality control facilities added in 1971 totaled $162 million, or approximately 10 percent of capital investments.

One merger of importance occurred as National Steel Corp. acquired Granite City Steel Co., effective August 16. Increasing interest was shown by a number of steel companies in the housing market, either through subsidiaries or company divisions.

[1] Physical scientist, Division of Ferrous Metals.
[2] The term raw steel, as used by the American Iron and Steel Institute, includes ingots, steel castings, and continuously cast steel. It corresponds to the term crude steel as used by the United Nations.

Table 1.—Salient iron and steel statistics

(Thousand short tons)

	1967	1968	1969	1970	1971
United States:					
Pig iron:					
Production	86,799	88,767	95,003	91 293	81,382
Shipments	86,819	89,085	95,472	91,[illegible]72	81,332
Exports	7	9	44	310	34
Imports for consumption	605	786	405	249	306
Steel: [1]					
Production of raw steel:					
Carbon	113,190	116,269	124,832	117,411	107,007
Stainless	1,451	1,432	1,569	1,279	1,263
All other alloy	12,572	13,761	14,861	12,824	12,173
Total	127,213	131,462	141,262	131,514	120,443
Index (1967 = 100)	100.0	103.1	111.0	103.4	94.7
Total shipments of steel mill products	83,897	91,856	93,877	90,798	87,038
Exports of major iron and steel products	2,100	2,673	5,788	7,657	3,528
Imports of major iron and steel products [2]	11,831	18,335	14,530	13,882	18,814
World production:					
Pig iron	385,707	418,108	453,126	471,006	474,347
Raw steel (ingots and castings)	544,000	584,000	632,561	655,380	641,673

[1] American Iron and Steel Institute. Includes ingots, continuous cast steel, and all other cast forms.
[2] Data not comparable for all years.

PRODUCTION AND SHIPMENTS OF PIG IRON

Domestic production of pig iron totaled 81.4 million tons in 1971, a decrease of 9.9 million tons, or 10.9 percent less than that produced in 1970. Average production of pig iron per blast-furnace-day increased to 1,654.3 tons, compared with 1,641.6 tons in 1970, and 1,609.0 tons in 1969, according to the American Iron and Steel Institute (AISI). A total of 152 blast furnaces were in blast at the beginning of the year, including two producing ferroalloys. At yearend the total number in blast had decreased to 126, with three producing ferroalloys. There were 219 producing furnaces at the beginning of the year, and 216 at yearend, of which eight were being relined.

Shipments of pig iron approximated total production for 1971. Yearend stocks at consumer and supplier plants were down 303,000 tons, 14.6 percent under those of 1970.

Metalliferous Materials Consumed in Blast Furnaces.—For each ton of pig iron produced in 1971, an average of 1.632 tons of metalliferous materials was consumed in the blast furnaces. Total net iron ore consumed in blast furnaces including agglomerates, was 125 million short tons. The total tonnage of iron ore including manganiferous ore, consumed by agglomerating plants at or near the blast furnaces in producing 37.8 million tons of agglomerates was 29.7 million tons. The remainder consisted of mill scale, coke, limestone, dolomite, and small amounts of other materials. Domestic pellets charged to the blast furnaces totaled 52.9 million tons, and sinter charged was 39.2 million tons. Pellets and other agglomerates from foreign sources added an additional 10.5 million tons.

Blast furnace oxygen consumption totaled 13.3 billion cubic feet according to the AISI, compared with 13.5 billion in 1970, and 9.1 billion cubic feet in 1969.

Data reported to the Bureau of Mines by the iron and steel industry showed that blast furnaces, through tuyere injection, consumed 22.6 billion cubic feet of natural gas, 8.1 billion cubic feet of coke oven gas, 110.8 million gallons of oil, and 39.2 million gallons of tar, pitch, and miscellaneous fuel in 1971.

PRODUCTION AND SHIPMENTS OF STEEL

Domestic production of raw steel for the first 6 months, 71.8 million tons, exceeded that for the same period in 1970 by 5.7 percent, with a monthly high of 12.9 million tons being poured in May. A sharp decline began in the second half which reached a low monthly output of 5.8 million tons in August. Production then trended upward for the remainder of the year but not enough to keep the total annual production, 120.4 million tons, from being the lowest since 1963.

The 1971 steel index, based on production in 1967 as 100, was 94.7, compared with 103.4 for 1970, and 111.0 for 1969. Production in 1971 was proportioned between the basic oxygen process (BOP), 53.1 percent, the open-hearth furnace, 29.5 percent, and the electric furnace, 17.4 percent. Domestic BOP production, which exceeded the 50 percent mark for the first time in the last half of 1970, gradually increased its lead during 1971 as more open-hearth furnaces were taken out of service.

Shipments of steel products for the year declined by 4.1 percent, from 90.8 million tons in 1970 to 87.0 million tons in 1971. First-half shipments were up 9.8 percent from the like period in 1970, indicating the degree of hedge buying in anticipation of the steel strike threatened for August. Continued high imports and the general steel recession throughout the free world contributed to lowered domestic steel output during the second half of the year.

On a percentage basis, domestic shipments followed essentially the same grade pattern as for 1970, the only significant change being a 2-percent rise in sheet and strip shipments. Recovery of the automotive industry was indicated with 20.1 percent of net shipments made directly to this market, compared with 15.9 percent in 1970 and 19.5 percent in 1969.

Materials Use in Steelmaking.—Metallics charged to domestic steel furnaces in 1971 per ton of steel produced averaged 1,269 pounds of pig iron, 1,051 pounds of scrap, and 35 pounds of iron ore including agglomerates. In 1970 comparable amounts were 1,244 pounds of pig iron, 1,011 pounds of scrap, and 51 pounds of iron ore.

According to the AISI, steelmaking furnaces consumed 543,300 tons of fluorspar, 2.1 million tons of limestone, 5.9 million tons of lime, and 817,000 tons of other fluxes. Oxygen consumption by the iron and steel industry amounted to the equivalent of 166.7 billion cubic feet, compared with a revised total of 177.6 billion in 1970.

CONSUMPTION OF PIG IRON

Pig iron consumed in steelmaking totaled 76.42 million tons. Basic oxygen converters consumed 51.80 million tons; open hearths, 24.00 million tons; and electric furnaces, 0.60 million ton. An additional 2.13 million tons was consumed by iron foundries and miscellaneous users, primarily for charging cupola furnaces. Also, 4.99 million tons in the form of molten metal was used in making ingot molds and direct castings.

PRICES

Prices throughout the steel industry trended upward during the year, except for a 90-day freeze period. Iron and steel were included in the President's general executive order to stabilize prices, rents, wages, and salaries from mid-August to mid-November.

In January, increases of up to 12.5 percent on some construction steel products were announced by the two leading domestic steelmakers. These were later revised downward by about 25 percent and the lower increases were followed by most steelmakers. Additional increases were posted in March on certain semifinished steels, wire, pipe, and bar mill products; the increases were to become effective at announced future dates. The pattern of increasing prices according to type of product appeared to be established and was followed by most of the major producers.

In April, the board chairman of Jones & Laughlin Steel Corp. reported that steel price increases of $21 per ton over the preceding 2-year period failed to cover the added increases in the cost of producing steel by $10. In May, blast furnace operators boosted the price of merchant pig iron by $5 per long ton or the equivalent of $4.46 per short ton. Major stainless steel producers announced base price increases averaging approximately 6.5 percent during the month. These increases were offset somewhat by widespread discounting practices. Boosts on sheet and strip products, averaging slightly over 6 percent, were quoted by the larger mills to become effective by July 1. Increases on selected items continued into August, with prices moving upward on a large number of products. A major producer announced price raises averaging 8 percent on most mill products to go into effect in August, October, or December, depending on the type of product. Some stainless steel producers cut price discounts which had been in effect, and prices of specialty steels were increased by others.

In mid-August, the President issued a 90-day wage-price freeze order which was to terminate November 12. Except for exports, which were not included, iron and steel prices remained fixed for this period. Actual prices charged during the period of July 16, 1971, to August 14, 1971, could be used if a price reduction resulted and the seller wished. A Federal Price Commission set up to control wages and prices after the freeze order expired granted both general price increases, as well as increases on a number of mill products. These raises were based on individual company decisions and specific cases, and continued to be granted throughout the remainder of the year.

In December, one stainless steel producer rolled back strip, sheet and plate base prices that were in effect as of May 25, 1970, as allowed by the Presidential freeze order. At the same time, discounts previously granted distributors were cut, with the idea of creating a more stable pricing level. Iron Age's composite price for No. 304 stainless sheet in December was 4 cents per pound over that for January.

The composite price of pig iron, according to Iron Age, increased from $65.71 per short ton at the beginning of the year to

$70.18 at yearend, and the composite price of finished steel went from $156.76 per ton for January to $175.54 for December. Comparable January and December prices, at Pittsburgh, for hot-rolled sheets were $150 and $159 per ton, and for cold-rolled sheets $179 and $191 per ton.

Other principal free-world producers had boosted or indicated intentions to raise prices of iron and steel by mid-year, owing to inflation and general increases in costs. The nationalized steel industry of the United Kingdom was restricted by Government order to about one-half its requested price increase, and finished the year with a deficit.

World currency realignments near the close of 1971 resulted in mixed pricing effect, with shifts in the competitive pattern of various countries. Major steel producers in Japan announced increases on exports to the United States of from $10 to $16 per ton on all contracts signed from September 1971; deliveries were to start in 1972.

FOREIGN TRADE

The 3-year voluntary steel import quota agreements with steelmakers of Japan and the European Economic Community (EEC) countries expired at the end of 1971. Negotiations between U.S. officials and spokesmen for these countries resulted in renewal of the voluntary pacts for an additional 3-year period. A major change was a reduction in the annual rate of growth of steel mill product exports from 5 percent to 2.5 percent; also the addition of the United Kingdom to the pact. Interest among domestic steelmakers for import quota legislation remained high in 1971 and, prior to the voluntary agreements, bills were introduced in the House and Senate to set limits.

Data compiled by AISI showed that exports of total steel products decreased to 3.2 million tons in 1971, from 7.5 million in 1970, and 5.6 million in 1969. Imports of total steel products reached a record high of 18.9 million tons, compared with 13.4 million in 1970, and 14.0 million in 1969. A major increase in imports over 1970 of 2.5 million tons of sheet and strip mill products occurred, which was thought to be due largely to increased overseas orders placed by the automobile industry in anticipation of a possible steel strike.

Exports of iron products totaled 304,300 tons in 1971, 527,500 in 1970, and 236,900 in 1969. Imports of iron products, largely pig iron, totaled 304,300 tons in 1971, 327,400 in 1970, and 495,000 in 1969.

Increasing movement of Japanese steel into the West European marketplace was slowed by a 3-year voluntary agreement with the Japan Iron and Steel Federation. Under a quota system, 1972 exports would be 1.25 million metric tons to the Common Market countries, including Great Britain.

WORLD REVIEW

The International Iron and Steel Institute (IISI) held its fifth annual meeting in Toronto, Canada, in October. Strengthening the steel industries of the member countries remained a primary objective. Finding practical solutions to the environmental problems and energy needs of the industry were subjects of discussion among the steelmakers. Delegates from 24 free world countries attended, representing about 100 steel companies.

The 11th Latin American Iron and Steel Congress was held in Mexico City in October also, by the Instituto Latino Americano del Fierro y el Acero (ILAFA). Planned increases in raw steel production discussed by one speaker, would make 1977 production almost twice that of 1970.[3] Every member country was expected to add at least 50 percent to its steelmaking capacity. Mexico's new Las Truchas steel complex plans, and the future of direct reduction in Latin America were subjects of considerable interest at the meeting.

Argentina.—The expansion program by Sociedad Mixta Siderúrgia Argentina (SOMISA) at its San Nicolas steel plant continued. Approximately $300 million was authorized in 1968 to raise the Govern-

[3] Journal of Metals. ILAFA—Steelmakers Look at a Bright Future. V. 23, No. 12, December 1971, pp. 16–17.

ment-owned plant's steel capacity to approximately 2.8 million tons per year. Completion has been scheduled by the end of 1972. The plant installations are to be such that future expansions will be possible to 4 million tons with minimum modifications.

Also underway was the Propulsora Siderúrgia project of installing 1.7 million tons of raw steel capacity, with projected plans for 2.8 million tons annually by 1975–76.

Argentina's pig iron and steel production in 1971 showed an increase of 8 and 5 percent over that for 1970. In 1969–70 the domestic steel industry was able to supply only about 55 percent of the country's needs. Plans for 6.6 million tons of capacity by 1975–76 will theoretically balance domestic demand.

Australia.—The Premier of Western Australia announced in April that a preliminary study on the feasibility of developing a large-scale steelworks at Kwinana, had been completed by Broken Hill Proprietary Co. Ltd. (BHP) for the company and other members of the Mount Newman Joint Venture, an iron ore project. The other members of the joint venture were American Metal Climax, Inc., and The Colonial Sugar Refining Co. Ltd. Proposed was a plant for making semifinished steel largely for export. Production should reach 4 million tons after initial output begins in 1975–76, and future expansion to 11 million tons will be considered as warranted. The port facilities in Cockburn Sound would be utilized and improved to handle vessels of up to 150,000 tons.

Two other groups, the Hanwright group and Jervis Bay consortium, were also competing for ore reserves as a basis for steelworks on Jervis Bay. The Jervis Bay consortium (Armco-Kaiser-Thyssen) has been engaged in feasibility studies for some time concerning a similar proposed development. The Hanwright group apparently holds the key to important iron ore rights.

BHP continued its expansion program at Port Kembla, and planned expenditures through its subsidiary, Australian Iron and Steel Pty. Ltd., will amount to over $300 million for the 4-year period through 1973. Production of steel would be boosted to 8.0 million tons per year.

Brazil.—In January President Medici announced a $3 billion plan to quadruple Brazil's steel output and reach 22 million tons annually by 1980. During the year, the three Government-controlled steel companies, Cia. Siderúrgica Nacional (CSN), Usina Siderúrgica de Minas Gerais (USIMINAS), and Cia. Siderúrgica Paulista (COSIPA), received approvals from the National Council for the Steel Industry (CONSIDER) for planned expansions involving approximately $1 billion in investments. International tenders for prequalification of suppliers of steel mill equipment to provide for an additional 3 million tons capacity were requested; procurement was to start in 1971 and installation is to be completed in 1975. Included in the installations would be three blast furnaces. Estimated cost would be $480 million for equipment and $615 million for other items, including interest and working capital.

Additional projects included a steel mill at Santa Cruz scheduled by Cia. Siderúrgica da Guanabara (COSIGUA) to begin production in 1972 at a rate of 275,000 tons per year and reach 2-million-ton capacity by 1980 and two plants based on direct reduction, one based on the HyL process, the other on the SL/RN process.

Two blast furnaces were expected to be imported from Japan, one for USIMINAS and the other for CSN. IHI would supply the former, to be completed by 1974, with a 2,700-cubic-meter capacity and a cost of approximately $13 million. The other would be supplied by Nippon Steel Corp. To be completed in 1975, it would have a 3,200-cubic-meter capacity and cost approximately $16 million.

Canada.—Raw steel production in Canada for 1971 was only 1.7 percent below the alltime high of 12,346,000 tons in 1970, and 1972 was expected to be another record year. Expenditures made or firmly committed in 1971 by the iron and steel industry, including foundries and pipe and tube mills, totaled about $500 million.[4]

The Algoma Steel Corp. Ltd. continued construction on its new basic oxygen shop and a new blast furnace. The basic oxygen plant, with two 250-ton converters, was to be in operation in 1973 and the blast furnace, in 1974. A new $75 million, 160-inch plate mill started production during the year.

The Steel Co. of Canada, Ltd. (STELCO) completed construction of

[4] Department of Energy, Mines and Resources. Canadian Mineral Industry in 1971—Preliminary. Miner. Bull. 122, Ottawa, Canada, 1972, p. 93.

three basic oxygen converters at its Hilton works, which were expected to begin producing early in 1972. Additional expenditures were made to increase finished products capacity, including a new electrolytic tinning line.

The new blast furnace and coking ovens of Dominion Foundries and Steel, Ltd. (DOFASCO) started up in 1971, and improvements were made in the basic oxygen shop. The Sydney Steel Corp. continued its modernization program, which is expected to cost about $100 million. The Government steel company, Sidérurgie du Québec (SIDBEC) continued its expansion and modernization program, including a new steel-producing plant at Contrecoeur. A metallized pellet facility was being built by Midland-Ross Corp. to supply feed for two new 100-ton electric furnaces scheduled to start up at the end of 1972.

The British Steel Corp., through its subsidiary Stanton Pipes Ltd. entered the Canadian mini-mill steel production by partial ownership of Burlington Steel Co. The works at Hamilton, Ontario, are equipped with three electric furnaces and two continuous-casting units.

Finland.—Rautaruuki Oy, a Government-controlled steel plant, planned additional expansion to double its capacity during the present decade. This was to follow completion of the new cold-rolling and galvanizing mill at Hämeenlinna. Expansion of hot-rolling facilities at Raahe was completed, and the facilities were expected to be used to process the output of a proposed stainless steel shop to be constructed by Outokumpu Oy, also a Government-controlled company.

The new Koverhar steelworks, controlled by the Ovako group, began operations and was expected to have an output of 385,000 tons annually, with about one-third to be exported to Sweden in the form of billets.

France.—Construction of initial sections of the Fos-sur-Mer steel complex continued during the year. An agreement was reached between the Government and Sollac (Wendel-Sidélor) on costs. These were estimated at approximately $1 billion for the period to 1975. A subsidiary of Sollac, Société Lorraine et Meridional de Laminage Continu (SOLMER), would be responsible for the complex. An additional expenditure of about $350 million would be made for the period from 1975 to 1980. Steel capacity was set at 3.9 million tons per year by 1974, and an additional 4 million tons is tentatively set for 1980.

A high-grade steel alloy complex near Fos was planned for by Péchiney Ugine-Kuhlmann. (Ugine-Kuhlmann's merger with Péchiney became official in 1971.) The stainless steel capacity is to be 440,000 tons per year; production is scheduled to start in 1973. Facilities for an additional 200,000 tons of special low-alloy steel will be installed and include a 100-ton ultra-high-power furnace. Investments for these two facilities will exceed $200 million.

Fos will typify the modern coastal steel complex. The Mediterranean port receives 250,000-ton tankers and by the late 1970's will be developed with a minimum of dredging to take ships of over 500,000 deadweight tons.

At Dunkirk, the other large French coastal steelworks, Usinor, awarded an order to a member of the Schneider Group, Société Industrielle Delattre-Levivier, to build a fourth blast furnace. This would have a hearth diameter of 45.93 feet (14 meters), and a daily capacity of 9,000 to 10,000 tons. Three 200-ton oxygen converters also will be installed as a part of the expansion program to bring steel capacity at Dunkirk to approximately 9 million tons by 1975.

The shift in location of and technology in French steelmaking was evident in an October announcement made in Lorraine by the Wendel-Sidélor complex which would eliminate 10,650 jobs by 1975. A large percentage would be made up at the Fos complex. In the 5-year period to 1971, French steel companies fell from 82 to 66, and works in operation from 118 to 99. This was due largely to mergers and elimination of smaller facilities.

Germany, Federal Republic of.—Steel production declined about 10 percent from that of 1970, resulting in the lowest output since 1967. The country was unchallenged, however, for its position as the world's fourth largest steel producer. Raw steel capacity utilization was rated at 70 percent, reflecting in part added capacity of about 5 million tons in 1971.

Capital investment in the industry had been planned for an estimated $690 million during the year, and the reduced steel demand was not expected to hamper further expansion plans and increased exports for the remainder of the 1970's.

Plans for a merger between the country's second largest producer, Hoesch A. G., and Hoogovens of the Netherlands were reported nearing completion. The new combine was to increase production by expansion of the Hoogovens plant at Ijmiden, or by building a new plant at Rotterdam.

Fried. Krupp Hüttenwerke A. G. approved a $125 million investment program calling for a 5,000-ton-per-day blast furnace and a 300-ton steel converter at Rheinhausen. The company's first continuous slab casting facility was completed at this location. Rated at approximately 1 million tons per year, it would supply the Bochum plant.

Mannesmann A.G.'s program included construction of a high-capacity pressurized blast furnace with a hearth diameter of 34 feet at its Duisburg-Huckingen works.

August Thyssen-Hütte A.G. completed a 300-ton steel converter at its Duisburg-Hamborn plant and had a 46-foot-hearth-diameter, 3-million-ton-per-year-capacity blast furnace under construction.

The mini-steelworks at Hamburg-Finkenwerder was near operating stage. Included was a direct-reduction facility using the Midrex (Midland-Ross) process, two 90-ton ultrahigh-power electric arc steelmaking furnaces, and continuous-casting facilities. The plant, with a capacity of 500,000 tons of finished steel products, is owned by the Korf group, and was to operate under the name Hamburger Stahlwerke G.m.b.H.

Greece.—The Ministry of Industry announced that two small steel mills, both with electric furnaces, were authorized for construction. One, a $5.8 million mill, was planned for Stylis, on the eastern coast of Central Greece, and the other, to cost $2 million, for the Patras area.

The Japanese were active in negotiations for participating in the $150 million Hellenic Steel Co. expansion. The additions, to be completed by 1975, would raise the company's employment from 600 to 1,500. Nippon Kokan of Japan announced that agreement in principle was reached for establishing a 1.5-million-ton hot-rolling mill, expansion of existing rolling facilities, and installation of electric furnaces.

India.—The Government licensed nine steel mini-mills in an effort to reduce continuing steel shortages and the necessity for increased imports. The new mills were to have an annual capacity of 30,000 to 100,000 tons each; others expected to be added on a joint government-private basis. The Minister for Steel and Mines expressed hope that enough units of this type could be installed to produce up to 1.5 million tons by 1976. Efficiency of installed steel capacity continued low and the mini-mills were to serve as a stop-gap measure. Two were to use sponge iron to supplement scrap resources.

Labor and technical troubles combined to disrupt the steel industry and production declined despite Government efforts to increase supply. Utilization of public sector steel plants was reported at 59 percent of capacity, with utilization of all installed steel capacity at 67 percent.

Emphasis on construction has been placed on the Bokaro project, Bhilai expansion, and Indian Iron and Steel Co. (IISCO) expansion, by the Steel Ministry to reach the Government's Fourth Plan projected capacity. The first stage of the Bokaro plant was scheduled to start up in 1973, and have a 2-million-ton-per-year production rate; construction would proceed simultaneously on a second stage 4-million-ton section. The Bhilai plant of Hindustan Steel, Ltd., commissioned a 600,000-ton-capacity blast furnace in July. The IISCO steel expansion plan for 300,000 tons added capacity is expected to be completed during the Fourth Plan period.

Italy.—The long-term outlook for growth in steel production appeared good, and expansions were planned and started accordingly. Construction continued in raising the capacity of Italsider's Taranto steel complex from 5 to 11 million tons per year by 1975.

The Piombino plant was to be changed by the Finsider group into a $160 million company jointly owned by Italsider and Fiat, and expanded to meet Fiat's steel needs. Completion of a new oxygen converter gave the plant a 2-million-ton capacity. The new company would be known as Acciaierie di Piombino S.p.a.

A fifth iron and steel center, planned for Southern Italy, in Reggio Calabria Province, was expected to have a steel capacity of 5 million tons per year. Enactment of the Mezzogiorno Development Bill, which provided $11.2 billion for a 5-year industrial expansion program for southern Italy, appeared to guarantee the new center, as well as other plants.

Siderurgia Monfalcone, in the private sector, was to install four more electric furnaces within 2 years. This would give the company a total annual steel capacity of 500,000 tons.

Japan.—After 9 years of high annual growth rates, Japan's steel production was caught in the depressed world steel market, resulting in a 5-percent reduction in the country's output. However, pig iron production increased over that of 1970 by 5.2 million tons. Some furnaces were banked the latter part of 1971 as expected increases in demand failed to materialize, and installation of some new iron and steel facilities were rescheduled.

Late in 1971 the Ministry of International Trade and Industry (MITI) permitted the six major steel companies to apply to the Fair Trade Commission to form a cartel for countering effects of the steel recession. This was approved in December and crude steel production adjustments were made. Cutbacks were in effect in iron ore and ferrous scrap purchases during the year.

In June, MITI established rules for blast furnace construction that permitted a new installation only when an older furnace was shut down. The older furnace could not be refired before 1974. Estimates for production in 1975, based on this decision, placed crude steel capacity at between 160 and 171 million tons, and pig iron at between 125 and 134 million tons.

Agreements were reached by the Japanese on steel exports to the Common Market and United Kingdom. No minimum price requirement was involved. Agreement in principle also was reached with the United States to extend voluntary controls.

Japan was informally requested by the Canadian steel industry to carry out orderly marketing of its steel exports to Canada, and the request was reportedly agreed to. Japan claimed the world's nine largest blast furnaces, ranging in size from 2,705 to 4,197 cubic meters; the latter of which Nippon Kokan's Fukuyama plant was fired in April and had a capacity of 10,000 tons per day.

The first Sendzimir mill to produce 60-inch stainless steel sheets was started up by Nippon Yakin's Kawasaki plant in April. Four other mills were under construction at other sites. These mills are capable of rolling stainless sheets with thickness up to 6 to 7 millimeters.

Mexico.—The final approval for Mexico's long-discussed Las Truchas steel complex was announced by President Echeverría in August, with construction to begin in 1972. The overall project, involving iron mines and a port, as well as a complete steel mill, would be Government-controlled. The Mexican Government and its development bank, Nacional Financiera, would own 76 percent of the shares. Initial ingot production, scheduled for 1975, would be approximately 2 million tons, and eventual capacity in 1978 would be 3 million tons.

It was also announced that the four existing steel mills would not be allowed to expand beyond their expected 1975 steelmaking capacity of 7.2 million tons. Annual capacity expansion plans of the existing industry were as follows: The Fundidora, addition of a basic oxygen plant, and capacity to reach 1.7 million tons of raw steel by 1975; Altos Hornos de México, to increase raw steel capacity to 2.2 million tons by 1972 and 4.4 million tons by 1975; Hojalata y Lámina, S.A., to reach 1.5-million-ton capacity by 1975; Tubos de Acero de México, S.A., capacity increased to 440,000 tons by 1972. The Fundidora conducted negotiations with Ugine-Kuhlmann for starting a Mexican plant to produce stainless steel.

Mexico City was the site of the 11th Latin American Iron and Steel Congress in October, which was attended by about 130 U.S. representatives.

South Africa, Republic of.—Expansion plans of the country's three major steelmakers proceeded on schedule during 1971. The Government-controlled South African Iron and Steel Industrial Corp. Ltd. (ISCOR), largest of the companies, would have the highest expenditure. Major work was in process at Vanderbijlpark, where a $100 million, 80-inch hot-strip mill was to be installed. Ancillary equipment included a continuous annealing line for tinplate products, and an HCl pickling line. ISCOR's new works at Newcastle, estimated to cost over $500 million, was scheduled to roll its first steel in 1973. Planned combined output from plants at Newcastle, Pretoria, and Vanderbijlpark would exceed 7.5 million tons by 1977.

Some shortages developed for steel products during the first half of 1971, but a drop in demand during the latter half enabled most domestic orders to be filled. Essentially all needs are expected to be met on completion of the expansions at Newcastle and Pretoria by 1974.

Spain.—The iron and steel sector was to receive priority, along with other basic industries, under Spain's third development plan (1972–75). Production of steel planned will satisfy 90 percent of domestic requirements. The merger of Unión de las Siderúrgicas Asturianas (UNINSA) and Empresa Nacional Siderúrgica S.A. (ENSIDESA) was expected under the plan, also further coordination among nonintegrated companies.

The Veriña steelworks of UNINSA was inaugurated and the first blast furnace blown in on May 6. Two additional blast furnaces have been scheduled. A 2-million-ton-per-year oxygen steel shop also was commissioned in May. This plant is expected to account for 20 percent of Spain's steel production in 1975. Situated at a deep-water Atlantic port site, it is also expected to be internationally competitive.

The new stainless steel works of Compañia Española para la Fabricacion de Acero Inoxidable (ACERINOX) was under construction with the first stage expected to be producing late in 1972.

Approval was given for a fourth integrated steel plant to be constructed in Sagunto. Annual production would be 5 to 6 million tons; startup will possibly be in 1975.

Sweden.—A number of investments in the iron and steel sector were being carried out; annual investments to 1976 of $130 to $140 million were planned. Labor availability and investment capital were given in a Government report as limiting factors in the expected overall future expansion program.

The Government-owned Norrbottens Järnverk was starting on a modernization program totaling about $83 million over a 4-year period. Included was a new blast furnace to replace the electric smelting furnaces and increase pig iron capacity from 0.6 to 1.8 million tons per year. A new oxygen steel converter was to be installed and replace most of the Kaldo capacity. The new equipment is expected to put the plant on a profitable basis by 1975.

The Gränges Co., formerly Grängesberg Co., started up a new furnace for treating slabs, and a 130-ton ASEA-SKF ladle furnace for making high-quality specialty steel. The company also installed a new version of the SKF melting-refining process at its Nyby Bruk plant, to produce high-quality stainless steel. Details of a new type of quenched and tempered steel plate, and its production at Oxelösund were published.[5] Development work for the process was carried out in the United States by Bethlehem Steel Corp. assisted by the Drever Co. The high-tensile steel is said to have superior qualities and to allow additional weight reductions when used for purposes such as construction and shipbuilding.

United Kingdom.—The British Steel Corp. (BSC) continued with the planned restructuring of its iron and steel industry. Several objectives were being achieved: Uniform systems of financial and management control were being installed in all plants, to include common accounting methods and definition of terms; additional older and uneconomic plants were closed; centralized purchasing and reduction of working capital further strengthened; and product orders were being shifted to the lower cost plants. Plans announced in April called for closing 10 plants affecting 7,255 workers.[6] This was to be accomplished between mid-1971 and 1973. Some of the workers would be utilized at other BSC steel installations. BSC's chairman pointed out that only through continued rationalization and installation of modern plants could it expect to meet the challenge of world competition.

Major construction work in 1971 occurred at Scunthorpe, Teesside, and the Rotherham areas. At Scunthorpe, the Anchor project was on schedule. When completed this will be the largest steel plant in the United Kingdom. New investments here will total about $500 million. In the Teesside area, about $200 million was being invested. Included in the plans was a new deep-water ore terminal at Redcar, and a new oxygen steel plant. In the Rotherham area, capacity of the Templeborough melting shop, largest electric steelmaking facility in the world, was to be increased. With other improvements, investments in the next 5 years for this area are expected to be $120 million. A decision was made to de-

[5] Carden, Philip. New Type of Quenched and Tempered Steel Plate in Production at Oxelösund. Steel Times, v. 199, No. 7, July 1971, pp. 593–597.

[6] Metal Bulletin. Ten Plants To Be Closed. No. 5593, Apr. 23, 1971, p. 29.

velop a deep-water port with an iron ore terminal in Scotland on the Clyde estuary, with a future steelworks in the planning stage.

The Government decided to push for entry into the Common Market during 1971 with mixed reactions in the iron and steel sector. Steel personnel were mostly in favor of the plan, and expected it to be beneficial over the long term for the industry.

The decision to change to the metric system over a 10-year period was made in 1965, and BSC announced that the metric system based on unit of sale of 1,000 kilograms would be used from April 1, 1972, for those products priced by weight.[7] This action was agreed on also by the British Independent Steel Producers Association.

U.S.S.R.—Steel production for 1971 was 133 million tons, exceeding that of the United States by 13 million tons. The Soviet Prime Minister announced that production may reach 165 million tons in 1975, the last year of the current 5-year plan. The previous 5-year plan showed an annual increase of over 5 million tons. The increase was credited by the Director of Technical Sciences largely to building of new facilities. In an article touching on all phases of the Soviet iron and steel industry, he reported that priority would be given to rolled sheet, with production of cold-rolled sheet to rise by 67 percent during the next few years.[8] This will call for a number of new rolling mills to be built.

Pig iron production in the U.S.S.R. was covered for the period from World War II in a summary of a Soviet "Industrial Series," 1971, pamphlet.[9] A 5,000-cubic-meter blast furnace was reported in the process of development. This would be located in the Novolipzek steel combine.

The first vacuum steel-melting plant began operating in Gorki during the year. Production of steel pipe, using a modified continuous-casting process was being carried out at the works in Tula, Central Europe. Cost savings over the standard method were reported as 13 percent.

The Soviet Minister of Metallurgy announced that an agreement had been reached between the U.S.S.R. and Japan, following a meeting with Japanese steel executives, to exchange technical information on steelmaking. Meetings were to be held periodically. Discussions would include possibilities for joint technology development programs, as well as data exchange.

TECHNOLOGY

Blast Furnace.—The economics involved in the future of the blast furnace—BOP method of steelmaking were compared with direct reduction—electric furnace production in two publications.[10] Comparisons made for United Kingdom conditions indicated the blast furnace to have the highest economic advantage when producing about 3 million tons per year or more of hot metal. Under coke and electricity costs prevailing at the time, and assuming coke continued to be available, the blast furnace was expected to remain as the principal hot-metal-producing process for two or three decades in all major steel-producing countries.

A 10,000-ton-per-day blast furnace was placed in production at the Fukuyama works of Nippon Kokan (NKK). This had a volume of 4,193 cubic meters and a hearth diameter of 13.8 meters, or 45.3 feet. The furnace, approximately 318 feet high, would operate at a top pressure of 35.5 pounds per square inch. Other units approximating this size were under construction or planned and would replace some of the smaller blast furnaces in Japan.

Blast furnace construction costs have been given as the major stumbling block to more steel capacity in the United States. For maximum efficiency, a proposal was made to install a battery of large blast furnaces as a common source of hot metal in major use areas. This would be backed by several steelmakers.[11] The arrangement

[7] Steel Metrication Bulletin. British Steel Corp., (London), June 1971, 8 pp.

[8] Shalimov, Anatoly. Technical Level of the Soviet Iron and Steel Industry. Iron and Steel Eng., v. 48, No. 11, November 1971, pp. 41–49.

[9] Intermet Bulletin. Development of Pig Iron Production in USSR. V. 1, No. 3, January 1972, pp. 35–39.

[10] Berczynski, Frank A. The Blast Furnace—The Old Girl's Alive and Kicking. Blast Furnace and Steel Plant, v. 59, No. 3, March 1971, pp. 154–160.

Cartwright, W. F. The Economic Survival of the Blast Furnace. J. Iron and Steel Inst., February 1971, pp. 89–95.

[11] Iron Age. Blast Furnace Complex: Steelmaking's Next Step? V. 207, No. 23, June 10, 1971, p. 71.

could be similar to arrangements now existing to supply pelletized ore on a partial ownership basis from large pellet plants.

Development of the blast furnace and its present-day basic concepts were considered along with engineering design problems of the larger blast furnaces in a publication covering proceedings of the conference held in the Netherlands in April 1970.[12]

Bethlehem Steel Corp. completed its second large blast furnace at Burns Harbor, Ind. The new furnace, with a hearth diameter of 38 feet, 3 inches, is the largest in the Western Hemisphere. U.S. Steel Corp. started construction on a furnace at its Gary, Ind., works which would have a capacity of 10,000 tons per day.

A paper presented at the British Iron and Steel Research Association (BISRA) 38th Blast Furnace Conference in England was published. It discussed alternative methods for producing solid fuel for the blast furnace.[13] The author narrows the choice for practical purposes to three: the Bergbau-Forschung, the FMC, and a Soviet process.

Shortage of coking coals and air pollution problems of present-day coke ovens have been of major concern in future operation of the blast furnace. Successful large-scale blast furnace tests in the use of formed or briquetted coke were reported in the United Kingdom and West Germany. Average weight ratios of coke consumed in blast furnaces to pig iron produced in 1971 were 0.451 for Japan and 0.627 for the United States.

Basic Oxygen Process (BOP).—Steel produced by the BOP in 1971 was 53.1 percent of the domestic total, exceeding the 50-percent mark for the first full year. Capacity throughout the world continued to increase; 42 million short tons was added in 1971. Five million of this was credited to the United States, and 17 million to Japan, giving yearend capacities of 78 million and 106 million tons, respectively. According to the latest Kaiser Engineers' survey, the world total amounted to 338 million tons.[14] An additional 117 million tons was scheduled, of which BSC accounted for approximately 10 percent.

The basic oxygen converter was scheduled to replace one of the world's few Kaldo operations, that of Norrbottens Järnverk Aktiebolag in Luløa, Sweden, as the plant began a modernization program.

A modified basic oxygen process developed in West Germany by Eisenwerk-Gesellshaft-Maximilianshüette m.b.H. (Maxhutte) and used in Europe for several years was introduced in the United States by Pennsylvania Engineering Corp. and the U.S. Steel Corp. The process, known as the OBM process, involves oxygen and hydrocarbon gas injection through the bottom tuyeres of the Bessemer or Thomas converter. Modified by U.S. Steel to include larger capacity converters than used in Europe, the process has been named the Q-BOP process. The first U.S. installation will be at the Fairfield, Ala., works of U.S. Steel where two 200-ton converters are scheduled.[15] Additional scrap usage and reduced refining time are two advantages claimed over regular BOP processing.

Bethelehem Steel Corp. patented a rapid method of sampling and temperature measurement in the BOP converter which involved an auxiliary lance. End-point corrections were said to be reduced and accuracy improved.

Experimental results of bottom injection of oxygen and powdered lime in an experimental converter to refine high-phosphorus pig iron indicated low-phosphorus content in the resulting metal and high P_2O_5 content in the slag. A single slag was possible, and the process was said to have some advantages over top-lancing practices.[16]

Electric Furnaces.—The electric furnace continued to increase its share of domestic steelmaking; 17.4 percent was produced by this method in 1971, compared with 15.3 percent in 1970. Total U.S. electric furnace capacity was estimated at 25 million short tons per year. In Japan, 17.7 percent of that country's steel production came from electric furnaces, compared with 16.7 percent in 1970. Planned Japanese expansion indicated that between JFY 1970/71 and 1975/76, 127 new electric furnaces would be

[12] Iron and Steel Institute. Proc. Engineering Design Problems of Large Iron- and Steelmaking Furnaces, Noordwijk aan Zee and Ijmuiden, Netherlands, Apr. 9–10, 1970. ISI Pub. 136, 1970, 139 pp.

[13] Barker, J. E. Possible Alternative Methods for the Manufacture of Solid Fuel for the Blast Furnace. J. Iron and Steel Inst., February 1971, pp. 100–108.

[14] Stone, J. K. Worldwide Round/Up of BOF Installations. 33 Magazine, December 1971, p. 48.

[15] Chemical Engineering. And U.S. Steel Will Be the First User of a German-Derived Steelmaking Method. V. 78, No. 29, Dec. 27, 1971, p. 18.

[16] Shenouda, F., E. Förster, H. Richter. Refining of High-Phosphorus Pig Iron by a Bottom Injection of Oxygen and Powdered Lime. Iron and Steel, v. 44, No. 3, June 1971, pp. 167–172.

installed with a total capacity of 16.5 million tons per year; 80 older units, with a combined annual capacity of 3.7 million tons, were to be taken out of service.

Major U.S. electric furnace startups during the year were U.S. Steel's Texas works with two 200-ton furnaces, Armco's Houston works with two, 175-ton furnaces, and addition of a 150-ton furnace for Timken at its Canton, Ohio plant. The largest operating electric furnace, 400 tons, began producing at the Sterling, Ill., works of Northwestern Steel & Wire Co.

The increasing use of and advancements in the electric furnace for steelmaking was brought out at the International Congress on Electric Arc Furnace in Steelmaking, held in Cannes, France in 1971.[17] Specific advancements discussed included design development allowing furnace capacities of up to 400 tons; new control techniques, with use of electronic computers; advanced transformer technology allowing higher power inputs; relative reduction in cost of electric power; and development in fields of electrodes and refractory products. Also discussed were Armco's new electric furnace shop at Houston, and BSC's Templeborough electric shop, already the world's largest, which would have additional capacity. Some improvements in furnace design noted included continuous charging systems, slanted electrodes for better power, and coatings for electrodes to decrease electrode consumption.

Electric steelmaking furnace research underway by BSC included a new arc initiation technique, which depends on bridging the arc gap with a seeded gas flame rather than mechanical contact, heat transfer mechanisms in arcs, and the influence of slags on arc characteristics.

Indications pointed to increasing electric furnace steelmaking capacity throughout the world for the next decade. Several factors, including adaptability to limited production at relatively lower capital and operating costs, and pollution control capabilities favor this method of steelmaking in many areas. The place of the small or mini-steelworks in the world and circumstances under which they are preferred was discussed by the deputy director of BSC in his delivery of the 22d Hatfield Memorial Lecture, University of Sheffield, December 9, 1971.

Iron and Steel Refining.—Electroslag remelting (ESR), after being favored in the U.S.S.R. for many years, began to be installed in the United States, replacing some air-melting and vacuum-degassing operations. Carpenter Technology Corp. started up two units designed to produce higher quality special steels.[18] Estimates for 1970 placed 80 percent of the world capacity in the U.S.S.R. and 10 percent in the United States.

Electron beam (EB) refining secured a start in domestic specialty steel production. Airco, for the second year, operated its EB facility using continuous hearth refining. The Cyclops Corp., Universal-Cyclops Specialty Steel Div., placed electron-beam-refined stainless steel products on the market in standard forms for the first time. Another division of Cyclops was manufacturing and marketing tubing from stainless produced by the EB method.

Modifications were made to the ASEA-SKF steel refining process to improve operation, including induction stirring and visual control. Additional capacity was installed during the year in Europe. Operation of a refining plant in Sweden using this process was described in a paper.[19] Larger sized vacuum refining equipment for conventional processing continued to be installed to replace older units and in new producing facilities. A review of the principal processes and installations were presented.[20] The Argon-oxygen decarburization (AOD) process developed by Union Carbide and Joslyn's Stainless Steels Div., received an increasing amount of publicity as additional units began operation. Five domestic plants and five foreign plants had a startup date of 1971; at least seven additional plants were expected to begin in 1972. A large percentage of the stainless steel made in the United States is expected to be refined by this process, which has been proven in several commercial operations during the past year.

Direct Reduction.—A second metallized pellet plant started operating in the

[17] Congrès International sur le Four électric à Arc en Aciérie. (International Conference on the Electric-Arc Furnace in Steelmaking) Cannes, France, June 7–9, 1971, 500 pp.

[18] McManus, G. J. Tool Steels Take the ESR Route. Iron Age, v. 208, No. 13, Sept. 23, 1971, pp. 55–57.

[19] Grevillius, N., P. Geete, and T. Krey. Operational Experience of the ASEA-SKF Ladle Furnace Process at Bofors Steelworks. Pres. at 28th Annual Electric Furnace Conference, AIME, Dec. 9–11, 1970, Pittsburgh, Pa. 14 pp.

[20] Leach, J. C. C. Vacuum Degassing and Secondary Refining of Steel. Iron and Steel, v. 44, No. 2, April 1971, pp. 105–114.

United States at Georgetown, S.C. Rated at 400,000 tons per year, the plant, operated by Midland-Ross Corp., was to serve as a source of melting stock for the adjoining electric furnace steelmaking plant of Korf Industries. Midland-Ross began construction of another metallized pellet plant at Contrecoeur, Canada. This also would supply 400,000 tons of metallized product as part of the steelmaking operation owned by Sidérurgie du Québec (SIDBEC).

Swindell-Dressler Co. was constructing a plant in Brazil using the HyL process. The plant, near Salvador, would be part of an integrated steelworks owned by Usina Siderúrgica da Bahia, S.A. (USIBA), and would have an initial capacity of 200,000 per year. Another plant, Aços Finos Piratini S. A., at Charqueadas, would produce, by the SL/RN process, approximately 65,000 tons per year in a new special steel plant to start operations in 1973.

Engineers of Hojalata y Lámina, S.A., published test results demonstrating the suitability of the HyL sponge iron product as a coolant in BOF steelmaking.[21]

U.S. Steel Corp.'s direct reduction plant in Venezuela was scheduled to start production during the year. The chairman of the board of U.S. Steel reported that the Orinoco plant, said to be the largest direct reduction facility in the world, would produce briquets to be converted into steel at the company's plants in Texas and Pennsylvania.[22]

The United Nations, under the auspices of Economic Commission for Europe (ECE), scheduled a seminar on the economic aspects of direct reduction to be held in Romania in 1972. One session would cover the place of direct reduction in iron and steelmaking.

Continuous Casting.—Two plants in the United States completed continuous-casting facilities during the year, and several others had construction underway or in the planning stage. Bethlehem Steel Corp. announced that its Burns Harbor plant would install the company's first continuous slab casting machine. U.S. Steel Corp. completed slab-casting facilities at its Baytown, Tex., installation and reported production records for the new Gary, Ind., slab caster. Startup of Armco Steel Corp.'s slab caster at the Butler, Pa., works was covered in an article.[23] Lukens Steel Co. operated its new $12.8 million slab-casting facility to produce sizes as large as 85 inches wide by 12 inches thick. High-strength and alloy steels were successfully cast on production basis, as well as carbon steels. Startups of new strands were announced in many of the other major steel-producing countries of the world. New machines were completed at three Italian, three West German, and four Japanese steelworks. Additional capacity also was scheduled to start up during the year in France, Spain, Portugal, Greece, and Finland. Total world capacity was estimated to be approximately 40 million tons; continuous-cast steel represented 6 to 8 percent of the world's raw steel production.

Nippon Kokan of Japan reported a new method of adding aluminum to the ladle for continuous casting. High-speed wire addition combined with bottom injection of inert gas was said to reduce aluminum consumption by 50 percent.

Thin-slab continuous casting for direct hot rolling to produce quality steel strip was promised by Continuas of Italy. A new machine offered by the company would produce slabs as thin as 25 millimeters and allow bypassing of the blooming mill.[24]

A horizontal process to continously cast steel developed in the United Kingdom was operated on a pilot scale. Advantages of height reduction and simplified design were cited for commercial use.[25]

The status of the Hazelett continuous-casting process was reviewed, including a feasibility study to use a pressure pouring furnace in connection with the caster. The latter was carried out by Oregon Steel Mills.[26]

Powder Metallurgy.—Forecasts of additional domestic iron powder growth were made with the commercial acceptance of powder metal (PM) forging. Growth rate for conventional ferrous PM parts, as anticipated by a vice president of Hoeganaes

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[21] Peña, J. M. and D. Radke. HyL Sponge Iron As a Coolant in BOF Steelmaking. J. Metals, v. 23, No. 8, August 1971, pp. 27–32.

[22] Chemical and Engineering News. Direct Iron Reduction. V. 49,No. 19, May 10, 1971, p. 55.

[23] Todd, David E. Design and Start-Up of 2-Strand Slab Caster at Armco's Butler Works. Iron and Steel Eng., v. 48, No. 10, October 1971, pp. 48–53.

[24] 33/Magazine. Continously Cast Thin Slab Feeds Direct to Hot Strip Mill. V. 9, No. 1, January 1971, pp. 51–58.

[25] Marsh, J. A New Horizontal Continuous Casting Process for Steel. Steel Times, v. 199, No. 6, June 1971, pp. 515–521.

[26] Wood, J. F. B., and P. C. Regan. The Hazelett Continuous Casting Process. Iron and Steel Eng., v. 48, No. 12, December 1971, pp. 47–55.

Corp., would be about 10 percent per year to 1980, reaching 210,000 tons annually. PM forging was expected to raise this an additional 100,000 tons.[27] Total iron powder production in the United States and Canada was approximately 120,000 tons in 1971.

Interlake, Inc., increased its ownership in Hoeganaes Corp., Riverton, N.J., to 80 percent by acquiring an additional 13⅓-percent interest in the company. The remainder was held by Hoeganaes Aktiebolag of Sweden.

A review of PM development in the United States was presented at a symposium on high-performance metals at the U.S. Trade Center in London.[28] An increasing interest in alloy steel powders and special tool steel powders was noted. The automotive field was pointed out as a major area of PM application for hot forgings.

Expansion of iron powder facilities occurred in Japan at the Chiba works of Kawasaki Steel, where monthly output was being expanded to 1,500 tons. Kobe Steel was to raise capacity at its Iwaya works from 100 to 450 tons per month. Kobe produces powder under a license agreement with A.O. Smith-Inland, Inc.

Research and development has played a major role in elevating iron powder metallurgy from a simple press and sinter operation to processing methods that offer opportunities for producing both conventional and complex components in many industrial areas.

Foundry.—Capital spending in the domestic foundry industry increased each year for the 10-year period prior to 1971, with expenditures of $180 million in 1961 and $1,110 million in 1970. Of the 1961 total, approximately 25 percent was for new plants and additions, and 75 percent for new machinery and equipment; in 1970, the percentage was 35 and 65 percent, respectively.[29] Iron and steel castings account for approximately 90 percent of foundry production; the remainder was nonferrous metals.

Foundry trends continued to be toward larger plants with increasing capacities, and away from smaller installations. The new foundry facility of Ford Motor Co. at Flat Rock, Mich., started pilot operations prior to full-scale production. To be known as Ford's Michigan Casting Center, it has been described as the largest casting facility in the world, and to represent the largest single-plant investment in the history of the company. Major items of equipment are six 50-ton electric-arc furnaces for melting and five 80-ton holding furnaces. The melting furnaces, with a capacity of about 3,000 tons per day, will be computer controlled and initially are expected to use 100 percent scrap. Ford also plans an expansion at its Cleveland foundry to produce castings for small car engines. Plant startup was expected by 1973; the project will increase the number of workers by 575.

Ductile iron has shown a steady growth rate over the past few years, and forecasts indicate that this will continue. The technical director of the Malleable Founders Society, at its annual meeting, reported on a new process for making ductile iron from malleable base iron that is 40 to 50 percent cheaper than conventional methods.[30] The process, developed in Switzerland, treats iron in a converter that has a chamber in the bottom to hold magnesium. Another development from Sweden involves magnesium addition in a treatment ladle by means of sponge iron briquets that incorporate pure magnesium. The product has a delayed reaction time, as the magnesium vaporizes and is dispersed through the pores of the briquet into the metal. A new nodularizing agent, developed by U.S. Pipe and Foundry Co., was offered by Union Carbide's Ferroalloy Division. The alloy, called Remag, contains both magnesium and rare-earth elements in a composition to give effective nodular treatment with a minimum of reactivity and vibration.

Results of a study relating to the costs and the economic impact of air pollution controls on gray iron foundries were published by the U.S. Department of Health, Education, and Welfare.[31]

A new edition of the Iron Castings Handbook was issued by the Gray and Ductile Iron Founders' Society which con-

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[27] Iron Age. PM Forging Logjam Starts to Break Up. V. 208, No. 20, Nov. 11, 1971, pp. 64–65.

[28] Knopp, Walter V. US Powder Metal Progress. Metal Bull. Monthly, No. 8, August 1971, pp. 37–40.

[29] Industry Week. Whatever Happened to Iron? V. 170, No. 2, July 12, 1971, pp. 33–39.

[30] Herrmann, Robert H. 1971 Annual Meeting-Malleable Founders Society. Foundry, v. 99, No. 7, July 1971, pp. 100–103.

[31] U.S. Department of Health, Education, and Welfare. Economic Impact of Air Pollution Controls on Gray Iron Foundry Industry. Nat. Air Pollution Control Admin. Pub. AP-74, November 1970, 124 pp.

tained an added chapter on Metallurgy of Cast Iron.[32]

Research and Development.—Investigations at Bureau of Mines research installations included projects on continuous electric furnace steelmaking, ferrous metal recovery from urban refuse, removal of copper from molten ferrous scrap, production of ductile iron from shredded scrap, and separation of coke from blast furnace dusts.

Progress was reported on continuous steelmaking at the Albany Research Center.[33] A stationary arc furnace was used in continuously making both carbon and low-alloy steels. Recovery of mineral values from urban refuse was demonstrated at the College Park Research Center pilot plant in College Park, Md. Recoverable ferrous metal in a ton of residue amounted to 610 pounds.

The Director of the Bureau of Mines, in a speech at an AISI meeting, called for increased emphasis on research and development in the steel industry to help meet foreign competition. He also announced the signing of a contract with the National Academy of Engineering to review the laboratory research programs of the Bureau. A review committee, reporting to the Secretary of the Interior, would make periodic recommendations on modifications, extensions or other changes in projects.[34]

The University of Alabama added new foundry facilities costing in excess of $500,000 to allow expansion of research and instruction. Included in the new programs was industrial research of foundry problems.

In the private sector, the AISI, as well as individual steel companies, supported projects in steelmaking at several universities. The major steelmakers continued research in company laboratories, but an overall reduction in both personnel and projects occurred in the industry as part of a general austerity program.

General Motors Corp. was developing its Oldsmobile Division's new process for converting in-plant scrap into hot metal, and continously casting the metal into horizontal molds. Vacuum degassing and bars cast directly to forging stock size has been used to produce ring gears and other car parts by its XTruCast method. The Institute of Scrap Iron and Steel, through its Scrap Metal Research and Education Foundation, joined with the Division of Solid Waste Management, Department of Health, Education, and Welfare, to fund a project at Battelle Memorial Institute. This was designed to identify problems preventing efficient recycling of an estimated 20 million junked cars, defunct home appliances, and metal containers, and to come up with new ways to get the scrap off the landscape and into the steel mill furnaces.[35]

Two continuous steelmaking processes were being actively developed. IRSID's process operated during the year in a 500-ton-per-day plant at the Hagondage, France, steelworks of Wendel-Sidélor. The British Iron & Steel Research Association (BISRA) spray steelmaking project was still being funded, and various phases of the process studied at the Sheffield, England, laboratories.

Research was directed toward producing higher quality steels that are free of all inclusions in several European research centers. In Japan the Nippon Steel Corp. was reported as planning a force of 2,000 scientists in its new research center. The use of nuclear energy in steelmaking continued to attract attention in Japan and West Germany, where iron production was proposed using helium heat transfer from gas-cooled reactors prior to its use for power generation.

The United Nations published a survey of important steel technologies of recent years, and some of the new properties introduced in steel products.[36]

Pollution Control.—Control of emissions from iron and steel plants was a topic of interest in all major producing countries. In the United States it was the subject of numerous articles which set forth the problems and possible solutions.[37] Laws in

[32] Gray and Ductile Iron Castings Handbook. 1971, 679 pp.

[33] Bureau of Mines Research 71. Continuous Electric Furnace Steelmaking, pp. 23,24.

[34] Research/Development. Steel Industry is Dragging Its Heels in Research, U.S. Bureau of Mines Director Charges. V. 22, No. 12, December 1971, p. 6.

[35] Blast Furnace and Steel Plant. Reclaim Metal Resources. V. 59, No. 2, February 1971, p. 77.

[36] United Nations. Development of Production Technology and New Properties of Steel Products, 1970. No. E. 70 II. E. 7, 1971 (price $1.00), 49 pp.

[37] Bramer, Henry C. Pollution Control in the Steel Industry. Environ. Sci. & Technol., v. 5. No. 10, October 1971, pp. 1004–1008.

Greenberg, J. H. Systems Analysis of Emissions —The Iron Foundry Industry. Chem. Technol., December 1971, pp. 728–736.

Herrmann, Robert H. Information Gap Hampers Foundry Pollution Control. Foundry, v. 99, No. 4, April 1971, AP–2–AP–32.

Richardson, H. L. Control of Sulphur Emissions in an Integrated Steel Mill. Iron and Steel Eng., v. 48, No. 7, July 1971, pp. 76–78.

general were being passed and standards set by local and State Governments. However, Federal Standards for particulate matter in the atmosphere were applied in 1971 by the Environmental Protection Agency (EPA) under the Clean Air Act of 1970. A Federal court order directed 23 companies in the Birmingham, Ala., area to temporarily curtail air-polluting operations after the danger level was reached. About one-half of the operators were involved in making iron and steel, or products therefrom. The shutdown was the first under the act, and was short-lived, but it indicated the necessity for proper environmental protection facilities throughout the industrial community of the United States.

AISI reported that $161.6 million was spent by the domestic steel industry in 1971 for air and water pollution control, about evenly split between the two. Budgeted for future facilities in 1972 and beyond by the steel industry was $320.3 million. To keep the installed facilities operating and maintained was expected to require about 12 percent annually of the original cost.

In other countries, concern over pollution by the iron and steel operations depended largely on the locations of the particular plants and number of people directly affected. In general, isolated operations were not being pressured into making changes. In populated areas such as the West German steel centers, pollution was being carefully watched by both the authorities for compliance with regulations and the operators to prevent penalties from being imposed. In the United Kingdom, stricter laws were expected in the future. In Japan, growing public concern over pollution was reported, and measures were taken by both industry and the Government to cope with the situation. Agreements were being reached between local governments and the steel corporations owning plants to cut the discharge of sulfur dioxide. About $167 million was spent in 1971 on control facilities by the steel industry.

In the Netherlands, the city of Rotterdam prevented an effort by Hoogovens and Hoesch to build a steel mill on reclaimed land in Europort because of possible pollution. The French Government adopted a series of measures to detect and control pollution at the new Fos steel project.

The ECE held a seminar on air and water pollution arising in the iron and steel industry, at Leningrad, U.S.S.R., in August. A number of papers were presented.

Table 2.—Pig iron produced and shipped in the United States, in 1971, by State

(Thousand short tons and thousand dollars)

State	Production	Shipped from furnaces	
		Quantity	Value
Alabama	3,946	3,862	$263,696
Illinois	6,500	6,466	446,534
Indiana	12,695	12,740	895,737
Ohio	13,703	13,739	1,014,840
Pennsylvania	18,812	18,819	1,288,740
California, Colorado, Utah	4,492	4,499	321,489
Kentucky, Maryland, Texas, West Virginia	9,772	9,808	695,489
Michigan, Minnesota	7,283	7,281	496,453
New York	4,179	4,118	289,063
Total	81,382	81,332	5,712,041

Table 3.—Foreign iron ore and manganiferous iron ore consumed in manufacturing pig iron in the United States, by source of ore

(Thousand short tons)

Source	1970 [1]	1971 [2]
Australia	526	729
Brazil	r 751	62
Canada	r 1,903	1,677
Chile	r 1,123	370
Venezuela	5,012	4,376
Other countries	r 904	198
Total	r 10,219	7,412

r Revised.
[1] Excludes 22,489 tons used in making agglomerates.
[2] Excludes 18,466 tons used in making agglomerates.

Table 4.—Pig iron shipped from blast furnaces in the United States, by grade [1]

(Thousand short tons and thousand dollars)

Grade	1970			1971		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Foundry	1,780	$110,281	$61.96	1,902	$128,480	$67.56
Basic	r 86,090	r 5,603,005	r 65.08	75,804	5,324,194	70.24
Bessemer	1,346	88,772	65.95	1,295	91,916	70.98
Low-phosphorus	131	8,718	66.55	153	10,900	71.24
Malleable	1,548	95,763	61.86	1,935	139,502	72.09
All other (not ferroalloys)	377	23,932	63.48	243	17,049	70.16
Total	r 91,272	r 5,930,471	r 64.98	81,332	5,712,041	70.23

r Revised.
[1] Includes pig iron transferred directly to steel furnaces at same site.

Table 5.—Number of blast furnaces (including ferroalloy blast furnaces) in the United States, by State

State	Jan. 1, 1971			Jan. 1, 1972		
	In blast	Out of blast	Total	In blast	Out of blast	Total
Alabama	11	8	19	8	8	16
California	4	--	4	4	--	4
Colorado	4	--	4	4	--	4
Illinois	13	6	19	13	6	19
Indiana	21	4	25	18	7	25
Kentucky	2	--	2	2	--	2
Maryland	8	2	10	4	6	10
Michigan	9	--	9	8	1	9
Minnesota	1	1	2	1	1	2
New York	9	6	15	6	9	15
Ohio	27	17	44	22	21	43
Pennsylvania	33	22	55	26	29	55
Tennessee	--	--	--	--	--	--
Texas	2	--	2	1	1	2
Utah	3	--	3	2	1	3
West Virginia	3	1	4	4	--	4
Total	150	67	217	123	90	213
Ferroalloy blast furnaces	2	--	2	3	--	3
Grand total	152	67	219	126	90	216

Source: American Iron and Steel Institute.

Table 6.—Iron ore and other metallic materials, coke and fluxes consumed, and pig iron produced in the United States, by State

(Thousand short tons)

Year and State	Metalliferous materials consumed: Iron and manganiferous ores: Domestic	Iron and manganiferous ores: Foreign	Agglomerates	Net ores and agglomerates [1]	Net scrap [2]	Miscellaneous [3]	Net total	Net coke	Fluxes	Pig iron produced	Metalliferous materials consumed per ton of pig iron made: Net ores and agglomerates [1]	Net scrap [2]	Miscellaneous [3]	Total	Coke and fluxes consumed per ton of pig iron: Net coke	Fluxes
1970:																
Alabama	1,482	W	4,632	7,741	137	9	r 7,887	3,519	800	4,654	1.663	0.029	0.002	r 1.695	0.756	0.172
Illinois	W	--	10,270	r 11,771	203	337	12,311	4,551	1,439	7,388	r 1.593	.027	.046	r 1.666	.616	.195
Indiana	W	W	18,415	20,585	281	533	21,399	7,618	1,720	13,348	1.542	.021	.040	1.603	.571	.129
Ohio	3,921	861	19,095	r 23,242	775	1,440	r 25,457	10,101	3,177	r 15,411	r 1.508	r .050	r .093	r 1.652	r .655	r .206
Pennsylvania	5,544	r 3,783	r 22,968	r 31,541	884	1,714	r 34,139	13,132	2,866	20,793	r 1.517	r .043	.082	r 1.642	.632	.138
California, Colorado, Utah	r 3,456	W	W	r 8,656	68	148	r 8,872	3,097	860	5,150	r 1.681	.013	.029	r 1.723	.601	.167
Maryland, West Virginia, Kentucky, Texas	W	W	13,837	r 16,969	298	998	r 18,265	7,133	1,287	11,451	r 1.482	.026	.087	r 1.595	.623	.112
Michigan and Minnesota	923	W	10,714	11,317	214	260	r 11,791	4,701	1,437	7,550	1.499	.028	.034	1.562	.623	.190
New York	1,755	89	W	8,856	185	250	9,291	3,472	805	5,548	1.596	.033	.045	1.675	.626	.145
Total	r 21,507	r 10,219	r 112,421	r 140,678	3,045	5,689	r 149,412	57,324	[4] 14,391	r 91,293	r 1.541	.033	.062	r 1.637	r .628	r .158
1971:																
Alabama	810	W	4,140	6,480	124	9	6,613	3,001	792	3,946	1.642	0.031	0.002	1.676	0.761	0.201
Illinois	W	--	8,970	10,225	171	229	10,625	4,072	1,132	6,500	1.573	.026	.035	1.634	.626	.174
Indiana	W	W	17,950	19,392	329	670	20,391	7,014	1,532	12,695	1.528	.026	.053	1.606	.553	.121
Ohio	3,666	715	16,820	20,682	565	1,412	22,659	8,922	2,725	13,703	1.509	.041	.103	1.654	.651	.199
Pennsylvania	5,608	3,201	20,357	28,527	812	1,343	30,682	11,775	2,446	18,812	1.516	.043	.071	1.631	.626	.130
California, Colorado, Utah	2,301	W	W	7,492	59	132	7,683	2,738	715	4,492	1.668	.013	.029	1.710	.610	.159
Maryland, West Virginia, Kentucky, Texas	W	W	13,412	14,982	184	773	15,939	6,102	984	9,772	1.533	.019	.079	1.631	.624	.101
Michigan and Minnesota	497	W	10,660	10,924	227	133	11,284	4,540	1,300	7,283	1.500	.031	.018	1.549	.623	.178
New York	1,444	107	W	6,555	179	165	6,899	2,630	688	4,179	1.569	.043	.039	1.651	.629	.165
Total	17,542	7,836	102,675	125,259	2,650	4,866	132,775	50,794	[5] 12,314	81,382	1.539	.033	.060	1.632	.624	.151

r Revised.
W Withheld to avoid disclosing individual company confidential data; included with total.
[1] Net ores and agglomerates equal ores plus agglomerates plus flue dust used minus flue dust recovered.
[2] Excludes home scrap produced at blast furnaces.
[3] Does not include recycled material.
[4] Fluxes consisted of the following: 7,417 limestone, 6,235 dolomite, and 739 other fluxes excluding 4,679 limestone, 3,503 dolomite, and 175 other fluxes used in agglomerate production at or near steel plants and an unknown quantity used in making agglomerates at mines.
[5] Fluxes consisted of the following: 6,211 limestone, 7 burnt lime, 5,736 dolomite, and 360 other fluxes excluding 4,154 limestone, 3,166 dolomite, and 139 other fluxes used in agglomerate production at or near steel plants and an unknown quantity used in making agglomerates at mines.

Table 7.—Steel production in the United States, by type of furnace [1]

(Thousand short tons)

Year	Open hearth [2]	Bessemer	Basic oxygen process	Electric	Total
1967	70,690	(3)	41,434	15,089	127,213
1968	65,836	(3)	48,812	16,814	131,462
1969	60,894	--	60,236	20,132	141,262
1970	48,022	--	63,330	20,162	131,514
1971	35,559	--	63,943	20,941	120,443

[1] Excludes castings produced by foundries not covered by AISI.
[2] Basic and acid open hearth production data reported separately in previous years.
[3] Included with "Open hearth."
Source: American Iron and Steel Institute.

Table 8.—Metalliferous materials consumed in steel furnaces [1] in the United States

(Thousand short tons)

Year	Iron ore		Agglomerates		Pig iron	Ferro-alloys [2]	Iron and steel scrap
	Domestic	Foreign	Domestic	Foreign			
1967	954	2,905	600	378	80,404	1,818	65,027
1968	958	2,514	684	337	79,948	1,676	67,281
1969	710	2,121	487	512	84,187	1,775	74,343
1970	502	1,889	465	476	r 81,797	1,641	66,451
1971	308	1,166	294	320	74,059	1,447	63,308

r Revised.
[1] Basic oxygen converter, open-hearth furnace, and electric furnace. Bessemer included in 1967 only.
[2] Includes ferromanganese, spiegeleisen, silicomanganese, manganese metal, ferrosilicon, ferrochromium alloys, and ferromolybdenum.

Table 9.—Consumption of pig iron [1] in the United States, by type of furnace

Type of furnace or equipment	1969		1970		1971	
	Thousand short tons	Percent of total	Thousand short tons	Percent of total	Thousand short tons	Percent of total
Basic oxygen converter	r 48,610	r 54.1	r 51,730	r 59.8	52,023	66.2
Open hearth	r 37,976	r 42.2	r 32,204	r 37.2	23,574	30.0
Electric	332	.4	453	.5	825	1.1
Cupola	2,911	3.3	2,076	2.4	1,865	2.4
Air	92	.1	94	.1	60	.1
Other furnaces [2]	3	--	10	--	204	.3
Total	r 89,924	100.0	r 86,567	100.0	78,551	100.0

r Revised.
[1] Excludes molten pig iron used for ingot molds and direct castings.
[2] Includes vacuum melting furnaces and miscellaneous melting processes.

Table 10.—Average value of pig iron at blast furnaces in the United States, by State

(Per short ton)

State	1971
Alabama	$68.29
California, Colorado, Utah	71.46
Illinois	69.06
Indiana	70.31
New York	70.19
Ohio	73.87
Pennsylvania	68.48
Other States [1]	69.75
Average	70.23

[1] Includes Kentucky, Maryland, Michigan, Minnesota, Texas, and West Virginia.

Table 11.—Consumption of pig iron [1] in the United States, by State

(Thousand short tons)

State	1971
Alabama	3,445
Connecticut	18
Delaware	(2)
Georgia	8
Illinois	6,376
Indiana	12,776
Iowa	25
Kansas	2
Kentucky	1,611
Louisiana	(2)
Maine	(2)
Massachusetts	17
Michigan	7,185
Missouri	17
Montana	(2)
Nebraska	(2)
Nevada	(2)
New Jersey	55
New York	3,734
North Carolina	5
Ohio	13,401
Oklahoma	5
Oregon	(2)
Pennsylvania	19,387
Rhode Island	5
Tennessee	95
Texas	636
Vermont	4
Washington	(2)
Wisconsin	117
Undistributed [3]	12,254
Total	81,178

[1] Includes molten pig iron used for ingot molds and direct castings.
[2] Less than ½ unit.
[3] Includes California, Colorado, Florida, Maryland, Minnesota, New Hampshire, South Carolina, Utah, Virginia, and West Virginia.

Table 12.—U.S. exports of major iron and steel products

Products	1967		1968		1969		1970		1971	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
SEMIMANUFACTURED										
Ingots and other primary forms:										
Puddled bars and pilings, blocks, lump and other primary forms of iron or steel, n.e.c.	5,880	$699	4,462	$729	8,643	$1,015	11,425	$1,721	2,153	$353
Blooms, billets, ingots, slabs, sheet bars, and roughly forged pieces	302,498	26,330	551,708	48,201	1,810,490	142,767	r 3,169,563	270,368	873,503	78,188
Coils for rerolling	60,486	34,446	50,432	26,987	421,531	61,911	340,630	49,903	14,347	7,646
Blanks for tubes and pipes, iron or steel	1,453	251	2,095	241	12,159	1,400	2,175	280	2,334	271
Total	370,317	61,726	608,697	76,158	2,252,823	207,093	r 3,523,793	322,272	892,337	86,458
Bars, rods, angles, shapes and sections:										
Wire rods	7,107	1,598	12,317	2,316	r 98,245	r 16,348	r 151,062	r 18,541	62,843	8,415
Bars, rods, and hollow-drill steel	78,857	26,193	100,200	28,251	215,674	51,797	216,362	48,415	129,796	38,516
Concrete reinforcing bars	21,577	2,904	26,097	3,903	86,762	11,592	r 92,534	r 12,134	40,540	6,089
Angles, shapes, and sections	113,789	18,454	121,899	20,757	170,424	29,261	r 212,405	r 37,554	163,941	31,093
Plates and sheets:										
Steel plates	15,622	8,517	15,584	7,878	25,441	12,603	27,011	14,021	23,353	12,062
Steel sheets	138,591	41,895	273,043	49,486	1,040,381	146,923	r 1,268,386	r 190,079	581,366	82,812
Black plate	19,854	1,895	27,867	3,097	49,723	6,789	r 67,931	r 9,133	85,202	13,527
Iron and steel plates, n.e.c.	254,410	53,725	209,269	43,628	403,715	66,152	r 292,803	r 56,835	161,921	37,492
Tinplate and terneplate	283,542	42,246	293,265	44,550	339,606	52,264	341,275	61,844	224,120	43,101
Tinplate circles, cobbles, strip and scroll	15,380	1,485	15,267	1,405	26,080	2,577	23,910	2,628	9,716	1,186
Hoop and strip	56,874	28,071	56,022	26,456	r 111,595	38,160	r 376,068	r 73,311	129,128	42,619
Total	r 1,005,603	226,983	1,150,830	231,727	r 2,567,646	r 434,466	r 3,069,747	r 524,495	1,611,926	316,912

See footnote at end of table.

Table 12.—U.S. exports of major iron and steel products—Continued

Products	1967		1968		1969		1970		1971	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
MANUFACTURED										
Rails and railway track construction materials:										
Rails	21,617	$3,211	61,654	$8,908	56,105	$7,903	63,980	$10,143	50,291	$8,489
Joints and tie plates	8,605	1,820	11,052	2,149	8,323	1,585	7,976	1,620	12,613	2,563
Sleeper and track material of iron or steel, n.e.c.	2,126	1,304	16,820	5,603	8,708	3,507	9,873	4,104	4,599	2,073
Wire, cables, ropes, bands, and slings	49,099	25,971	63,710	28,960	r 82,480	r 37,172	72,868	r 38,479	62,746	38,282
Tubes, pipes, and fittings:										
Cast-iron pressure pipe and fittings	r 31,546	r 6,991	30,821	9,328	22,782	6,639	22,034	8,173	15,481	8,095
Cast-iron soil pipe and fittings	33,026	6,325	18,277	3,992	9,637	2,701	11,537	3,690	8,288	2,813
Steel tube and pipe fittings, unions, and flanges	17,189	21,261	20,044	25,953	18,344	27,397	r 22,262	r 33,214	21,707	36,679
Steel tube and pipe fittings, welded	13,324	20,258	9,878	15,185	11,641	18,708	12,840	19,469	10,546	18,306
Malleable iron tube and pipe fittings, n.e.c.	1,623	1,625	1,440	1,771	2,087	2,290	1,560	1,857	2,407	2,764
Electrical conduit fittings of iron or steel	10,655	8,040	12,123	6,806	12,317	7,965	10,453	7,971	7,289	8,880
Iron tube and pipe fittings n.e.c.	6,217	8,769	6,650	8,562	7,191	10,562	r 7,935	r 10,414	7,820	12,063
Seamless tubes and pipe	183,802	77,165	228,877	83,999	251,996	99,235	r 243,835	r 100,295	222,768	99,542
Welded, clinched or riveted tubes and pipe	70,602	30,982	93,738	29,122	73,767	28,992	r 100,721	r 40,579	111,564	44,709
Finished structural iron and steel	r 102,393	r 45,811	87,019	38,940	116,054	55,013	142,462	67,727	117,275	63,023
Castings and forgings	r 105,515	r 62,873	r 176,532	r 76,157	r 205,612	r 79,452	r 255,671	r 102,726	295,619	114,320
Storage tanks, lined or unlined	19,514	11,585	19,015	12,165	15,245	11,426	16,539	11,174	15,582	10,494
Nails, tacks, staples and spikes, n.e.c.	7,952	6,078	7,686	5,871	9,349	7,058	7,667	6,499	7,720	5,835
Bolts	19,948	18,122	24,230	20,327	27,753	23,829	26,069	23,634	23,837	23,348
Nuts	5,126	8,967	5,764	8,809	6,567	9,647	5,846	8,684	5,780	9,374
Screws, rivets, washers	14,140	21,246	18,417	23,445	22,003	26,546	21,271	27,622	19,939	27,342
Total	r 724,019	r 388,404	r 913,747	r 416,052	r 967,961	r 467,627	r 1,063,399	r 528,074	1,023,871	538,994
Grand total	r 2,099,939	r 677,113	r 2,673,274	r 723,937	r 5,788,430	r 1,109,186	r 7,656,939	r 1,374,841	3,528,134	942,364

r Revised.

Table 13.—U.S. imports for consumption of pig iron, by country

Country	1969		1970		1971	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
Australia	674	$31	--	--	171	$10
Brazil	--	--	--	--	25,620	1,111
Canada	295,076	14,449	249,129	$13,720	270,048	15,402
Finland	69,843	2,422	--	--	--	--
Germany, West	36,484	1,436	112	9	--	--
Norway	2,811	107	--	--	--	--
South Africa, Republic of	--	--	--	--	10,481	441
Total	404,888	18,445	249,241	13,729	306,320	16,964

Table 14.—U.S. imports for consumption of major iron and steel products

Products	1967		1968		1969		1970		1971	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
Iron products:										
Cast iron pipes and tubes	r 20,183	r $3,593	29,010	$5,594	26,108	$5,883	18,491	$5,534	12,356	$2,516
Malleable cast-iron fittings	7,124	2,763	10,054	3,839	8,287	3,568	9,690	4,229	11,962	6,164
Bars of wrought iron	306	93	478	173	617	153	428	123	226	65
Castings and forgings	r 6,537	r 2,497	10,117	3,572	24,311	6,283	15,819	5,446	12,975	5,219
Total	r 34,150	r 8,946	49,659	13,178	59,323	15,887	44,428	15,332	37,519	13,964
Iron and steel products:										
Ingots, blooms, billets, slabs, and sheet bars	220,289	31,298	298,678	42,359	195,176	37,514	170,647	29,917	274,411	37,191
Bars of steel:										
Concrete reinforcement bars	567,026	42,003	r 739,755	53,514	470,807	40,563	202,699	21,200	514,813	49,809
Solid and hollow steel bars	651,286	75,717	r 976,820	r 108,247	r 903,813	r 119,522	r 727,742	r 115,027	1,027,768	153,831
Hollow drill steel	5,014	1,953	3,708	1,351	5,412	2,036	4,212	1,687	2,392	1,088
Plates and sheets:										
Black plate	9,887	1,001	6,669	648	11,657	1,684	r 5,753	r 987	7,452	1,371
Steel plate	r 1,025,308	r 95,486	r 1,789,686	r 160,738	r 1,201,523	r 120,201	r 968,677	r 124,109	1,572,560	198,952
Steel sheets	r 4,213,336	r 438,076	r 7,327,008	r 761,900	4,891,047	559,808	5,307,553	716,425	7,830,910	1,080,955
Plates and sheets of iron or steel	299	343	229	250	809	692	250	404	417	550
Plates, sheets and strip of iron or steel	r 11,558	r 3,030	r 10,007	r 2,885	r 30,320	r 6,204	r 50,963	r 10,100	75,970	14,255
Strip of iron or steel	67,591	23,112	90,961	28,873	r 96,162	32,921	92,335	r 37,934	114,902	43,678
Tinplate and terneplate	156,351	27,112	227,663	39,156	300,664	51,339	327,725	59,066	417,691	80,595
Structural iron and steel	1,149,580	121,834	1,559,104	157,546	1,517,373	171,669	1,300,847	186,385	1,637,154	231,060
Angles, shapes, and sections	r 506,433	r 45,480	r 668,728	r 56,690	r 522,601	r 48,747	r 416,124	r 50,030	550,350	61,971
Wire rods of steel	1,076,472	r 101,865	1,600,929	150,534	1,260,890	129,803	1,055,570	r 131,810	1,538,288	187,607
Sheet piling	29,669	3,050	67,545	6,654	65,957	6,854	52,335	6,189	89,208	10,605
Pipes, tubes and fittings	r 1,103,854	r 174,767	r 1,664,777	r 258,370	r 1,702,536	r 267,062	r 1,976,749	r 341,441	1,888,942	340,425
Bail ties of iron or steel	16,247	2,138	24,467	3,124	23,881	3,193	15,353	2,279	21,047	3,307
Steel castings and forgings	r 17,413	r 7,874	r 13,193	r 6,013	r 18,539	r 8,352	r 14,039	r 6,660	12,958	5,275
Rails and railway track construction materials	r 36,401	r 5,520	r 53,200	r 7,308	r 67,581	r 10,630	r 72,306	r 11,323	68,863	11,034
Wire:										
Round wire	r 431,179	r 82,953	r 562,740	r 105,985	r 563,265	r 110,097	r 505,164	r 116,561	530,194	125,722
Other wire	145,869	26,769	163,729	30,739	146,127	29,021	143,726	33,875	135,737	33,464
Nails	216,061	31,587	287,873	44,876	301,817	51,184	244,993	47,259	293,562	55,134
Total	r 11,657,123	r 1,342,968	r 18,137,469	r 2,027,760	r 14,297,957	r 1,809,096	r 13,655,762	r 2,050,668	18,605,589	2,727,879
Advanced manufactures: Bolts, nuts, rivets and washers	139,543	47,432	147,952	49,607	172,904	58,795	181,559	73,718	170,966	67,235
Grand total	r 11,830,816	r 1,399,346	r 18,335,080	r 2,090,545	r 14,530,184	r 1,883,778	r 13,881,749	r 2,139,718	18,814,074	2,809,078

r Revised.

Table 15.—Pig iron [1]: World production by country

(Thousand short tons)

Country [2]	1967	1968	1969	1970	1971 [p]
North America:					
Canada	7,108	8,383	7,461	9,086	8,687
Mexico [3]	1,776	2,173	2,313	2,492	2,598
United States	[r] 86,799	88,767	95,003	91,293	81,382
South America:					
Argentina	657	633	[r] 648	899	947
Brazil	3,383	3,714	[r] 4,097	4,632	5,222
Chile	549	487	535	530	552
Colombia [4]	228	218	[r] 215	254	217
Peru [4]	34	122	194	94	99
Venezuela [4]	465	677	573	562	[e] 562
Europe:					
Austria	2,359	2,727	3,104	3,267	3,140
Belgium	9,813	11,411	12,454	11,951	11,467
Bulgaria	1,135	[r] 1,194	1,209	1,325	1,472
Czechoslovakia	7,470	[5] 7,629	[5] 7,726	[5] 8,320	[5] 8,775
Denmark	119	196	223	227	244
Finland	1,174	1,218	1,357	1,348	1,134
France	16,967	17,720	19,603	20,652	19,731
Germany, East [6]	2,783	2,572	2,313	2,198	2,235
Germany, West [7]	29,886	33,045	36,956	36,791	32,826
Greece [8]	[e] 300	[e] 300	320	331	321
Hungary	1,824	1,804	1,932	2,008	2,172
Italy	8,040	8,627	8,593	9,184	9,409
Luxembourg	4,365	4,749	[r] 5,363	5,302	5,057
Netherlands	2,853	3,110	[r] 3,813	3,962	4,144
Norway [8]	702	743	[r] 752	747	691
Poland	6,845	7,083	7,277	7,546	[e] 8,000
Portugal	313	310	370	340	[e] 390
Romania	2,708	3,298	3,833	4,641	4,830
Spain	2,953	3,063	3,674	4,591	5,321
Sweden [3]	2,771	2,919	2,949	3,079	3,037
Switzerland	26	24	28	31	35
U.S.S.R.	80,970	85,297	88,682	93,486	[e] 97,300
United Kingdom	16,801	18,218	18,185	19,297	16,823
Yugoslavia	1,297	1,324	1,321	1,405	1,669
Africa:					
Algeria [e]	11	11	66	77	77
Egypt, Arab Republic of	[e] 220	[e] 220	466	[e] 500	[e] 500
Rhodesia, Southern [4]	287	287	[e] 300	[e] 310	[e] 310
South Africa, Republic of	3,770	4,159	4,333	4,326	[e] 4,400
Tunisia	108	141	144	[e] 140	[e] 140
Asia:					
China, People's Republic of [e] [9]	15,400	20,900	22,000	24,300	30,000
India	7,618	7,883	8,114	7,754	7,234
Israel [e]	40	40	40	40	40
Japan	44,197	51,144	64,096	75,010	80,188
Korea, North [e] [9]	1,930	2,200	2,500	2,600	2,800
Korea, Republic of	26	51	46	54	25
Malaysia [e]	20	70	70	70	70
Taiwan	[r] 93	[r] 83	[r] 87	61	84
Thailand	7	19	12	12	15
Turkey	[r] 933	1,003	1,045	1,139	[e] 1,000
Oceania:					
Australia	5,574	6,142	6,731	6,777	6,755
New Zealand (all sponge iron)	--	--	NA	[e] 25	[e] 220
Total	385,707	418,108	453,126	475,066	474,347

[e] Estimate. [p] Preliminary. [r] Revised. NA Not available.

[1] Table excludes all ferroalloy production except where otherwise noted.

[2] In addition to the countries listed, North Vietnam and Zaire (formerly Congo-Kinshasa) presumably have facilities to produce pig iron, but available information is inadequate to make reliable estimates of output levels.

[3] Includes sponge iron output as follows in thousand short tons: Mexico: 1967—359, 1968—410, 1969—444, 1970—679, 1971—743; Sweden: 1967—168, 1968—168, 1969—196, 1970—203, 1971—191.

[4] Includes ferroalloys, if any are produced.

[5] Includes blast furnace ferroalloys.

[6] May include ferroalloys.

[7] Includes blast furnace ferroalloys except ferromanganese and spiegeleisen.

[8] Includes blast furnace ferroalloys, if any are produced.

[9] Includes ferroalloy production.

Table 16.—Ferroalloys: World production by country[1] and furnace type

(Thousand short tons)

Country	1967	1968	1969	1970	1971 p
BLAST FURNACE[2]					
Europe:					
Belgium	--	21	14	3	--
Czechoslovakia	49	(3)	(3)	(3)	(3)
Denmark	8	8	7	10	8
France	355	412	472	536	491
Germany, West[4]	280	362	262	277	231
Hungary	11	13	--	7	8
Italy	20	18	17	24	20
Poland	128	140	147	151	e 220
Portugal	8	8	12	8	--
Romania	--	15	9	1	--
U.S.S.R.	1,496	1,552	1,305	1,239	e 1,100
United Kingdom	170	185	172	183	170
Africa:					
South Africa, Republic of	57	58	81	51	e 60
Asia: Korea, Republic of[5]	8	e 10	12	15	16
ELECTRIC FURNACE[6]					
North America:					
Canada[2]	168	167	204	210	213
Mexico	60	62	64	83	e 83
United States[2]	2,750	2,621	2,629	2,595	2,692
South America:					
Argentina	20	27	27	35	e 34
Brazil	65	r 73	81	99	e 98
Chile	11	11	13	13	e 13
Europe:					
Austria	6	6	7	6	6
Bulgaria	e 31	31	41	55	47
Czechoslovakia	107	111	107	115	134
Finland	--	9	29	36	39
France	289	301	341	374	386
Germany, West	177	230	277	297	258
Hungary	15	10	15	11	11
Italy	168	168	168	193	192
Norway	r 657	r 787	r 837	610	714
Poland	119	115	126	131	e 132
Spain	89	107	105	123	144
Sweden	230	r 254	272	257	e 250
Switzerland	2	7	7	e 10	25
Yugoslavia	87	94	99	112	128
Africa:					
South Africa, Republic of	338	326	386	389	e 430
Asia:					
India	167	186	221	236	235
Japan	1,042	1,175	1,430	1,835	2,083
Taiwan	2	2	2	6	8
Turkey	9	9	10	e 10	e 10
Oceania:					
Australia[2][7]	96	71	87	87	e 86
Total	9,295	9,762	10,095	10,433	10,775

e Estimate. p Preliminary. r Revised.

[1] In addition to the countries listed, the People's Republic of China and North Korea are known to produce ferroalloys but output of these materials are included in estimates for pig iron in the iron and steel chapter; therefore they have been omitted here to avoid duplication. East Germany also is known to produce ferroalloys but it is not clear from source publications whether output has been included together with that of pig iron in the iron and steel chapter. Also, Colombia, Greece, Norway, Peru, Venezuela, and Southern Rhodesia may produce ferroalloys and output, if any, is also included with pig iron in the iron and steel chapter.

[2] Blast furnace ferroalloy production by Australia, Canada, and United States included under electric furnace output.

[3] Production not reported separately from that of pig iron, which is presented in the iron and steel chapter.

[4] Blast furnace ferromanganese and spiegeleisen only; other blast furnace ferroalloys are included with pig iron production in the iron and steel chapter.

[5] Includes electric furnace ferroalloys if any are produced.

[6] In addition to the countries listed, the United Kingdom and the U.S.S.R. are known to have produced electric furnace ferroalloys and Romania may have produced some electric furnace ferroalloys, but output is not reported and no basis for estimation is available.

[7] Year ended November 30 of that stated.

Table 17.—Raw steel [1]: World production, by country

(Thousand short tons)

Country [2]	1969	1970	1971 p
North America:			
Canada	10,307	12,346	12,130
Cuba e	60	60	60
Mexico	3,825	4,278	4,199
United States [3]	141,262	131,514	120,443
South America:			
Argentina	r 1,863	2,010	2,109
Brazil [4]	5,429	5,941	6,611
Chile	r 707	653	e 660
Colombia	r 300	342	e 360
Peru	r 214	104	e 210
Uruguay	15	18	e 18
Venezuela	r 926	1,022	e 1,045
Europe:			
Austria	4,328	4,496	4,365
Belgium	14,145	13,897	13,717
Bulgaria	1,670	1,984	2,147
Czechoslovakia	11,907	12,655	13,304
Denmark [5]	531	521	519
Finland	1,067	1,289	1,130
France	24,814	26,205	25,198
Germany, East	5,318	5,570	5,897
Germany, West	49,952	49,649	44,439
Greece	496	480	526
Hungary	3,342	3,428	3,428
Ireland	89	e 100	e 100
Italy	18,109	19,045	19,238
Luxembourg	6,086	6,021	5,777
Netherlands	5,204	5,558	6,537
Norway	936	959	951
Poland	12,446	13,002	14,041
Portugal	440	424	e 450
Romania	6,107	7,184	7,499
Spain	6,619	8,189	8,553
Sweden	5,866	6,058	5,810
Switzerland	551	578	586
U.S.S.R.	r 121,618	127,746	133,380
United Kingdom	29,593	31,213	26,648
Yugoslavia	2,447	2,456	2,945
Africa:			
Algeria	20	e 20	e 20
Rhodesia, Southern e	r 154	165	165
South Africa, Republic of [6]	5,061	5,185	e 5,500
Tunisia	110	e 110	e 110
Uganda	23	22	30
United Arab Republic	540	e 550	e 550
Asia:			
Burma e	r 23	19	19
China, People's Republic of e	18,000	20,000	23,000
India [4]	r 7,028	6,722	6,559
Israel e	130	130	130
Japan	90,572	102,870	97,617
Korea, North e	2,200	2,400	2,600
Korea, Republic of	[4] 412	[4] 530	571
Lebanon e	20	20	20
Malaysia e	65	65	75
Pakistan e	110	110	NA
Philippines e	95	95	95
Singapore	--	--	136
Taiwan	299	324	432
Thailand	10	7	132
Turkey	1,290	1,446	1,237
Oceania:			
Australia	7,735	7,520	7,425
New Zealand	e 75	e 75	220
Total	r 632,561	655,380	641,673

e Estimate. p Preliminary. r Revised. NA Not available.

[1] Steel formed in first solid state after melting suitable for further processing or sale.

[2] In addition to the countries listed, North Vietnam produces raw steel, but information is inadequate to make reliable estimates of output levels.

[3] Data from American Iron and Steel Institute (AISI). Excludes steel produced by foundries not reporting output to AISI but reported to Bureau of Census as follows (in thousand tons): 1969—1,906; 1970—1,723; 1971—1,583.

[4] Ingots only.

[5] Apparently excludes shipyard production of steel castings.

[6] Revised to exclude iron castings.