Iron and Steel

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STEEL production during 1963 was about 11 percent above the 1962 rate. Pig iron production increased more than 9 percent, and shipments of steel products increased 7 percent. The automobile industry continued to be the largest customer, but its share of the business was the same as in 1962, when it was 22 percent. There was a significant gain in imports of major iron and steel products from 4.3 million tons in 1962 to 5.6 million in 1963. The European Coal and Steel Community supplied 44 percent, and Japan 36 percent of imports.

Through negotiations, the steel industry's human relations committee resolved areas of conflict which might have resulted in a strike. Early settlement of these industry problems was without precedent and had a steadying influence which was reflected in a smaller drop in summer orders and a larger increase in fall steel buying than had been expected.

There was an increase in the average composite price of steel which just equaled the raise in total employment costs per hour, according to the American Iron and Steel Institute (AISI). The 1963 payroll was $3.9 billion as compared with $3.8 billion in 1962. The net billing value of products shipped and other services was $14.4 billion, compared with $13.8 billion in 1962. Net income was $782 million compared with $566 million in 1962, or a 38-percent increase.

The producing industry was getting acquainted with the many new facets of steel technology. New basic oxygen converters were being installed, continuous casting of steel began commercial operation, more oxygen was being used in open hearth and blast furnaces, and prepared charges of higher iron content were used more widely.

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TABLE 1.—Salient iron and steel statistics

(Thousand short tons)

	1954-58 (average)	1959	1960	1961	1962	1963
United States:						
Pig iron:						
Production	69,077	60,210	66,501	64,853	65,638	71,840
Shipments	68,800	61,245	65,612	65,307	65,727	72,211
Imports for consumption	267	700	331	377	500	645
Exports	260	10	112	416	154	70
Steel:[1]						
Production of ingots and castings (all grades):						
Carbon	94,955	84,539	[2] 90,862	[2] 89,338	[2] 89,160	98,714
Stainless	1,055	1,131	1,004	1,137	1,085	1,204
All other alloy	7,697	7,776	[2] 7,416	[2] 7,539	[2] 8,083	9,343
Total	103,707	93,446	99,282	98,014	98,328	109,261
Capacity, annual Jan. 1	130,545	147,634	148,571	(3)	(3)	(3)
Percent of capacity	79.4	63.3	66.8	(3)	(3)	(3)
Index (1954-58=100)	100.0	90.1	95.7	94.5	94.8	105.4
Total shipments of steel mill products	74,186	69,377	71,149	66,126	70,552	75,555
Imports for consumption of major iron and steel products [4] [5]	1,308	4,615	3,570	3,308	[2] 4,297	5,582
Exports of major iron and steel products	4,281	1,973	3,247	2,221	[2] 2,266	2,664
World production:						
Pig iron [6]	209,970	247,230	285,270	282,370	291,820	308,970
Steel ingots and castings	293,580	336,510	381,560	386,780	[2] 396,260	425,310

[1] American Iron and Steel Institute.
[2] Revised figure.
[3] Data not available.
[4] Data not comparable for all years.
[5] Bureau of the Census.
[6] Includes ferroalloys.

PRODUCTION AND SHIPMENTS OF PIG IRON

U.S. production of pig iron was 9-percent higher than in 1962 and 4-percent higher than the 5-year average of 1954–58. There were 9 more blast furnaces in operation at the end of 1963 than in January. According to AISI, the average production of pig iron per blast-furnace day was 1,427 tons, compared with 1,349 tons in 1962 and 1,305 tons in 1961. All producing areas except Illinois improved production with the Lake Superior region showing the best gain. With 24, 18, and 14 percent, respectively, Pennsylvania, Ohio, and Indiana continued to be the best producers.

There were three fewer blast furnaces at the end of 1963 than at the start. The Armco Steel Corp. completed a new blast furnace at Ashland, Ky., and the Jones and Laughlin Steel Corp. completed one at Cleveland, Ohio; but one furnace was dismantled and four were abandoned.

Metalliferous Materials Consumed in Blast Furnaces.—There were 111.8 million tons of ores and agglomerates, 3.5 million tons of scrap, and 7.1 million tons of miscellaneous materials consumed in pig iron production in 1963. The combined net charge was 1,703 tons of material per ton of pig iron produced, compared with 1,715 tons of charge per ton of pig iron produced in 1962.

The agglomerate charge consisted of 38.3 million tons of sinter, 11.3 million tons of self-fluxing sinter, 19.4 million tons of pellets, 263,000 tons of self-fluxing nodules, 1.6 million tons of unclassified agglomerates, 1.2 million tons of foreign agglomerates, and only 12,577 tons of nodules.

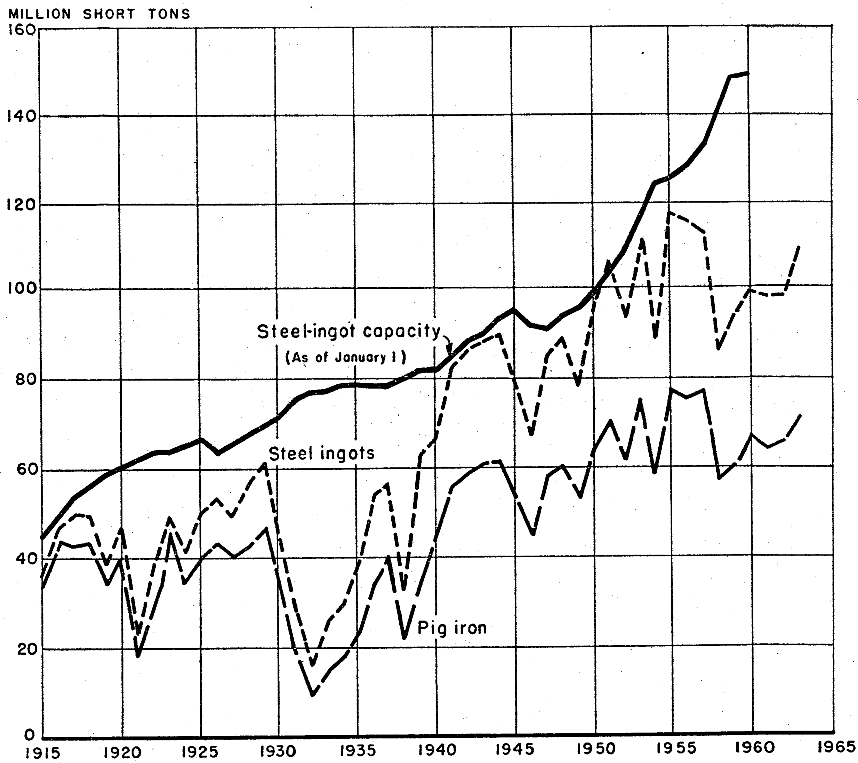

FIGURE 1.—Trends in production of pig iron and steel ingots, 1915–63, and steel-ingot capacity in the United States, 1915–60.

Consumption of miscellaneous materials included 3 million tons of mill cinder and roll scale and 3.9 million tons of open-hearth and Bessemer slag.

Canada, Venezuela, and Chile furnished 94 percent of the foreign iron ore and manganiferous iron ore consumed in U.S. blast furnaces.

TABLE 2.—Pig iron produced and shipped in the United States, by States

(Thousand short tons and thousand dollars)

State	Produced		Shipped from furnaces			
	1962	1963	1962		1963	
	Quantity		Quantity	Value	Quantity	Value
Alabama	3,628	3,908	3,595	$206,565	3,899	$217,020
Illinois	4,715	4,476	4,775	282,210	4,541	261,186
Indiana	8,817	9,957	8,796	504,326	10,050	564,355
Ohio	11,548	12,734	11,470	686,860	12,772	737,990
Pennsylvania	15,726	17,290	15,886	936,184	17,338	1,028,796
California, Colorado, Utah	3,708	4,044	3,719	191,866	4,062	204,378
Kentucky, Tennessee, Texas	1,499	1,759	1,507	81,396	1,782	91,314
Maryland and West Virginia	6,650	6,948	6,608	391,136	6,938	466,552
Michigan and Minnesota	5,432	6,451	5,415	307,634	6,523	360,659
New York	3,915	4,273	3,956	233,962	4,306	290,218
Total	65,638	71,840	65,727	3,822,139	72,211	4,222,468

According to the AISI, blast furnaces consumed 10.3 billion cubic feet of oxygen in 1963, a decrease of 11.4 billion cubic feet from 1962. There were 8.9 billion cubic feet used in blast furnaces in 1961. Data collected by the Bureau of Mines showed that 31.6 billion cubic feet of natural gas, 3.8 billion cubic feet of coke-oven gas, and 43.9 million gallons of oil were injected through blast furnace tuyères in the United States. Also, for the first time, companies reported 29,303 tons of bituminous coal and some anthracite coal was used in blast furnaces in 1963.

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

(Short tons)

Source	1962	1963 [1]	Source	1962	1963 [1]
Brazil	91,804	48,229	Venezuela	4,299,230	4,749,444
Canada	4,652,643	5,829,190	Other countries	133,772	526,359
Chile	1,117,112	1,220,384			
Peru	363,348	191,282	Total	10,657,909	12,564,888

[1] Excludes 19,236,790 tons used in making agglomerates.

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

(Thousand short tons and thousand dollars)

Grade	1962			1963		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Foundry	1,398	$82,304	$58.87	1,657	$92,156	$55.62
Basic	58,919	3,412,990	57.93	65,062	3,803,535	58.46
Bessemer	2,764	166,105	60.10	2,821	171,317	60.73
Low-phosphorus	171	10,846	63.43	173	10,554	61.01
Malleable	2,295	140,550	61.24	2,299	135,070	58.75
All other (not ferroalloys)	180	9,344	51.91	199	9,836	49.43
Total	65,727	3,822,139	58.15	72,211	4,222,468	58.47

[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 States

State	January 1, 1963			January 1, 1964		
	In blast	Out of blast	Total	In blast	Out of blast	Total
Alabama	11	10	21	11	10	21
California	3	1	4	3	1	4
Colorado	3	1	4	3	1	4
Illinois	11	11	22	9	13	22
Indiana	17	6	23	21	2	23
Kentucky	2		2	2	1	3
Maryland	6	4	10	6	4	10
Michigan	9		9	9		9
Minnesota	1	1	2	1	1	2
New York	9	8	17	10	7	17
Ohio	25	24	49	27	22	49
Pennsylvania	33	35	68	37	27	64
Tennessee	1	2	3	1	2	3
Texas	2		2	2		2
Utah	2	3	5	2	3	5
Virginia		2	2		2	2
West Virginia	3	1	4	3	1	4
Total	138	109	247	147	97	244

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 States

(Short tons)

Year and State	Metalliferous materials consumed: Iron and manganiferous ores: Domestic	Metalliferous materials consumed: Iron and manganiferous ores: Foreign	Metalliferous materials consumed: Agglomerates	Metalliferous materials consumed: Net ores and agglomerates [1]	Metalliferous materials consumed: Net scrap [2]	Metalliferous materials consumed: Miscellaneous [3]	Metalliferous materials consumed: Net total	Net coke	Fluxes	Pig iron produced	Metalliferous materials consumed per ton of pig iron made: Net ores and agglomerates [1]	Metalliferous materials consumed per ton of pig iron made: Net scrap [2]	Metalliferous materials consumed per ton of pig iron made: Miscellaneous [3]	Metalliferous materials consumed per ton of pig iron made: Total	Coke and fluxes consumed per ton of pig iron: Net coke	Coke and fluxes consumed per ton of pig iron: Fluxes
1962:																
Alabama	3, 697, 017	748, 471	2, 711, 811	6, 985. 348	120. 462	123, 439	7, 229, 249	3, 215, 390	930, 027	3, 628, 060	1. 925	0. 033	0. 034	1. 992	0. 886	0. 256
Illinois	3, 603, 758	(4)	4, 222, 202	7, 533, 847	280. 962	604, 221	8, 419, 030	3, 540, 610	947, 136	4, 715, 200	1. 598	. 060	. 128	1. 786	. 751	. 201
Indiana	5, 048, 076	886, 883	8, 502, 704	13, 783, 844	59, 861	1, 426, 294	15, 269, 999	5, 775, 139	1, 262, 642	8, 816, 526	1. 563	. 007	. 162	1. 732	. 655	. 143
Ohio	5, 625, 619	1, 923, 772	10, 445, 052	17, 229, 531	861, 265	1, 266, 226	19, 357, 022	8, 185, 856	2, 976, 021	11, 547, 845	1. 492	. 074	. 110	1. 676	. 709	. 258
Pennsylvania	5, 066, 984	2, 345, 637	16, 270, 271	22, 943, 918	946, 298	2, 009, 737	25, 899, 953	10, 763, 289	2, 682, 734	15, 725, 819	1. 459	. 060	. 128	1. 647	. 684	. 171
California, Colorado, Utah	(4)	(4)	3, 104, 467	6, 770, 470	494, 582	103, 291	7, 368, 343	2, 350, 123	628, 964	3, 707, 880	1. 826	. 133	. 028	1. 987	. 634	. 170
Kentucky, Tennessee, Texas	538, 569	363, 309	1, 530, 072	2, 393, 757	116, 922	133, 654	2, 644, 333	768, 030	328, 205	1, 498, 471	1. 597	. 078	. 089	1. 764	. 513	. 219
Maryland and West Virginia	(4)	(4)	6, 437 769	10, 134, 669	167, 094	559, 817	10, 861, 580	4, 386, 140	885, 911	6, 650, 302	1. 524	. 025	. 084	1. 633	. 660	. 133
Michigan and Minnesota	(4)	(4)	5, 925, 960	8, 635, 490	216, 942	211, 959	9, 064, 391	3, 532, 664	1, 234, 232	5, 432, 269	1. 590	. 040	. 039	1. 669	. 650	. 227
New York	1, 725, 440	352. 494	4, 263, 264	6. 109, 912	117, 349	243, 536	6, 470, 797	2, 725, 353	1, 003, 797	3, 915, 160	1. 561	. 030	. 062	1. 653	. 696	. 256
Total	32, 291, 374	10, 657, 909	63, 413, 572	102, 520, 786	3, 381, 737	6. 682, 174	112, 584, 697	45, 242, 594	[5] 12, 879, 669	65. 637, 532	1. 562	. 051	. 102	1. 715	. 689	. 196

1963:																
Alabama	2, 872, 047	4, 129, 847	3, 139, 514	6, 967, 701	119, 372	113, 974	7, 201, 047	3, 240, 051	1, 055, 212	3, 907, 537	1.783	.031	.029	1.843	.829	.270
Illinois	3, 167, 151	(4)	4, 249, 190	7, 222, 567	320, 492	471, 620	8, 014, 679	3, 271, 955	819, 839	4, 476, 337	1.614	.072	.105	1.791	.731	.183
Indiana	6, 095, 289	1, 829, 021	9, 432, 431	16, 632, 897	225, 326	1, 529, 729	18, 387, 952	6, 581, 129	1, 436, 894	9, 957, 082	1.670	.023	.154	1.847	.661	.144
Ohio	5, 119, 029	2, 007, 183	12, 226, 113	18, 558, 176	1, 074, 130	1, 472, 743	21, 105, 049	8, 852, 586	2, 926, 796	12, 733, 837	1.458	.084	.116	1.658	.695	.230
Pennsylvania	5, 424, 093	2, 848, 667	17, 761, 693	25, 335, 965	961, 519	2, 004, 602	28, 302, 086	11, 259, 322	2, 598, 801	17, 289, 805	1.465	.056	.116	1.637	.651	.150
California, Colorado, Utah	(4)	(4)	4, 249, 452	6, 857, 560	139, 988	131, 051	7, 128, 599	2, 387, 376	703, 462	4, 044, 051	1.696	.035	.032	1.763	.590	.174
Kentucky, Tennessee, Texas	1, 059, 349	353, 062	1, 751, 297	3, 119, 595	60, 720	126, 691	3, 307, 006	1, 182, 501	475, 416	1, 759, 012	1.773	.035	.072	1.880	.672	.270
Maryland and West Virginia	(4)	(4)	6, 732, 922	10, 433, 717	187, 988	599, 636	11, 221, 341	4, 446, 682	676, 751	6, 947, 446	1.502	.027	.086	1.615	.640	.097
Michigan and Minnesota	(4)	(4)	7, 663, 773	10, 032, 859	258, 528	307, 979	10, 599, 366	4, 094, 351	1, 433, 738	6, 451, 261	1.555	.040	.048	1.643	.635	.222
New York	1, 647, 015	280, 503	4, 929, 479	6, 618, 290	116, 476	378, 603	7, 113, 369	2, 845, 734	1, 087, 396	4, 273, 375	1.549	.027	.089	1.665	.666	.254
Total	30, 938, 796	12, 564, 888	72, 135, 864	111, 779, 327	3, 464, 539	7, 136, 628	122, 380, 494	48, 161, 687	[6] 13,214,305	71, 839, 743	1.556	.048	.099	1.703	.670	.184

[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] Included in total.
[5] Fluxes consisted of 9,100,454 tons of limestone and 3,779,215 tons of dolomite, excluding 4,424,975 tons of limestone and 1,629,284 tons of dolomite used in agglomerate production at or near steel plants and an unknown quantity used in making agglomerates at mines.
[6] Fluxes consisted of 9,066,274 tons of limestone and 4,148,031 tons of dolomite, excluding 4,686,330 tons of limestone and 1,913,125 tons of dolomite used in agglomerate production at or near steel plants and an unknown quantity used in making agglomerates at mines.

PRODUCTION AND SHIPMENTS OF STEEL

Steel production rose 11 percent in 1963 to 109.3 million short tons. This does not include 1.4 million tons of steel castings made by independent foundries, which produced 1.2 million tons in 1962. Basic oxygen furnaces produced four times as much steel as they had in 1958 and accounted for 7.8 percent of all steel produced in 1963. Open-hearth furnaces accounted for 81.3 percent; electric furnaces 10 percent; and Bessemer 0.9 percent. Pennsylvania, Ohio, Indiana, and Illinois remained the four leading producing States with 23, 17, 14, and 8 percent of production, respectively. Improvement was even throughout the entire Nation. It took 65 years to produce the first billion tons of steel ingots, 18 years to produce the second billion tons, and 10 years to produce the third billion tons of steel ingots.

Total shipments of steel products increased 5 million tons compared with 1962. Automotive uses increased by 1.7 million tons. Construction and contractor's products used 1 million tons more in 1963. Shipments to service centers increased by 1 million tons, while rail transportation accounted for 0.5 million tons of the increase.

Alloy Steel.[2]—The production, 9.3 million tons of alloy steel (excluding stainless), was a 15.6 percent increase over that produced in 1962. This included 50,975 tons of alloy steel for castings. Total stainless production of 1.2 million tons included 1,441 tons of steel for castings, an increase of 10.9 percent over that of 1962. Alloy steel represented 9.7 percent of total steel production.

Austenitic stainless steel (AISI 200 and 300) production was 67.6 percent of total stainless production, an increase of 16.1 percent compared with 1962, whereas production of series 400 steels decreased. Output of AISI 501 and 502 and other high-chromium heat-resisting steels declined nearly 4 percent from 1962.

Open-hearth furnaces produced 59 percent and electric furnaces 40.5 percent of all alloy output. Basic oxygen furnaces accounted for a little over 0.5 percent.

Total output of carbon-steel ingots and castings was 98.7 million tons, nearly an 11-percent improvement compared with 89.2 million tons (revised) for 1962.

Materials Used in Steelmaking.— Consumption of pig iron and scrap for steelmaking totaled 122.7 million tons. Pig iron made up 54 percent of the total, a decrease of 1 percent compared with 1962. Consumption of ore decreased 13 percent, to 5,778,000 tons, of which 69

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[2] The Bureau of Mines uses the American Iron and Steel Institute specifications for alloy steels, which include stainless and any other steel containing one or more of the following elements in the designated percentages: Manganese in excess of 1.65 percent, silicon in excess of 0.60 percent, and copper in excess of 0.60 percent. The specifications also include steel containing the following elements in any quantity specified or known to have been added to obtain a desired alloying effect: Aluminum, boron, chromium, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, and other alloying elements.
Stainless steel includes all grades of steel that contain 10 percent or more of chromium with or without other alloys or a minimum combined content of 18 percent of chromium with other alloys. Valve or bearing steels, high-temperature alloys, or electrical grades with analyses meeting the definition for stainless steels are included. All tool-steel grades are excluded.
Heat-resisting steel includes all steel containing 4 percent or more but less than 10 percent of chromium (excluding tool-steel grades).

percent was foreign ore. According to the AISI, 232,892 tons of fluorspar, 4,997,931 tons of limestone, 1,883,150 tons of lime, and 492,326 tons of other fluxes were consumed in steelmaking. Total consumption of oxygen in 1963 was 69,761 million cubic feet, 28 percent more than in 1962. Nearly 74 percent of the oxygen was used in open-hearth steelmaking, and 23 percent in basic oxygen converters.

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

(Thousand short tons)

Year	Open hearth		Bessemer	Basic oxygen process	Electric [2]	Total
	Basic	Acid				
1954–58 (average)	92,685	528	2,594	[3] 488	7,412	103,707
1959	81,225	444	1,380	1,864	8,533	93,446
1960	85,964	404	1,189	3,346	8,379	99,282
1961	84,108	394	881	3,967	8,664	98,014
1962	82,578	379	805	5,553	9,013	98,328
1963	88,437	397	963	8,544	10,920	109,261

[1] Includes only that steel for castings produced in foundries operated by companies manufacturing steel ingots. Omits about 2 percent of total steel production.
[2] Includes crucible, oxygen converter steel, 1954–55.
[3] Data for 3-year period only.

Source: American Iron and Steel Institute.

CONSUMPTION OF PIG IRON

Domestic consumption of pig iron increased 9 percent in 1963. The East North Central and Middle Atlantic States again took 76 percent of the total.

TABLE 8.—Metalliferous materials consumed in steel furnaces in the United States

(Thousand short tons)

Year	Iron ore		Agglomerates [1]	Pig iron	Ferro-alloys [2]	Iron and steel scrap
	Domestic	Foreign				
1954–58 (average)	2,860	4,666	1,521	61,224	1,433	53,981
1959	1,690	5,238	961	54,699	1,380	49,794
1960	1,570	6,251	931	60,092	1,395	51,140
1961	1,913	5,277	855	59,418	1,367	49,455
1962	1,875	4,768	[3] [4] 644	60,561	1,408	49,606
1963	1,783	3,995	[5] 885	66,188	1,557	56,506

[1] Includes consumption of pig iron and scrap by ingot producers and iron and steel foundries.
[2] Includes ferromanganese, spiegeleisen, silicomanganese, manganese briquets, manganese metal, ferrosilicon, ferrochromium alloys, and ferromolybdenum.
[3] Includes 20,039 tons of sinter, 342,466 tons of pellets, 276,632 tons of nodules, 702 tons of briquets, 3,661 tons of other agglomerates. (532,031 tons of foreign origin.) 1959–62 see Iron and Steel chapter, Minerals Yearbook, v. I, p. 695.
[4] Revised figure.
[5] Includes 71,116 tons of sinter, 487,886 tons of pellets, 300,411 tons of nodules, and 25,189 tons of other agglomerates. (875,573 tons of foreign origin.)

TABLE 9.—Consumption of pig iron in the United States, by type of furnace

Type of furnace or equipment	1962		1963	
	Thousand short tons	Percent of total	Thousand short tons	Percent of total
Open hearth	54,509	81.8	57,291	78.8
Bessemer	792	1.2	1,603	2.2
Oxygen converter	5,020	7.5	7,082	9.8
Electric [1]	240	.4	212	.3
Cupola	3,402	5.1	3,597	4.9
Air	186	.3	178	.2
Direct castings	2,446	3.7	2,726	3.8
Total	66,595	100.0	72,689	100.0

[1] Includes a small quantity of pig iron consumed in crucible furnaces.

TABLE 10.—Consumption of pig iron in the United States, by districts and States

(Short tons)

District and State	1962	1963
New England:		
Connecticut	33,024	30,802
Maine and New Hampshire	2,251	1,741
Massachusetts	59,876	49,025
Rhode Island	41,836	42,660
Vermont	7,288	6,020
Total	144,275	130,248
Middle Atlantic:		
New Jersey	119,757	113,289
New York	3,355,305	3,837,813
Pennsylvania	15,975,716	17,460,390
Total	19,450,778	21,411,492
East North Central:		
Illinois	4,932,854	4,837,935
Indiana	8,972,216	9,863,042
Michigan	5,534,555	6,531,984
Ohio	11,430,509	12,556,922
Wisconin	186,327	173,669
Total	31,056,461	33,963,552
West North Central:		
Iowa	71,050	74,685
Kansas and Nebraska	5,337	5,850
Minnesota	446,331	454,249
Missouri	29,247	33,490
Total	551,965	568,274
South Atlantic:		
Delaware and Maryland	4,802,288	4,844,795
Florida and Georgia	11,445	12,306
South Atlantic—Con.		
North Carolina	29,457	30,213
South Carolina	18,684	17,949
Virginia and West Virginia	1,950,305	2,229,954
Total	6,812,179	7,135,217
East South Central:		
Alabama	3,104,152	3,427,531
Kentucky, Mississippi, Tennessee	852,388	963,950
Total	3,956,540	4,391,481
West South Central:		
Arkansas, Louisiana, Oklahoma	8,302	7,990
Texas	780,226	942,427
Total	788,528	950,417
Rocky Mountain:		
Arizona and Nevada	162	92
Colorado, Idaho, Montana, Utah	2,012,961	2,230,501
Total	2,013,123	2,230,593
Pacific Coast:		
California and Hawaii	1,817,823	1,891,049
Oregon and Washington	3,810	16,417
Total	1,821,633	1,907,466
Grand total	66,595,482	72,688,740

PRICES

There were several changes in pig iron and steel prices during 1963. The composite average price of pig iron was $66.33 per long ton in January, high for the year.[3] It dropped to $63.33 from February

[3] Iron Age. V. 193, No. 1, Jan. 2, 1964, pp. 195, 199.

through August and then to $63.11 for the balance of 1963. The composite price of 6.196 cents per pound for steel, unchanged since 1959, lasted through April. It rose then to 6.279 cents per pound through September and then to 6.368 cents for the balance of the year. This made an annual composite price of 6.273 cents per pound during 1963.

TABLE 11.—Average value of pig iron at blast furnaces in the United States, by States

(Per short ton)

State	1954–58 (average)	1959	1960	1961	1962	1963
Alabama	$50.68	$56.81	$56.52	$56.62	$57.46	$55.66
California, Colorado, Utah	54.20	60.47	59.73	50.50	51.59	50.31
Illinois	54.84	60.12	60.30	60.42	59.10	57.52
Indiana	54.22	58.82	58.90	58.96	57.34	56.15
New York	56.66	61.01	62.54	60.05	59.13	67.40
Ohio	52.68	59.50	57.79	60.78	59.89	57.78
Pennsylvania	55.27	59.84	60.12	59.48	58.93	59.34
Other States [1]	55.47	58.38	58.06	57.44	57.66	60.26
Average	54.40	59.33	59.53	58.51	58.15	58.47

[1] Comprises Kentucky, Maryland, Michigan, Minnesota, Tennessee, Texas, West Virginia, and Massachusetts (1954–60).

TABLE 12.—Average prices of chief grades of pig iron

(Per short ton)

Month	Foundry pig iron at Birmingham furnaces, 1963	Foundry pig iron at Valley furnaces, 1963	Bessemer pig iron at Valley furnaces, 1963	Basic pig iron at Valley furnaces, 1963
January–December	53.13	56.70	57.14	56.25

Source: Metal Statistics.

TABLE 13.—Free-on-board value of steel mill products in the United States, in 1962 [1]

(Cents per pound)

Product	Carbon	Alloy	Stainless	Average
Ingots	4.140	15.905	32.151	13.640
Semifinished shapes and forms	5.767	10.210	40.452	6.530
Plates	6.596	9.711	[3] 60.865	7.724
Sheets and strips	7.012	15.388	48.445	7.912
Tin mill products	9.023	----------	----------	9.023
Structural shapes and piling	6.409	8.552	----------	6.434
Bars	7.517	13.344	66.307	8.967
Rails and railway-track material	8.206	----------	----------	8.206
Pipes and tubes	10.389	18.800	157.762	11.653
Wire and wire products	12.850	37.916	80.811	14.018
Other rolled and drawn products	(2)	37.774	60.154	40.480
Average total steel	7.696	13.737	57.332	8.583

[1] This table represents the weighted average value based on the quantity of each type of steel shipped; therefore, it reflects shifts in the distribution of the 3 classes of steel.
[2] Included with rails and railway-track material.
[3] Includes unknown quantity of hot-rolled bars.

Source: Computed from figures supplied by the Bureau of the Census.

FOREIGN TRADE

For the fifth consecutive year, imports of steel mill products exceeded exports.

Imports.—Imports of iron and steel products totaled 5.6 million tons for 1963. Of these, 80 percent came from the European Coal and Steel Community and Japan. Imports of pig iron were 645,334 tons, compared with 500,074 tons in 1962.

Exports.—Exports of iron and steel products totaled 2.7 million tons, an increase of 17 percent over 1962. Exports of pig iron were 70,154 tons, compared with 154,380 tons in 1962.

TABLE 14.—U.S. imports for consumption of pig iron, by countries

(Short tons)

Country	1954–58 (average)	1959	1960	1961	1962	1963
North America: Canada	234,092	437,095	281,593	349,403	[1] 386,296	387,449
South America: Brazil	3,924					
Europe:						
Belgium-Luxembourg			4,408			
Finland		10,253			681	12,123
Germany, West	9,164	[2] 71,805	386	719	56,341	87,435
Netherlands	2,077	4,427	1,575			
Norway	876	168			3,584	3,319
Portugal		4,395				
Spain	4,514	78,499	21,551	19,113	42,416	45,161
Sweden	2,054	1,071	1,445	1,201	1,416	10,146
U.S.S.R.		1,550	1,298	396		
United Kingdom		51			94	8
Total	18,685	172,219	30,663	21,429	104,532	158,192
Asia:						
India	3,805	56	6,742			
Japan		10,674				
Total	3,805	10,730	6,742			
Africa:						
Rhodesia and Nyasaland, Federation of [3]	437	4,863	392			
South Africa, Republic of [4]	1,414	70,519	7,543	4,096	5,030	76,696
Total	1,851	75,382	7,935	4,096	5,030	76,696
Oceania: Australia	4,864	4,167	3,914	2,252	4,216	22,997
Grand total:						
Short tons	267,221	699,593	330,847	377,180	[1] 500,074	645,334
Value	$14,255,010	$35,493,259	$18,351,333	$20,511,391	$24,684,220	$28,936,920

[1] Revised figure.
[2] Includes 110 tons from East Germany.
[3] Classified as Southern Rhodesia through June 30, 1954; 1,562 short tons was produced from January through June 1954.
[4] Effective Jan. 1, 1962, formerly Union of South Africa.

Source: Bureau of the Census.

TABLE 15.—U.S. imports for consumption of major iron and steel products

Products	1962		1963	
	Short tons	Value	Short tons	Value
Iron products:				
Bar iron, iron slabs, blooms, or other forms	211	$64,710	265	$87,906
Pipes and fittings:				
Cast-iron pipe and fittings	35,540	4,043,946	37,949	4,117,651
Malleable cast-iron pipe fittings	3,325	1,304,389	3,936	1,534,890
Castings and forgings	15,056	5,220,909	22,258	7,606,168
Total	54,132	10,633,954	64,408	13,346,615
Steel products:				
Steel bars:				
Concrete reinforcement bars	607,024	44,284,929	545,203	39,254,792
Solid and hollow, n.e.s	[1] 126,356	[1] 17,012,239	206,839	19,504,819
Hollow and hollow drill steel	2,567	1,188,238	2,173	975,144
Wire rods, nail rods, and flat rods up to 6 inches in width	[1] 644,271	[1] 61,985,868	800,994	76,606,414
Boiler and other plate iron and steel, n.e.s	[1] 216,570	[1] 26,399,846	(2)	(2)
Steel ingots, blooms, and slabs; billets, solid and hollow	[1] 174,372	[1] 13,545,558	260,355	24,831,885
Die blocks or blanks, shafting, etc	2,100	828,928	1,757	664,005
Circular saw plates	54	67,991	[3] 146	[3] 70,639
Sheets of iron or steel, common, or black and boiler or other plate of iron or steel	215,179	26,261,302	(2)	(2)
Sheets and plates and steel n.s.p.f	10,976	4,669,932	1,018,299	121,688,057
Tinplate, terneplate, and taggers' tin	52,479	8,586,908	82,941	14,197,413
Structural iron and steel	[1] 708,795	[1] 74,872,972	933,075	89,203,358
Rails for railways	10,560	905,247	6,759	936,452
Rail braces, bars, fishplates, or splice bars and tie plates	268	29,123	638	67,260
Steel pipes and tubes	[1] 635,615	[1] 93,414,620	735,463	103,685,865
Wire:				
Barbed	66,598	8,762,116	90,029	11,522,607
Round wire, n.e.s	242,250	44,608,626	277,874	49,707,055
Telegraph, telephone, etc. except copper, covered with cotton jute, etc	[1] 781	[1] 357,761	1,751	1,012,236
Flat wire and iron and steel strips	86,366	17,337,359	99,607	23,107,292
Rope and strand	39,323	11,958,768	47,561	13,610,182
Galvanized fencing wire and wire fencing	73,042	9,641,734	50,762	6,887,012
Iron and steel used in card clothing	(4)	[1] 241,391	(4)	349,694
Hoop and band iron and steel, for baling	24,694	3,174,978	27,707	3,701,291
Hoop, band and strips, or scroll iron or steel, n.s.p.f	12,909	2,265,682	11,714	2,229,591
Nails	[1] 281,807	[1] 40,085,434	308,274	41,297,304
Steel castings and forgings	8,384	1,490,612	7,443	1,636,589
Total	[1] 4,243,340	[1] 513,978,162	5,517,364	646,746,956
Advanced manufactures:				
Bolts, nuts, and rivets	67,934	20,096,908	70,403	20,227,151
Chains and parts	9,506	6,102,429	9,243	6,200,689
Hardware, builders		2,961,011		2,748,845
Hinges and hinge blanks		1,875,449		2,014,423
Screws (wholly or chiefly of iron or steel)		3,137,480		3,629,403
Tools		20,071,345		18,672,207
Other		1,550,041		923,728
Total		55,794,663		54,416,446
Grand total		[1] 580,406,779		714,510,017

[1] Revised figure.
[2] Due to changes in classification of iron and steel plates by the Bureau of the Census, all classes of iron and steel plates and sheets for this table have been tabulated under "sheets and plates and steel n.s.p.f.", for 1963.
[3] Data are Jan.–Aug.; effective Sept. 1, 1963 saws were reported in number, Sept.–Dec., 127250 ($181,280).
[4] Weight not recorded.

Source: Bureau of the Census.

TABLE 16.—U.S. exports of major iron and steel products

Products	1962		1963	
	Short tons	Value	Short tons	Value
Semimanufactures:				
Steel ingots, blooms, billets, slabs, and sheet bars	[1] 252,998	[1] $20,526,277	304,516	$24,665,086
Iron and steel bars, and rods:				
Carbon-steel bars, hot-rolled, and iron bars	52,491	9,682,725	47,269	9,105,344
Concrete reinforcement bars	22,398	2,950,860	46,009	6,016,137
Other steel bars	27,731	12,037,785	24,901	12,352,386
Wire rods	17,006	3,853,784	24,033	4,145,703
Iron and steel plates, sheets, skelp, and strips:				
Plates, including boilerplate, not fabricated	119,856	26,187,475	139,483	26,389,591
Skelp iron and steel	11,528	1,121,853	2,482	234,626
Iron and steel sheets, galvanized	124,692	25,046,171	108,282	21,601,977
Steel sheets, black, unglavanized	458,073	102,825,501	457,610	114,057,783
Strip, hoop, band, and scroll iron and steel:				
Cold-rolled	33,196	15,784,152	37,732	17,625,323
Hot-rolled	31,617	6,779,069	51,297	11,260,004
Tinplate and terneplate	329,852	53,011,244	342,363	51,059,805
Tinplate circles, cobbles, strip, and scroll shear butts	24,633	2,756,006	23,355	2,489,110
Total	[1] 1,506,071	[1] 282,562,902	1,609,332	301,002,875
Manufactures-steel mill products:				
Structural iron and steel:				
Water, gas, and other storage tanks (unlined), complete and knockdown material	[1] 20,468	[1] 8,611,680	21,031	9,759,863
Structural shapes:				
Not fabricated	145,702	20,841,902	154,229	22,975,571
Fabricated	[1] 58,817	[1] 29,474,702	169,750	37,052,602
Plates and sheets, fabricated, punched, or shaped	[1] 15,945	[1] 5,429,148	16,463	5,645,433
Metal lath	1,215	479,552	1,163	477,968
Frames, sashes, and sheet piling	13,881	2,940,590	8,235	1,953,252
Railway-track material:				
Rails for railways	102,191	12,922,089	44,045	5,970,153
Rail joints, splices bars, fishplates, and tieplates	19,921	4,645,589	45,323	9,183,035
Switches, frogs, and crossings	3,816	1,158,206	3,867	1,582,820
Railroad spikes	381	110,574	3,436	1,071,737
Railroad bolts, nuts, washers, and nut locks	881	445,877	6,023	1,429,887
Tubular products:				
Boiler tubes	[1] 10,470	[1] 7,573,794	11,840	8,066,150
Casing and line pipe	86,083	27,581,701	122,520	34,501,999
Seamless black and galvanized pipe and tubes, except casing, line and boiler, and other pipes and tubes	[1] 32,077	[1] 8,699,114	42,553	12,074,972
Welded black pipe	[1] 10,158	[1] 3,097,688	7,357	2,069,338
Welded galvanized pipe	5,609	1,305,537	12,017	2,610,468
Malleable-iron screwed pipe fittings	1,192	1,389,825	1,279	1,308,765
Cast-iron pressure pipe and fittings	22,630	4,209,718	119,397	15,450,543
Cast-iron soil pipe and fittings	6,373	1,651,629	7,246	1,803,201
Iron and steel pipe, fittings, and tubing, n.e.c	[1] 50,205	[1] 41,929,545	58,743	46,352,732
Wire and manufactures:				
Barbed wire	12,896	2,685,658	23,178	4,294,517
Galvanized wire	10,108	3,116,705	22,492	6,025,095
Iron and steel wire, uncoated	16,206	5,504,412	21,477	6,956,824
Spring wire	1,469	986,920	1,418	915,333
Wire rope and strand	9,553	5,332,085	9,227	5,042,761
Woven-wire screen cloth	1,956	[2] 2,031,332	1,540	[2] 2,138,642
All other	[1] 15,591	[1] 9,680,812	17,160	10,798,742
Nails and bolts, iron and steel, n.e.c.:				
Wire nails, staples, and spikes	[1] 3,591	[1] 2,969,254	4,348	3,587,563
Bolts, screws, nuts, rivets, and washers, n.e.c	15,025	19,210,961	19,580	22,465,248
Tacks	692	455,429	671	455,958
Castings and forgings: Iron and steel, including car wheels, tires, and axles	[1] 64,425	[1] 24,575,538	76,766	25,533,033
Total	[1] 759,527	[1] 261,047,566	1,054,374	309,554,205

See footnotes at end of table.

TABLE 16.—U.S. exports of major iron and steel products—Continued

Products	1962		1963	
	Short tons	Value	Short tons	Value
Advanced manufactures:				
Building (prefabricated and knockdown)	-----------	[1] $7,849,479	-----------	$6,458,148
Chains and parts	7,993	10,069,098	8,189	11,201,215
Construction material	9,264	6,598,605	8,099	5,888,865
Hardware and parts	-----------	23,563,072	-----------	24,422,387
House-heating boilers and radiators	-----------	6,666,330	-----------	6,197,711
Oil burners and parts	-----------	8,856,731	-----------	9,712,142
Plumbing fixtures and fittings	-----------	2,701,981	-----------	4,987,304
Tools	-----------	[1] 59,146,072	-----------	39,725,808
Utensils and parts (cooking, kitchen, and hospital)	-----------	3,774,726	-----------	3,298,068
Other	-----------	[1] 45,447,634	-----------	53,391,629
Total	-----------	[1] 174,673,728	-----------	165,283,277
Grand total	-----------	[1] 718,284,196	-----------	775,840,357

[1] Revised figure.
[2] Includes wire cloth as follows: 1962, $1,455,917 (7,463,741 square feet); 1963, $1,638,819 (3,404,155 square feet).

Source: Bureau of the Census.

WORLD REVIEW [4]

World production of pig iron (including ferroalloys) reached a new high with a 5-percent increase. The largest increase, 6 million tons, was in the United States. World steel production increased 7 percent compared with 1962. The United States, with an increase in production of nearly 11 million tons, produced nearly 26 percent of the total world amount, but the 14-percent increase in production in Japan was the world's largest.

TABLE 17.—World production of pig iron (including ferroalloys) by countires [1] [2]

(Thousand short tons)

Country [1]	1954–58 (average)	1959	1960	1961	1962	1963
North America:						
Canada	3,327	4,318	4,436	5,064	5,427	6,059
Mexico	425	635	756	864	912	947
United States	71,294	62,135	68,620	66,717	67,636	73,853
Total	75,046	67,088	73,812	72,645	73,975	80,859
South America:						
Argentina	36	39	198	437	438	[3] 495
Brazil	1,333	1,750	1,965	2,050	2,064	[3] 2,205
Chile	356	320	293	314	422	461
Colombia	131	160	204	208	164	223
Venezuela	--------	--------	--------	6	136	333
Total	1,856	2,269	2,660	3,015	3,224	[3] 3,717

See footnotes at end of table.

[4] Values in this section are U.S. dollars based on the average rate of exchange by the Federal Reserve Board unless otherwise specified.

TABLE 17.—World production of pig iron (including ferroalloys) by countries [1] [2]—Continued

(Thousand short tons)

Country [1]	1954-58 (average)	1959	1960	1961	1962	1963
Europe:						
Austria	1,846	2,028	2,467	2,500	2,339	2,326
Belgium	5,925	6,575	7,223	7,104	7,439	7,622
Bulgaria	37	195	212	227	246	222
Czechoslovakia	3,613	4,679	5,176	5,480	5,732	5,792
Denmark	56	64	76	73	76	[3] 75
Finland	115	119	151	168	377	413
France	12,312	13,951	15,921	16,372	15,619	15,985
Germany:						
East	1,730	2,092	2,199	2,239	2,287	2,370
West (including Saar)	19,369	23,814	28,372	28,033	26,732	25,253
Hungary	980	1,217	1,373	1,440	1,523	1,530
Italy	2,082	2,416	3,113	3,528	4,054	4,264
Luxembourg	3,494	3,795	4,173	4,226	3,965	3,954
Netherlands	785	1,259	1,485	1,606	1,732	1,884
Norway	472	686	794	834	797	821
Poland	3,709	4,822	5,030	5,258	5,854	5,947
Portugal	[3] [4] 20	40	45	134	248	276
Rumania	662	933	1,118	1,211	1,666	1,881
Spain	1,144	1,889	2,124	2,340	2,374	2,194
Sweden	1,458	1,657	1,799	2,094	2,014	2,075
Switzerland	47	[3] 50	[3] 60	[3] 60	[3] 60	49
U.S.S.R.[5]	38,730	47,368	51,541	56,100	60,919	64,706
United Kingdom	14,511	14,092	17,655	16,517	15,335	16,342
Yugoslavia	676	995	1,123	1,161	1,216	1,168
Total [5]	113,773	134,736	153,230	158,705	162,604	167,149
Asia:						
China	[6] 5,800	[6] 22,600	30,300	[3] 16,500	[3] 16,500	[3] 18,700
India	2,201	3,519	4,705	5,621	6,522	7,431
Japan	6,899	10,908	13,604	18,059	20,325	22,525
Korea:						
North	247	765	940	1,025	1,337	[3] 1,280
Republic of	----------	9	15	10	----------	[3] 6
Taiwan (Formosa)	17	36	26	58	69	60
Thailand	3	8	7	6	6	7
Turkey [7]	235	260	272	260	323	233
Total [5]	15,402	38,105	49,869	41,539	45,082	50,242
Africa:						
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	71	79	95	243	266	276
South Africa, Republic of	1,513	1,992	2,204	2,566	2,680	2,691
United Arab Republic (Egypt)	[8] 17	130	163	[3] 110	[3] 110	----------
Total	1,601	2,201	2,462	2,919	3,056	2,967
Oceania: Australia [9]	2,288	2,829	3,240	3,549	3,879	[10] 4,032
World total (estimate)	209,970	247,230	285,270	282,370	291,820	308,970

[1] Pig iron is also produced in Republic of the Congo, but quantity produced is believed insufficient to affect estimate of world total.
[2] This table incorporates some revisions. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[3] Estimate.
[4] One year only as 1958 was the first year of commercial production.
[5] U.S.S.R. in Asia included with U.S.S.R. in Europe.
[6] Based on figures from Chinese sources. 1958 does not include approximately 4,000,000 tons produced of sub-standard grade iron produced at small plants. 1959 production probably includes pig iron obtained from reworking the low-grade product of 1958 and an unreported quantity (probably relatively small) of sub-standard iron from small plants most of which were shut down early in the year.
[7] Includes foundry iron through 1962.
[8] Average annual production 1955-58.
[9] Includes scrap.
[10] Excludes ferroalloys.

TABLE 18.—World production of steel ingots and castings by countries [1]

(Thousand short tons)

Country [1]	1954–58 (average)	1959	1960	1961	1962	1963
North America:						
Canada	4,492	5,901	5,790	6,466	7,173	8,190
Mexico	955	1,473	1,657	1,882	1,896	2,235
United States [2]	103,707	93,446	99,282	98,014	98,328	109,261
Total	109,154	100,820	106,729	106,362	107,397	119,686
South America:						
Argentina	290	236	305	486	711	987
Brazil	[3] 1,519	2,072	2,530	2,756	[4] 2,870	[4] 2,980
Chile	381	457	465	400	546	539
Colombia	88	121	173	194	151	219
Peru	[5] 22	56	66	83	79	80
Venezuela	[4] 55	[4] 55	52	83	248	401
Total	2,355	2,997	3,591	4,002	4,605	5,206
Europe:						
Austria	2,305	2,769	3,487	3,418	3,274	3,249
Belgium	6,509	7,096	7,923	7,728	8,115	8,294
Bulgaria	140	254	279	375	466	508
Czechoslovakia	5,357	6,764	7,460	7,764	8,421	8,375
Denmark	269	322	349	356	405	396
Finland	207	262	285	305	335	346
France	14,306	16,617	18,907	19,211	19,004	19,353
Germany:						
East	2,980	3,535	3,678	3,796	3,993	3,997
West (including Saar)	25,608	32,446	37,589	36,881	35,895	34,830
Greece	85	99	[4] 140	[4] 150	[4] 170	[4] 180
Hungary	1,661	1,939	2,080	2,263	2,572	2,617
Ireland	32	44	44	31	21	22
Italy	6,299	7,454	9,071	10,283	10,755	11,195
Luxembourg	3,611	4,038	4,502	4,534	4,420	4,445
Netherlands	1,231	1,841	2,141	2,173	2,301	2,582
Norway	288	470	540	550	539	599
Poland	5,369	6,790	7,585	7,974	8,470	8,823
Rumania	875	1,565	1,991	2,344	2,702	2,981
Spain	1,469	1,995	2,157	2,579	2,547	2,606
Sweden	2,481	3,155	3,547	3,922	3,982	4,297
Switzerland [6]	213	276	303	327	351	342
U.S.S.R. [7]	53,242	66,107	71,973	77,990	84,106	88,427
United Kingdom	22,452	22,609	27,222	24,737	22,950	25,222
Yugoslavia	987	1,432	1,590	1,689	1,758	1,750
Total [7]	157,976	189,879	214,843	221,380	227,552	235,436
Asia:						
China	5,050	[8] 14,720	[8] 20,340	10,500	11,000	13,000
India	1,939	2,726	3,623	4,488	5,635	6,576
Israel	[9] 14	26	44	68	88	74
Japan	11,673	18,330	24,403	31,160	30,364	34,724
Korea:						
North	226	497	707	855	1,157	1,127
Republic of	13	42	55	73	163	176
Taiwan (Formosa)	80	175	220	218	201	303
Thailand	4	7	8	9	8	[4] 8
Turkey	195	236	292	312	267	365
Total [7]	19,194	36,759	49,692	47,683	48,883	56,353
Africa:						
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	62	51	95	101	88	55
South Africa, Republic of	1,804	2,091	2,328	2,738	2,903	3,124
United Arab Republic (Egypt) [4]	103	110	150	165	165	410
Total	1,969	2,252	2,573	3,004	3,156	3,589
Oceania: Australia	2,934	3,803	4,137	4,351	4,667	5,040
World total (estimate)	293,580	336,510	381,560	386,780	396,260	425,310

[1] This table incorporates some revisions. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[2] Data from American Iron and Steel Institute. Excludes production of castings by companies that do not produce steel ingots.
[3] Includes iron castings.
[4] Estimate.
[5] One year only as 1958 was the first year of commercial production.
[6] Including secondary.
[7] U.S.S.R. in Asia included with U.S.S.R. in Europe.
[8] Claimed figures. Data appear to be exaggerated by a fifth or more.
[9] Average annual production 1957–58.

NORTH AMERICA

Canada.—The Algoma Steel Corp. at Sault Ste. Marie, Ontario, equipped two blast furnaces with coke oven gas injection to reduce coke consumption and increase hot metal production. They are planning to use screened sinter also.

The Steel Co. of Canada, Ltd., announced plans for the installation of a 148-inch-wide plate mill, claimed to be the widest in Canada. The company also announced plans to build a research center for steel production in Burlington, near Hamilton, Ontario.

Construction started on a steel rolling mill with an annual capacity of 25,000 tons at Calgary, Alberta. The mill will use steel from an electric arc furnace using scrap feed.

Costa Rica.—Costa Rica has issued a charter to Cia. de Hierro del Pacifico, S.A., to exploit the black sand deposits at Caldera on the Pacific Coast. Iron for steelmaking will then be extracted by the R–N process, now used only in Japan, which leaves a titanium-rich slag which will be stockpiled.

SOUTH AMERICA

Argentina.—Construction of a $200 million integrated steel mill at Rio Santiago, in La Plata province, is being considered jointly by Propulsora Siderurgica, S.A., and Italian interests.

Brazil.—Usinas Siderurgicas de Minas Gerais (USMINAS) attained a nominal capacity of 500,000 tons of steel ingots during 1963. Financing from France has been obtained for study of the problems of erecting a 750,000 ingot-ton steel mill at Santa Cruz.

Chile.—The Export-Import Bank has granted a loan of $8.3 million to Cia. de Acero del Pacifico to finance the expansion of its steel mill at Huachipato. An oxygen plant producing 110 tons per day is planned for the mill. In addition, financing has been arranged for 2,000 single-family homes to be erected in the area for steel mill employees.

Venezuela.—Venezuela announced plans to construct a plant to convert ore into reduced or sponge iron, with a projected output of 5 million tons by 1970 and 10 million tons by 1975. About 80 percent of the output will be exported.

EUROPE

European Coal and Steel Community (ECSC).—At the end of 10 years, steel production in the European Coal and Steel Community was nearly double the production in 1953. Internal trade expanded more than five times, constituting over 20 percent of the total ECSC trade.

In December, the ministers of the European Coal and Steel Community decided not to raise tariffs as some member nations had been demanding. Italy, with the highest tariffs, and the Netherlands, with the lowest, both opposed any revision. The ECSC ministers were aware of U.S. opposition to any tariff raise, and fear of U.S. tariff retaliation may have been a factor in their decision.[5]

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[5] Wall Street Journal. V. 162, No. 109, Dec. 3, 1963, p. 7.

A rolling mill complex which includes a blooming mill, a continuous billet mill, and a wire rod mill has been started by Cockerill-Ougree at Liege, Belgium. The new complex costs about $40 million and will handle about 792,000 short tons annually.

An inspection technique for continuous cast steel was developed by the National Metallurgy Research Center of Brussels, Belgium. As the cast section emerges from the water-cooled mold, a low-energy gamma ray, like that from cobalt 60, is beamed upon the steel and the results are evaluated automatically.[6]

Allegheny-Longdoz dedicated their new plant at Genk, Belgium, near Liège, on November 7.

Usinor of Dunkirk increased blast furnace capacity by 5,000 tons daily with the addition of two blast furnaces during 1963.

Finland.—Except for a 10-percent gain in pig iron production compared with 1962, the iron and steel industry suffered slight losses in production in 1963.

Sweden.—The iron and steel industry set new records in 1963, producing over 4 million short tons of crude steel and over 2 million tons of pig iron. Exports exceeded imports by 54 percent, a 20-percent gain over that of 1962.

The erection of a new tube rolling mill has been started at Hofors Bruk by A.B. Svenska Kullagerfabriken (SKF). The mill will have an annual capacity of 35,000 to 40,000 tons. The SKF-Hofors Works is installing an IBM 1710 unit to control steel production by electronic data processing from steel furnace to rolling mill.

A research institute in steelmaking processes to be sponsored jointly by the State-owned iron ore mining company and the Swedish Ironmasters' Association is to be erected at Luleå in northern Sweden.

Sandvik Steel Works Co., Ltd., started production of stainless steel tubing by a new process under license from Cefilac of France. The initial capacity is 12,000 tons per year.

United Kingdom.—The English Steel Co.'s new Tinsley Park steelworks in Sheffield was opened October 15. The $73 million plant has a rated capacity of 500,000 ingot tons of alloy steel per year. There are two 100-ton electric arc furnaces with a DH degassing plant. Use of the degassing plant makes possible the production of two different steels from one heat by the addition of alloys under the vacuum.[7]

The British Iron and Steel Research Association (BISRA) has completed experimental work on spray refining as a desiliconizing technique and now intends to investigate the possibilities of developing the process for continuous steelmaking.[8]

BISRA has an agreement with Thomas strip division of the Pittsburgh Steel Co. allowing the latter to use their process of aluminizing steel strip known as Elphal (electrophoretic deposition of aluminum).[9]

Two 100-ton capacity L–D (Linz-Donawitz) basic oxygen steel furnaces built by Head Wrightson & Co., Ltd., were floated down the River Tees to a place where they were loaded on the South Africa

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[6] Steel. V. 153, No. 5, July 29, 1963. p. 20.
[7] Metal Bulletin (London). No. 4838, Oct. 15, 1963, p. 9.
[8] Journal of Metals. V. 15, No. 7, July 1963, p. 471.
[9] Steel & Coal (London). V. 186, No. 4941, Mar. 29, 1963, p. 615.

Star for their journey to Australia. The two 90-ton L–D furnaces will be installed at the Broken Hill Pty. Co., Ltd., at Whyalla, Australia.

ASIA

Japan.—Continuous casting has been used in Japan since 1955. Sumitomo Metal Industries purchased a license for the Concast process in 1954. Then, in 1957, Yawata Steel Co. leased the same process. In 1961, four other major producers introduced the Mannesmann continuous casting process. In 1963 Kobe Steel Works signed an agreement with the Soviet license agency for use of the Russian continuous casting process.[10]

Nippon Kokan KK., has an output of 3.3 million tons of steel operating eight L–D basic oxygen converters and six open-hearth furnaces. The company expects to be producing about 90 percent of its steel by using L–D oxygen converters when they complete their modernization.

Yawata Iron & Steel Co., Ltd., has been testing the Nakajima process of producing steel by direct reduction of iron ore for several years in a 5–ton pilot plant. The Nakajima process employs a fluidized bed with heavy oil used for fuel and reduction, although pulverized coal or natural gas can serve also. The process yields molten steel as a final product instead of sponge iron.[11]

Hot-rolled H-shaped steel bars with tapered flanges for higher tensile strength are being produced for the highway construction industry by Nippon Kokan KK.

The Fuji Iron and Steel Co., Ltd. may have come up with a substitute for tinplate. Two investigators found that steel sheet could be plated with about 0.002 mills of chromium then lacquered and deep drawn as easily as tinplate. Successful food packaging tests with the new plate have been carried on since August 1959.[12]

Singapore.—The National Iron and steel Mill dedicated its first steel plant in Singapore. Initial capacity is 70,000 tons annually.

AFRICA

Ethiopia.—An iron and steel foundry producing 25 tons of ingot and 30 tons of iron bar per day was dedicated by the Emperor on February 13, 1963. The new plant is located at Akaki, about 12 miles from Addis Ababa.

Rhodesia and Nyasaland, Federation of.—A steel castings foundry using a three-electrode arc furnace is under construction in Southern Rhodesia. It is planned to make castings for agricultural implements.

Uganda.—The Steel Corp. of East Africa, Ltd., joins the growing list of world producers, announcing production of two heats per day of 10 to 12 tons each. It is expected to produce 24,000 tons of finished steel products annually under full capacity.

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[10] Journal of Metals. V. 15, No. 12, December 1963, p. 881.
[11] Skillings Mining Review. V. 52, No. 38, Sept. 21, 1963, pp. 1, 4.
[12] Metal Progress. V. 83, No. 1, January 1963, p. 113.

OCEANIA

Australia.—Steelmaking capacity in Australia at the beginning of 1963 was 4.9 million tons. A new blast furnace installed at the Broken Hill Pty. Co., Ltd. steel works at Newcastle has a rated capacity of 1,400 tons per day.

The KM-Steel Products Ltd. of Richmond recently commissioned the first continuous casting plant of Australia. The new plant will use the patented operations of Concast A.G. of Zurich, Switzerland, and is designed for casting billets from 2 to 4½ square inches as well as slabs up to a size of 8 by 4½ inches in twin-strand operation.

Australia joined the list of steelmakers using basic oxygen converters when the first of two 200-ton-capacity basic oxygen converters were tapped in recently at the Broken Hill Newcastle steelworks.

TECHNOLOGY

The application of continuous casting to commercial production in the United States was a major highlight of 1963. In Roanoke, Va., Babcock & Wilcox built a continuous casting unit for the Roanoke Electric Steel Corp. Twenty-two tons of low-carbon and medium-carbon steel can be cast into approximately 700 feet of 4½-inch-square ingots in approximately 40 minutes. Surface and subsurface quality of the cast bar is outstanding, the finished product being free of pipe and surface defects. The casting moulds are 42 inches long and are cold drawn from either brass or copper tubing. The plant itself is 45 feet wide by 60 feet long and is built up to 80 feet above ground level.

Also United States Steel Corp. officially announced the development of commercial continuous casting. Another source reported that United States Steel Corp. had changed from a 25-ton electric furnace to a 40-ton basic oxygen furnace to produce the steel for its continuous casting machine. In addition to this, United States Steel used vacuum degassing in the ladles after the furnace tap and before teeming into its continuous casting machine.[13]

Two twin-strand casting units for the Connors Steel Division of the H. K. Porter Co. and one twin-strand casting unit, capable of producing two billets, for the Seaway Steel Division of Roblin-Seaway Steel Industries, Inc., were being designed and built by the Koppers Co. One machine for making large slabs was ordered by McLouth Steel Corp., Detroit, with Concast A.G. of Zurich, Switzerland, as the contractor.

Von Moos'sche Eisenwerke of Lucerne, Switzerland, installed a curved mold in its continuous casting unit. Since the curved mold installation requires much less height and space, as well as less control equipment, the initial cost is said to be 40- to 50-percent lower than that for conventional continuous casting units.[14]

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[13] United States Steel Corp. 1963 Annual Report, 1964.
[14] Shah, Raymond. Curved Mold Lowers Silhouette of Continuous Casting Line. Iron Age, v. 192, No. 5, Aug. 1, 1963, pp. 58–59.

Pressure pouring or pressure casting is another step in the continuous effort to improve efficiency. Pressure casting can be used to cast steel slabs up to 28 feet long weighing up to 20 tons or to cast shapes in permanent graphite molds such as steel wheels for railroad cars. The controlled pressure pouring process was developed by Griffin Wheel Co., a subsidiary of Amsted Industries, Inc. For the past several years Lebanon Steel Co., under license from Amsted, has used the technique to cast items such as turbine blades and valve bodies. Amsted now has Controlled Pressure Pouring license agreements with nine steel producers: United States Steel Corp., Washington Steel Corp., Michigan Seamless Tube Co., Carpenter Steel Co., McLouth Steel Corp., Eastern Stainless Steel Corp., Roblin-Seaway Industries Inc., Youngstown Sheet & Tube Co., and Sharon Steel Corp. Three of these producers; U.S. Steel, McLouth Steel, and Roblin-Seaway Industries, also are already operating or building continuous casting lines. Although Amsted engineers claim that the process can be used to cast any quality steel, including low-carbon, most of the licensees, including for example United States Steel, are planning to use the process for stainless and alloy steel slabs and billets. Among other advantages, Amsted engineers claim that slabs cast with the pressure pouring process have a smooth surface finish which requires little or no conditioning. In addition, less molten metal is wasted with pressure pouring. And finally, tests have given slab yields which average about 95 percent of the melt as compared with lower yields for conventional ingot practice.[15]

Washington Steel Corp. started to break in its new pressure-casting equipment for making steel slabs at its new plant in Houston, Pa. The equipment is said to be capable of producing three 10-ton slabs or a single large slab weighing 20 tons from each pouring of its electric furnaces. The equipment is licensed by Amsted Industries, Inc., which developed the technique for the manufacture of cast steel railroad wheels.

Washington Steel says yield on this process is at least 95 percent from molten metal to finished slab. On conventional processing the yield is a little more than 70 percent. Grinding loss is reckoned at about 1 percent where normal loss in stainless conditioning is from 5 to 8 percent.[16]

Phoenix Steel Corp. awarded an engineering contract to Concast Inc. for a continuous casting machine at its Claymont, Del., plant.

The most rapidly developing segment of the steelmaking industry, however, was the basic oxygen converter. During 1963 the following commitments to install basic oxygen converters were announced: United States Steel, three at Gary, Ind., and Republic Steel, two each at Gadsden, Ala., Cleveland, Ohio, and Warren, Ohio.

Inland Steel Co. started work on the second phase of its expansion program. The major facility will be an oxygen steelmaking shop capable of turning out 230 tons of raw steel every 30 minutes. The new oxygen shop will replace an existing 12-furnace open-hearth shop.

Armco Steel Corp. spent $50 million for the Nation's newest L–D process basic oxygen equipment, constructing a plant consisting of

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[15] Journal of Metals. Pressure Pouring Steel Shapes Now on Stream. V. 15, No. 11, November 1963, p. 814.

[16] McManus, G. J. Washington Praises Pressure Casting. Iron Age, v. 193, No. 4, Jan. 23, 1964, p. 25.

two 140-ton vessels, each equipped with a hot-water-steaming hood and dry electrostatic precipitators at Ashland, Ky. This gives the firm 1.4 million tons per year of basic oxygen capacity. Adjacent to the plant is a 680-ton-per-day oxygen supply plant built and operated by Air Products and Chemicals Inc. This plant is the world's largest single-customer oxygen facility.[17]

Jones & Laughlin in its Cleveland shop on July 17, 1963, produced a 239.4-ton heat in 27 minutes from tap-to-tap. This is equivalent to the exceptionally high rate of 532 tons per furnace hour. Although this is only a one-heat mark, it is a useful gauge of the inherent potential of the basic oxygen process under optimum conditions.[18]

Allegheny Ludlum Steel Corp. of Pittsburgh signed a licensing agreement with Henry J. Kaiser Co., Oakland, Calif., for the experimental use of the L–D process for oxygen steelmaking at its Brackenridge, Pa., works to see if the basic oxygen furnace (BOF) can be used for producing Allegheny alloy steels. The first product to be tried will be silicon electrical steel.[19]

Electric furnaces will be producing 15 percent of the U.S. steel output by 1970 at the present rate of growth. In the last 3 years U.S. steelmakers have installed or are in the process of installing electric-arc furnaces with a combined total capacity of 3,847,000 tons of carbon steel per year.[20]

The Colorado Fuel and Iron Corp. announced plans to replace the nine-furnace open-hearth shop at its Roebling plant in New Jersey with three electric-arc furnaces of 45-ton capacity.

A 100-ton electric steelmaking furnace was put into operation at the Mansfield, Ohio, plant of the Universal-Cyclops Steel Corp. The addition of this new furnace put the company's capacity at between 825,000 and 850,000 tons a year.

The results of two-stage electric furnace smelting tests on high-iron manganiferous materials was reported by Bureau of Mines engineers.[21]

The first U.S. blast furnace controlled by punched paper tape and designed for later installation of a process computer for entirely automated operation was installed at the Duquesne works of the United States Steel Corp. The furnace has a hearth diameter of 28 feet and is expected to reach an output of 4,000 or more tons per day. A major advance in ironmaking practice incorporated in the furnace is an automatic electronically controlled system for weighing, measuring, and feeding iron ore, coke, and other raw materials. The control system was designed to give the operator maximum flexibility in operation and maximum system reliability.[22]

Jones & Laughlin Steel Corp. put a new 29-foot-hearth blast furnace in operation at its Cleveland works. The new furnace has an initial capacity of 2,500 tons per day with an ultimate capacity of 3,500 tons per day. This is one of the first furnaces in the industry to have

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17 Iron and Steel Engineer. Armco's Ashland Works Practically Rebuilt in Last 10 years. V. 40, No. 12, December 1963, pp. 133–140.

18 Stephens, William J. Technical Advances in Steelmaking. Iron & Steel Eng., v. 40, No. 11, November 1963. pp. 77–80.

19 Metalworking News. Allegheny Licensed for L–D Process. V. 4, No. 153, Aug. 12, 1963, p. 10.

20 Journal of Metals. Growing Use of Electrics. V. 15, No. 12, December 1963, pp. 881–882.

21 Peterman, F. B., and R. S. Lang. Two-Stage Electric Furnace Smelting of High-Iron Manganiferous Materials for Producing Ferromanganese. BuMines Rept. of Inv. 6225, 1963, 10 pp.

22 Howard, H. Highly Automated "Dorothy" at Duquesne Works Aims at Free World Record in Ironmaking. Am. Metal Market, v. 70, No. 104, May 31, 1963, p. 16. Iron and Steel Engineer. New Blast Furnace Has Unique Control System. V. 40, No. 7, July 1963, pp. 178, 181.

screening in the materials stockhouse for sinter and pellets. Materials are taken from the stockhouse on conveyor belts controlled by a punch-tape system. The principal burden will be sinter with pellets available later. The hot metal will be used to feed basic oxygen converters.[23]

Also Armco put into operation its new 3,340-ton-per-day blast furnace, Amanda. Charging and stockhouse functions are fully automatically programmed.[24]

Solid fuel injection experiments on a commercial blast furnace, the No. 2 blast furnace at the Hanna Furnace Corp., have demonstrated that coal injection is both technically and economically feasible. A one-to-one coal to coke replacement ratio has been obtained when injecting coal into the blast furnace at a rate of about 17 percent of the total blast furnace fuel requirements.[25] The Weirton Steel Co. No. 4 blast furnace is the fifth commercial blast furnace to be equipped with solid-fuel injection system. So far coal has been injected at rates up to 15 percent of the total furnace fuel requirements.[26]

Substantial coke savings with fuel-oil injection was reported by engineers of the Bureau of Mines. Oil-to-coke replacement ratios have been calculated for various conditions, and oil is compared with natural gas.[27]

There have been several modifications of blast furnaces. The Colorado Fuel and Iron Corp. introduced a major modification on blast furnace D at the Pueblo Plant with the installation of Venturi gas washers. This wet cleaning system thoroughly removes the flue dust from the gas, thus considerably reducing stove maintenance.[28] Another trend which seems to be on the increase is the use of pellets. Great Lakes Steel Corp. has slated the use of pellitized iron ore instead of sintered ore as a fuel for its four blast furnaces.

Vacuum melting gained additional recognition. A vacuum induction furnace with a 60,000-pound capacity of hot metal or 30,000 pounds of cold metal is part of a $5.5 million melt shop under construction in Latrobe Steel Co., Latrobe, Pa. The unit is designed to operate at vacuums as low as 1 to 5 microns.[29] A new vacuum-induction furnace with a total melt capacity of 15,000 to 20,000 pounds per heat was put in operation by the Carpenter Steel Co. In full production it will boost Carpenter's total vacuum-melting capacity from 10,000 tons per year to over 20,000 tons per year. This figure includes 11,000 tons from vacuum-induction furnaces and 9,000 tons from vacuum consumable-electrode furnaces. The new furnace can refine and cast hot metal under a vacuum of five microns.[30]

Special Metals, Inc., New Hartford, N.Y., placed a vacuum induction melting furnace in operation. It has a power rating of 1,000

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[23] Iron & Steel Engineer. Jones & Laughlin Dedicates Blast Furnace at Cleveland Works. V. 41, No. 1, January 1964, pp. 115–116.
[24] Steel. Armco Shows Its New Blast Furnace, Oxygen Facilities. V. 153, No. 23, Dec. 2, 1963, pp. 31, 33.
[25] Strassburger, J. R. Experiences With Injection of Coal. Blast Furnace and Steel Plant, v. 51, No. 6, June 1963, pp. 447–457.
[26] Dietz, J. R. Solid Fuel Injection at Weirton. J. Metals, v. 15, No. 7, July 1963, pp. 499–501.
[27] Woolf, P. F., and W. M. Mahan. Fuel-Oil Injection in an Experimental Blast Furnace. BuMines Rept. of Inv. 6150, 1963, 23 pp.
[28] Blast Furnace & Steel Plant. Washers Placed on Blast Furnace. V. 51, No. 1, January 1963, p. 69.
[29] Iron and Steel Engineer. Latrobe Installs Hot Metal Vacuum Induction Steel Unit. V. 40, No. 12, December 1963, pp. 167–168.
[30] Journal of Metals. Largest Vacuum-Induction Furnace on Stream. V. 15, No. 12, December 1963, p. 878.

kilowatts and is capable of melting 16,000 pounds of steel in approximately 3½ hours.[31]

Braeburn Alloy Steel Division of Continental Copper & Steel Industries, Inc., Braeburn, Pa., announced the installation of a new consumable-electrode vacuum arc remelt furnace for the production of clean, superstrength steels and alloys.[32]

A circular describing vacuum melting processes and the applications to the steel industry was issued by the Bureau of Mines.[33]

Sealed Power Corp., Muskegon, Mich., used 85 to 90 percent of borings and turnings in its melting charges for a new induction furnace that operates on 60-cycle line current. The design of the new furnace is such that a high percentage of metal is being recovered from these marginal materials. This means that the company is now using borings which it formerly sold for $10 a ton to replace pig iron and scrap which it had to buy at a much higher price.

Caldwell Foundry and Machinery Co., Inc., Birmingham, Ala., started construction of a stainless steel casting plant in the fall to be completed within 90 days. New equipment to be installed included a $40,000 induction furnace. Vacuum also was being used more after melting. Construction has been started on a 300-ton vacuum degassing unit at United States Steel Corp.'s south works. The quality steel produced in the vacuum degassing unit will be used primarily for high temperature materials, gears, bearings, missile motor cases, forgings, and other applications where exceptional stresses are encountered.[34]

The St. Louis Die Casting Corp., St. Louis, Mo., found that they could increase from 165,000 to 410,000 the number of castings obtained from a single set of dies by using vacuum-melted steel, such as the Carpenter furnace will put out.[35]

Republic Steel Corp. reported the awarding of a contract to build the world's largest waste heat boiler. The boiler is designed to reclaim heat from the waste gases of two oxygen-lanced open-hearth furnaces.[36] Six new waste heat boilers of a type designed to accommodate the larger quantity of higher temperature gases released during oxygen-blown open-hearth steelmaking will bring to 11 the number ordered for United States Steel's Homestead, Pa., district works.[37]

A steam-cooled roof which has been in service for a year on an electric furnace may change the technology not only in electric furnaces but every other type of steelmaking furnace. The construction may make it possible to put a tilting roof on an open hearth and convert it to a top-loading oxygen type. A hybrid furnace of this type would combine the best features of oxygen and open-hearth steelmaking—the fast melting and fast loading of the oxygen furnace and the economies of unlimited scrap usage of the open hearth.[38]

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31 Iron and Steel Engineer. V. 40, No. 4, April 1963, p. 207.
32 Iron and Steel Engineer. Braeburn Alloy Steel Division Adds New Units. V. 40, No. 2, February 1963, p. 131.
33 Kerr, James R. Vacuum Melting of Steel. BuMines Inf. Cir. 8136, 1962, 32 pp.
34 Iron and Steel Engineer. Vacuum Degassing Unit Is Under Construction. V. 40, No. 12, December 1963, p. 202
35 Steel. Vacuum Melted Steel Doubles Die Life. V. 152, No. 6, Feb. 11, 1963, p. 101.
36 Blast Furnace & Steel Plant. V. 51, No. 10, October 1963, p. 920.
37 Iron and Steel Engineer. To Install Waste Heat Boilers at Homestead. V. 40, No. 4, April 1963, p. 207.
38 Milhaupt, Thomas. Cooled Roofs May Save Steelmen Buck a Ton. Steel, v. 153, No. 24, Dec. 9, 1963, pp. 96–98.

Sharon Steel Corp., Sharon, Pa., reported its two Stora-Kaldo furnaces differed from other Kaldo operations in that they are equipped with two oxygen lances, a low and a high-pressure lance. This provides better control of carbon, phosphorus, sulfur, hydrogen, oxygen, and nitrogen. Because of the high thermal efficiency which results from the burning of the carbon monoxide formed during the reaction within the furnace, the use of up to 50 percent scrap is permitted in the total metallics charged. This gives about 1⅜ tons of steel per ton of hot metal as opposed to 1 ton of steel per ton of hot metal when iron ore is used.[39] To allow more latitude for ladle additions, the Lynchburg Foundry Co., division of Woodward Iron Co., awarded a contract for the fabricaton of two 11-ton shaking ladles. The shaking ladle achieves high mixing efficiencies because of a patented circular motion which creates a rotating wave and breaker on the surface of the metal bath, thus providing rapid and intimate contact between the metal and added reagents.

Nondestructive testing gained wider acceptance in the steel industry. Efforts were made to apply tests at the assembly line in order to eliminate faulty products at an early stage rather than to reject defects in the finished product. A nondestructive testing technique has been devised to investigate damage of cast iron due to severe nonfracturing impact. Dr. Elizabeth Plénard of the Technical Center of French Foundries, Paris, and Dr. Antoni Karamara of the Polish Foundry Institute, both working at the Paris Center on a joint Franco-Polish research project are reported to have developed methods based on changes in the magnetic properties accompanying alterations in the internal structure of castings under various kinds of impact.[40]

A new sonic testing technique has been devised for routine quality control inspection of ductile iron castings. Although it will not detect tiny flaws it can be used to evaluate physical properties that can be correlated with the elastic moduli.[41]

Bureau of Mines engineers had some degree of success using an electrochemical cell to analyze high-purity iron.[42]

Analyses of samples taken from the stack, bosh, and hearth of an experimental blast furnace quenched with cold nitrogen instead of hot blast air are given in a report by Bureau of Mines engineers.[43]

A method of monitoring the efficiency of iron production in an experimental blast furnace was described by the Bureau of Mines. The technique, called gravimetric because it involves weighing procedures, permits continuous and direct analysis of all constituents in the furnace top or exit gas. When analysis indicates too much or too little of a given substance in this gas, a deficiency in furnace operation is indicated.[44] Much research has been done on continuous monitoring of temperatures in open-hearth blast furnace and electric arc

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[39] Oswald, R. C. Kaldo Operations in North America. Blast Furnace and Steel Plant, v. 51, No. 9, September 1963, pp. 783–786.

[40] Steel & Coal (London). Magnetic Diagnosis of Cast Iron. V. 187, No. 4978, Dec. 13, 1963, p. 1190.

[41] Iron Age. Test Tunes in Tensile Properties. V. 192, No. 5, Aug. 1, 1963, pp. 60–61.

[42] Kilau, H. W., and J. P. Hansen. Experiments in Using an Electrochemical Cell to Analyze High-Purity Iron. BuMines Rept. of Inv. 6183, 1963, 11 pp.

[43] Morris, J. P., and P. L. Woolf. Examination of an Experimental Iron Blast Furnace After Quenching With Nitrogen. BuMines Rept. of Inv. 6217, 1963, 36 pp.

[44] Kusler, David J. An Improved Gravimetric Method for Analyzing Blast Furnace Top Gas. BuMines Rept. of Inv. 6168, 1963, 21 pp.

furnace. Radiation or optical pyrometers or thermocouples are being used. Various types of refractory jackets are being developed in order to protect the instruments during constant immersion.[45]

Nuclear gauging techniques found increased use in the steel industry. Moisture gauges, burden level indicators, bulk density gauges, and bulk flow gauges are some of the new applications using radioisotopes.

Advanced mathematical and computer techniques are being applied to steelmaking research. Scientists of the U.S. Bureau of Mines have issued a report on the development of a thermochemical model of a blast furnace. Analysis is made of the behavior of a hypothetical furnace with contrasting types of air flow, turbulent and nonturbulent.[46]

One mathematical model is used to describe the sources, availability, chemistry, and the cost of iron ores. In 2½ hours on one of the largest digital computors commercially available, the cheapest overall allocation for current requirements for iron ore can be determined. Blast furnace performance improvement has been facilitated by the development of a second mathematical model which simulates the many complex chemical reactions which take place within the furnace. Calculation time is dramatically reduced here by a medium-sized electronic digital computor. A third model which uses an analog computer has been used to describe the operation of blast furnace stoves.[47] Jones & Laughlin Steel Corp. set up a thermochemical model of a blast furnace to predict the performance of blast furnaces. These predictions have shown the significance of high blast temperature in increasing iron production and in reducing coke rate. It was found that instrumentation should be used to give (1) better analysis of burden, (2) top gas analysis, (3) gas pressure at various stack positions, (4) hearth temperatures, and (5) heat balance indications.[48] The increased use of oxygen in open-hearth furnaces even more than the change from open-hearth to basic-oxygen has caused a considerable change in the refractory industry. At first, of course, the use of oxygen greatly increased the burnup of the refractory lining but sheer necessity speeded up the modification and improvement of refractory linings until the cost of bricks per ton of ore has now been decreased because of the increased output of the furnaces.[49]

Nine research projects costing $100,000 were announced by the Steel Founders' Society of America for 1963–64. Among the projects planned are better gating systems for steel castings, destructive testing to determine the influence of surface discontinuities, deoxidation of molten steel to improve ductility and toughness, desulfurization to

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[45] Foundry. Pyrometer Reads Molten Iron Temperatures Continuously. V. 91, No. 11, November 1963, p. 86.
Iron Age. Monitoring Molten-Metal Baths. V. 192, No. 15, Oct. 10, 1963, p. 160.
Sharp, John D. Continuous Temperature Measurement of Molten Steel. J. of Metals, v. 15, No. 12, December 1963, pp. 902–903.

[46] St. Clair, Hillary W. Developing a Thermochemical Model for the Iron Blast Furnace. Model of Ideal Furnace at Equilibrium. BuMines Rept. of Inv. 6233, 1963, 38 pp.

[47] Stephens, William J. Technological Advances in Steelmaking. Iron & Steel Eng., v. 40, No. 11, November 1963, pp. 77–80.

[48] Morgan, E. R., W. F. Huntley, and S. Vajda. The Rejuvenated Blast Furnace, Use of the Thermochemical Model. Steel & Coal (London), v. 186, No. 4942, Apr. 5, 1963, pp. 668–670.

[49] Chesters, J. H. Lining the New Steel Furnaces. New Scientist (London), v. 18, No. 338, May 9 1963, pp. 326–329.

improve mechanical properties, ladle linings and metallic abrasives for blast cleaning.[50]

Automatic programming of rolling mill operation probably represents the most significant advance made in this part of the steel industry.[51] Ninety-percent reductions in a single pass are claimed for a new type of rolling mill that features small diameter rolls that oscillate in the rolling direction 860 times a minute or more. Additional laboratory work is being planned by Dr. Karel Saxel, Imperial Metal Industries, England.[52]

Battelle Memorial Institute studied high-density compacting of iron powder seeking to determine the feasibility of achieving densities of over 99 percent in iron and iron-base compacts as compared with the current upper density limits of about 97.2 percent. A technique of pressing and condensing specimens prior to high-velocity compacting produced densities of 99.3 to 99.9 percent for pure iron and somewhat less for steels. Several electrolytic iron specimens were pressed at 20,000 to 60,000 psi, sintered 1 hour at 2,000° F in hydrogen, and then compacted explosively at about 400 feet per second.[53] The Alberta Research Council process for producing high-purity iron powders from low-grade iron ore will be tested in a large-scale pilot plant to be built this year by Peace River Mining and Smelting Co., Ltd., Edmonton, Alberta.[54]

The high degree of corrosion-resistance of plastic-coated steel was demonstrated under practical conditions at the pickle fan house of the plant of the company producing this steel. Sheets of the plastic-coated steel in position for as long as 14 months were found capable of further prolonged use. This is in contrast to a 5- or 6-week period of total use for galvanized steel sheet.[55]

An improved grade of grain oriented-electrical steel, with the lowest core loss limit ever offered by the steel industry, was claimed by Armco Steel Corp. M–4 oriented steel will be produced in 11-mill thickness and will be available in coils from ⅛ to 31 inches in width. Maximum core loss at 60 cycles and 15 kilogausses for M–4 is 0.53 watts per pound. Base price of the new steel is $21.70 per hundred pounds.

The International Nickel Co., Inc., announced development of a cast maraging steel with a tensile strength of approximately 250,000 psi, a yield strength of 240,000 psi, and a minimum elongation of 8 percent. The strengthening results from the precipitation of intermetallic nickel compounds such as nickel-titanium, nickel-aluminum, or other nickel combinations in a martensitic matrix.[56] International Nickel Co., Inc., has also developed a cryogenic iron alloy. This alloy designated as type D–2M austenitic ductile iron combines excellent castability and ease of manufacture with exceptional low-temperature metallurgical and mechanical properties. At temperatures as low as −423° F, the alloy exhibits superior resistance to brittle fracture.[57]

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[50] Foundry. Steel Founders Add $100,000 to Research Expenditures. V. 91, No. 11, November 1963, p. 119.

[51] Iron Age. Six-Stand Rolling Mill Steps Up Coil Stock Production Rates. V. 192, No. 25, Dec. 19, 1963, pp. 82–83.

[52] Steel. Oscillating Rolling Mill Holds High Speed Promise. V. 153, No. 27, Dec. 30, 1963, pp. 13–14.

[53] Journal of Metals. Dense Metal Compacts. V. 15, No. 12, December 1963, p. 882.

[54] Chemical Engineering. V. 70, No. 10, May 13, 1963, p. 83.

[55] South African Mining & Engineering Journal (Johannesburg). Plastic Coated Steel Resists Acid Fumes. V. 74, pt. 1, No. 3653, Feb. 8, 1963, p. 321.

[56] Journal of Metals. Cast Maraging Steel. V. 15, No. 3, March 1963, p. 179.

[57] Journal of Metals. Cyrogenic Iron Alloy. V. 15, No. 1, January 1963, p. 12.

New York City Transit Authority announced a decision to purchase 600 stainless steel subway cars. The Transit Authority estimated that noncorrosive, lightweight stainless cars will save $6 million in power and maintenance costs over a projected 35-year life. Improved appearance also is achieved. Western Pacific Railroad added 18 stainless steel covered hopper cars to its original 12-car fleet. The decision was prompted by analysis of operating costs. Preparation costs prior to loading foodstuffs average $70 per load for regular cars and $1.50 per load for stainless steel cars. Stainless steel tank trucks also have proved advantageous for transporting alcoholic beverages because of ease of cleaning, lighter weight of metal, and economies of bulk haulage.[58] Type 304 stainless steel was reported to be the most desirable material for cryogenic containers of 1,000-gallon or less capacity. This conclusion is based on reliability, ease of repair and welding, and metal cost.[59]

Stainless steel can be made porous with the internal arrangement of the fibers in random pattern so that densities as low as 5 percent of the solid can be achieved. The porosity can also be controlled up to 95 percent.

Stainless steel double disk gate valves were substituted for groups of steel diaphragm and plug valves in an electrolytic zinc plant. An outstanding record of maintenance-free service has been claimed.[60]

There was renewed interest in the use of stainless steel for razor blades; stainless steel table flatware; stainless steel extrusions used in window mullions; automobile trim both in the domestic and foreign market; automatic home washers made of stainless; copper plated stainless steel coil springs; and explosive-formed denture plates.

Du Pont announced work on the coating of carbon steel with diffused stainless steel which if successful would compete with chromium plating and solid stainless steel. The coating may be applied before or after the steel is fabricated.[61]

The application of new high-strength building steels was recognized in building codes. The city of Chicago amended its code to provide for six grades of structural steel instead of the one approved under the old specification.[62]

Three new high-strength structural steels, ASTM A242, A440, and A441 were accepted by amendments to the New York City building construction code.

Six different grades of structural steel were used in the truss span of the new John Day highway bridge near the Columbia River, to keep the structural members uniform in size and reduce weight and fabrication costs. Engineers specified A441, A7, A36, A373, A440, and a special heat-treated steel.[63]

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[58] Stainless Outlook. (The Committee of Stainless Steel Producers, American Iron and Steel Institute). No. 19, August 1963, pp. 1-2.

[59] Materials in Design Engineering. What Metal for Cryogenic Containers? V. 57, No. 6, June 1963, pp. 162, 164.

[60] Canadian Mining Journal (Canada). Stainless Steel Gate Valves in Zinc Plant. V. 84, No. 1, January 1963, pp. 52-53.

[61] Chemical & Engineering News. V. 41, No. 12, March 25, 1963, p. 39.

[62] Engineering News-Record. V. 171, No. 18, Oct. 31, 1963, p. 9.

[63] Engineering News-Record. Six Kinds of Structural Steel Make a Highway Bridge. V. 170, No. 26, June 27, 1963, pp. 30-32.

Use of two new improved structural vanadium steels was reported to have saved $100,000 in the erection of a new library at Johns Hopkins University in Baltimore.

North American Aviation Inc. plans to use increasingly large amounts of maraging steel in the No. 2 and No. 3 B–70 aircraft in what is probably the first major application of this high-nickel steel.

Inland Steel Co. has produced a new high strength structural steel called INX 70 containing either columbium or vanadium (minimum of 0.01 percent of either element). Copper added as an alloying element boosts corrosion resistance.[64]

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[64] Chemical & Engineering News. V. 41, No. 21, May 27, 1963, p. 39.