MONTHLY

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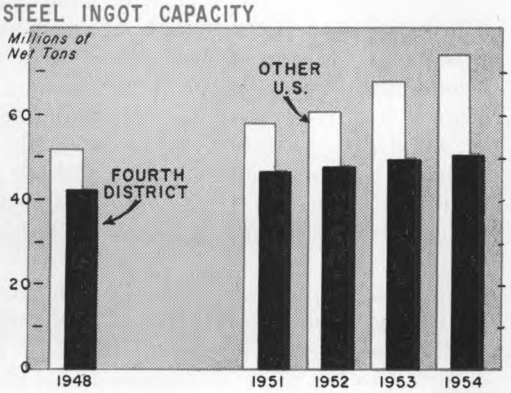
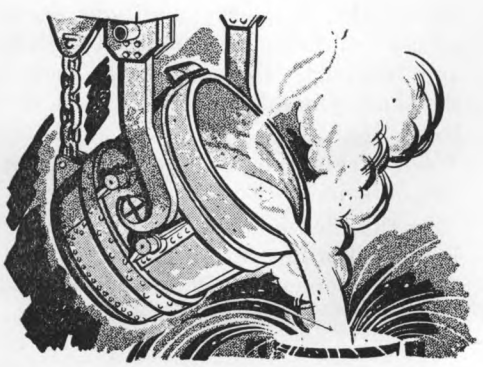
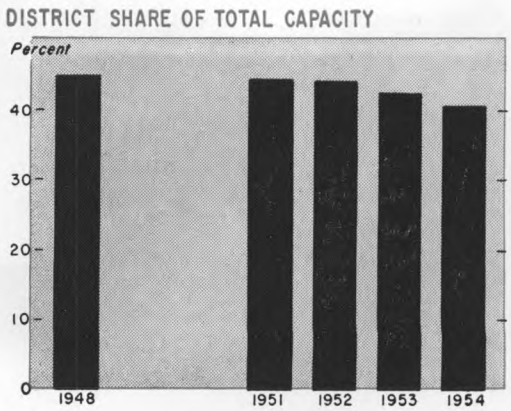



***Fourth District steel capacity has been expanded in recent years, but not as rapidly as capacity outside the District. Consequently the District's share of the steel market is declining.***

***(See page 2)***





# Regional Expansion in Steel Capacity

THE NATION'S STEEL INDUSTRY has expanded its ingot-making capacity 32 percent since the end of 1947, with the bulk of the new or improved facilities coming into production during the last three years. Steel mills located in the Fourth Federal Reserve District participated in the industry's expansion, but not to the same extent as mills outside the District. Fourth District steel areas, as defined by *Iron Age,* include Pittsburgh, Youngstown, Cleveland, the South Ohio River area, and Wheeling.

The proportion of the country's basic steel-producing facilities located in this District, in the aggregate, has shrunk from 45.0 percent to 40.6 percent during the past six years. Such a shrinkage highlights a trend towards greater geographic dispersion of steel furnaces that may continue for the next few years.

The relatively low rate of steel expansion in the Fourth District from 1948 through 1953 is due to the small percentage gains in capacity made in the Pittsburgh and Youngstown producing areas, where nearly two-thirds of the Fourth District's steel capacity is concentrated. During the last six years, the capacity of these two areas was increased from 33.5 to 36.9 million net tons or only 10 per cent, while the industry elsewhere boosted its production potential 44 percent. With the sole exception of the small Eastern district (New England and eastern New York) every other steel district increased capacity by more than 30 percent.

**LOCATION OF STEEL-MAKING FURNACES IN THE FOURTH DISTRICT**


The Pittsburgh-Youngstown area is regarded by some authorities as a single producing center. Taken together, the two areas contain nearly 30 percent of the nation's steel capacity and comprise the largest concentration of steel furnaces in the country. If Pittsburgh and Youngstown are considered as separate steel-producing areas, they rank second and fourth, respectively, among the country's thirteen steel districts as delineated by *Iron Age.* Pittsburgh, traditionally the nation's top producing center, yielded first place to Chicago in 1953, while Youngstown lost the third-ranking spot to Philadelphia during 1952.

Changes at plants in other Fourth District steel areas during the six years 1948 through 1953 ranged from the abandonment of some facilities to the threefold expansion of others. The biggest percentage increases were made in the South Ohio River steel district where capacity was expanded nearly two-thirds since 1948. Capacity additions exceeded 70 percent at mills in Portsmouth, Middletown and Newport. Two new mills were built in the same general steel area — one at Owensboro, Kentucky, and one at Huntington, West Virginia; both of the latter happen to fall outside the Fourth District.

In the Cleveland producing district (which includes Lorain) individual mill gains ranged from 26 percent to 72 percent, averaging 48

## REGIONAL CHANGES IN STEEL CAPACITY: 1948-1953

(Capacity figures in thousands of net tons as of January 1st)

| Iron Age District | STEEL CAPACITY | | NET INCREASE 1948-1953 | | PERCENTAGE OF TOTAL | | RANK | |
|---|---|---|---|---|---|---|---|---|
| | 1954 | 1948 | Tons | Pct | 1954 | 1948 | 1954 | 1948 |
| CHICAGO | 24,587 | 18,856 | 5,731 | 30.4 | 19.8 | 20.0 | 1 | 2 |
| DETROIT | 6,551 | 3,473 | 3,078 | 88.6 | 5.3 | 3.7 | 6 | 10 |
| ST. LOUIS | 2,785 | 1,674 | 1,111 | 66.4 | 2.2 | 1.8 | 12 | 12 |
| Subtotal | 33,923 | 24,003 | 9,920 | 41.3 | 27.3 | 25.5 | .. | .. |
| PITTSBURGH | 23,016 | 20,829 | 2,187 | 10.5 | 18.5 | 22.1 | 2 | 1 |
| YOUNGSTOWN | 13,896 | 12,644 | 1,252 | 9.9 | 11.2 | 13.4 | 4 | 3 |
| CLEVELAND | 6,241 | 4,224 | 2,017 | 47.8 | 5.0 | 4.5 | 8 | 7 |
| SOUTH OHIO RIVER | 4,875 | 2,933 | 1,942 | 66.2 | 3.9 | 3.1 | 10 | 11 |
| WHEELING | 4,866 | 3,495 | 1,371 | 39.2 | 3.9 | 3.7 | 11 | 9 |
| Subtotal | 52,894 | 44,125 | 8,769 | 19.9 | 42.5 | 46.8 | .. | .. |
| PHILADELPHIA | 16,386 | 11,505 | 4,881 | 42.4 | 13.2 | 12.2 | 3 | 4 |
| BUFFALO | 6,452 | 4,423 | 2,029 | 45.9 | 5.2 | 4.7 | 7 | 6 |
| EASTERN | 733 | 634 | 99 | 15.6 | 0.6 | 0.7 | 13 | 13 |
| Subtotal | 23,571 | 16,562 | 7,009 | 42.3 | 19.0 | 17.6 | .. | .. |
| Total N. E. States | 110,388 | 84,690 | 25,698 | 30.3 | 88.8 | 89.9 | .. | .. |
| WESTERN | 8,883 | 5,706 | 3,117 | 55.7 | 7.1 | 6.1 | 5 | 5 |
| SOUTHERN | 5,060 | 3,837 | 1,223 | 31.9 | 4.1 | 4.1 | 9 | 8 |
| TOTAL U. S. | 124,330 | 94,233 | 30,097 | 31.9 | 100.0 | 100.0 | .. | .. |
| FOURTH DISTRICT | 50,538 | 42,435 | 8,103 | 19.1 | 40.6 | 45.0 | .. | .. |
| OTHER U. S. | 73,792 | 51,799 | 21,994 | 42.5 | 59.4 | 55.0 | .. | .. |

American Iron and Steel Institute data. Compilations by *Iron Age* and Federal Reserve Bank of Cleveland. Details may not add to totals because of rounding. The subtotal for the *Iron Age* districts of Pittsburgh, Youngstown, Cleveland, South Ohio River and Wheeling differs from the Fourth District total because: (1) several plants included in the Pittsburgh and South Ohio River districts are not in the Fourth District; and (2) several Erie, Pa. plants, which are located in the Fourth District, are included with the Buffalo district.

percent for the three companies in the area. Percentage gains in capacity in both the South Ohio River and Cleveland districts thus exceeded the 44 percent average increase posted by all U. S. mills outside the Pittsburgh-Youngstown area.

The increase in the Wheeling area averaged 36 percent, with a Steubenville mill nearly doubling its capacity. Other plants in the area are located at Weirton and Toronto.

Geographic changes in the location of steel capacity that have occurred in the last six years are given in an adjoining table. The regional compilations were made by *Iron Age* from the comprehensive reports of American Iron and Steel Institute. As the table suggests, the *Iron Age* districts of Pittsburgh, Youngstown, Cleveland, South Ohio River and Wheeling are almost identical with the Fourth District.

As might be expected, most of the new or expanded steel facilities added since 1947 have been located in the nation's "industrial belt," which may be defined roughly as the states east of the Mississippi River and north of the Ohio River and Mason-Dixon line. The geographic relocation of steel furnaces in recent years has been largely a shift to the east and west of the Fourth District within the limits of this "industrial belt." The Fourth District "lost" capacity mainly to the Chicago, Detroit and St. Louis steel districts on the west and to the Philadelphia and Buffalo steel districts on the east. The Western district increased its share of the U. S. total from 6 to 7 percent during this interval, while that of the Southern district remained unchanged at 4 percent.

## Factors in Location

There are several reasons for the location of most of the new and improved furnaces outside the Pittsburgh and Youngstown areas. First, these two districts have traditionally been surplus production areas. Rising freight rates have made the proximity to metal fabricating markets an important factor in determining the location of expansion programs. Economies in transport costs dictated locations in, or nearer to, areas of production deficits. This helps account for the large additions to capacity in the Chicago and Detroit districts, since both areas have long been ones of production deficits.

A second factor is the age of furnaces in the Pittsburgh and Youngstown areas. The steel industry, as we know it today, traces its beginnings to this area as the historic meeting place of iron ore and coal. It would be only natural to find that the area has a higher proportion of older furnaces than newer steel-making centers. Since 1948, the retirement of tired facilities has served to offset, somewhat, improvements and additions. In the Pittsburgh area, for example, one major steel company has retired 1.8 million tons of old capacity since the end of World War II, while adding 3.7 million tons of new capacity. During 1953, the scrapping of old furnaces in the Pittsburgh district more than offset expansion in the area, reducing the area's annual capacity by more than 2 percent. Some of the abandoned furnaces were first fired in 1900. Further reductions will take place this fall, when other marginal high-cost facilities in the area are scheduled for retirement. Scrapping older furnaces results in operating economies and improves the area's competitive position.

A third factor that bears on the differential growth rates exhibited among the various producing areas is the development of new sources of iron ore, notably in Venezuela and Canada. Two steel companies have developed properties in Venezuela. One company began shipments in 1951 after several years of development work and imported more than 2,000,000 tons of iron ore last year. First shipments from the other Venezuelan mine were received at an Eastern port this January, with shipments for the current year expected to exceed 2,000,000 tons and to increase gradually for several years. An entirely new steel works was constructed on the Delaware River to use the output of the newest Venezuelan property.

*(Continued on Page 9)*

# Current Trends In Farm Prices

WHETHER AGRICULTURE is a big enough factor in today's industrialized economy to "make or break prosperity" is still debatable. The economic well-being of countless towns and villages throughout the nation in 1954, however, will rest directly and unquestionably upon the level of farm income. To these may be added the large industries such as farm machinery, feed processing and fertilizer manufacture, as well as a host of other nonfarm enterprises, whose sales are a direct function of farmers' ability to buy.

It is reassuring in this respect both to farm and to many nonfarm groups that farm prices have held within a fairly narrow range of fluctuation since last spring. Such stability has followed a precipitous price decline which extended over two years. Many problems and an element of uncertainty still prevail, however, as farm production plans for 1954 are being pushed into action.

## Farm Income

During the first four months of 1954, sales of farm products, nationally, totaled somewhat short of $8½ billion—moderately below a year ago. The net contribution to national income continues short of $12½ billion at an annual rate, as compared with an approximate $16 billion rate in early 1951 and a still higher rate in the early postwar years.

Farm-product prices in the aggregate have shown a strong tendency so far this year to level out very near to the year-ago position, although they have been decidedly lower than in the corresponding periods of 1951 and 1952. Prices received by farmers in April, for example, were less than one percent below the comparable date of 1953. As usual, any such aggregate measure fails to reveal the contrasts among individual commodity lines.

Similar comments apply to the physical volume of farm marketings. Farm products hauled to market during the first quarter of this year are estimated as about on a par with 1953 in tonnage. Contrasting situations, such as shortages of hogs and surpluses of dairy products, again illustrate a wide variation among specific products.

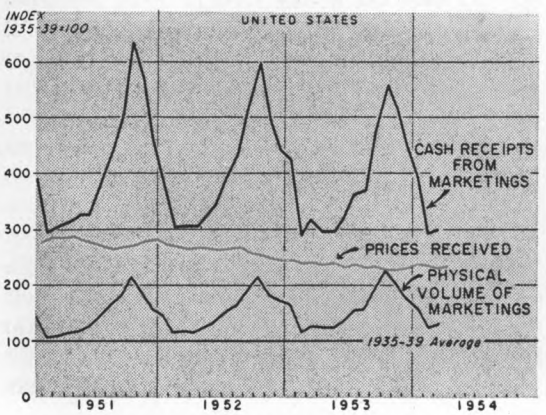
## Milk

Milk prices in April (Ohio prices) were the lowest at wholesale in four years and the lowest for any April since the end of World War II. Despite evidence of a prolonged cost-price squeeze, however, milk production throughout the nation during the first quarter of 1954 continued to expand, reaching a record level about 5 percent above the year-ago output. Even after allowance for population growth, milk production is the largest since early in the postwar period.

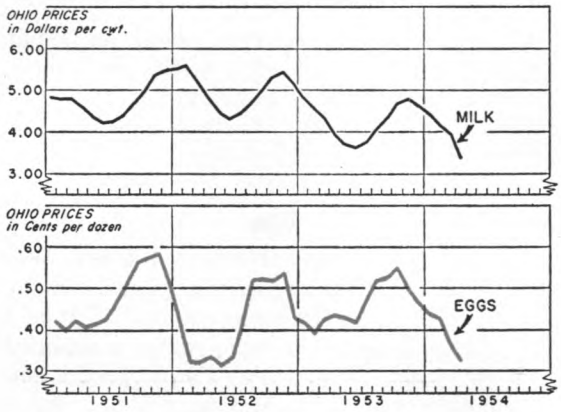
Continued high milk production without corresponding demand has brought the government into prominence as a buyer of dairy products. Continued failure to adjust output to market needs has forced a lowering of support rates on dairy products from 90 percent to 75 percent of parity as of April 1 of this year. These support prices are indicated in a later table.

Adjustment to the milk-price dilemma seems particularly difficult for dairymen.

***Compared with recent years, prices are lower, marketings are steady to larger, income has eased.***



*Milk prices and egg prices have dropped sharply this spring.*




Attempts to lower unit production costs usually yield an end product of higher aggregate production, while basically the problem is already one of greater production than the market will take at prices favorable to the producer. In addition, the introduction of cost-cutting mechanization into the dairy operation frequently requires substantial sums in new capital investment — a difficult decision to make when net returns have been whittled away year after year.

That dairymen are attempting to boost output per cow and per man is illustrated in the current rate of grain consumption per cow and the larger average size of herds. There are numerous indications, however, that much of this feed is going into "extra" cows which are not paying their way, as contrasted with use of the feed in other livestock enterprises. Accurate accounting methods would probably reveal the slaughter-house as the most profitable current use for many dairy cows which would have returned a profit at the higher prices of a few years ago.

## Eggs

Eggs, a popular supplementary enterprise on dairy farms, have also suffered from sharper than expected price drops so far into 1954. What at first appeared to be a seasonal drop "just a bit more severe than last year" failed to reverse on schedule in late winter. This is shown by the Ohio prices in the accompanying chart. Forecasts of the U. S. Department of Agriculture anticipate egg prices below a year ago until mid-year, although still high enough to provide "favorable returns."

Large production is apparently responsible for the price weakness in eggs. Some increase in production and lowering of price is normally expected during the late winter and early spring season. This year, however, impetus has been added to these seasonal movements by the greater number of layer hens on farms and a corresponding increase in the rate of lay per hen.

A current increase in hatchery output is providing some further apprehension concerning the egg price outlook for late this year. March hatchings of chicks in commercial hatcheries topped last year by 12 percent and broke a monthly record of ten years standing. The margin over a year ago for the first four months of 1954 averaged about 11 percent. Most of the gain in number of hatchings has been in chicks for laying-flock replacement.

## Hogs

Hog price trends provide a sharp contrast to both milk and eggs as indicated in the charts. Reduced slaughter supplies of hogs this year have pushed prices up to and frequently above the 1947 all-time highs for the comparable months. The spring seasonal price decline, which is quite pronounced in most years, was barely discernable in 1954.

The currently light hog receipts are still a reflection of farmer adjustments to overproduction and a profitless output back in 1952. For the most part, the restricted supply of hogs has met with strong demand for over a year. Furthermore, profitable prices still seem assured for the light marketing months of the early summer.

Numbers of pigs born this spring and to be marketed next fall have not as yet been determined. An official U. S. Department of Agriculture count of the spring pig crop will

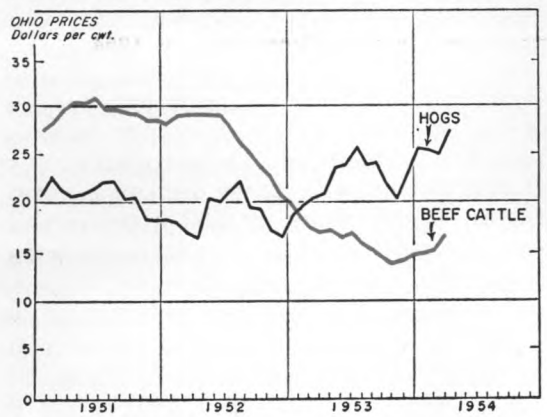
be released in late June. By all indications available, however, a substantial expansion has again occurred in the nation's hog enterprises.

## Cattle

Beef cattle have also experienced considerable recent price improvement. The winter and spring of this year marked the first prolonged price advance since early 1951. In Ohio, at any rate, April was the fifth consecutive month of price increase for the average of all types and grades of beef, as shown in the accompanying chart. It will be noted, however, that as of April, the 19 percent gain since last November has lifted prices only to a par with a year ago. Current beef cattle prices are still decidedly lower than the unusually prosperous 1947-52 period.

The price series shown in the chart serves as a guide to the trend for beef cattle; however, it does not reflect satisfactorily the selling prices of specific grades. Finished cattle prices at Fourth District markets, for example, are substantially improved from a year ago at $22 per hundredweight for the good-choice grades. Conversely, beef cows and light cattle have shown some improvement from late last year, but prices of these grades still appeared weak during the opening months of 1954 by comparison with a year ago.

***Beef cattle (all grades) still undersell hogs; both have shown substantial recent price advances.***




Current cattle supplies likewise show substantial variations by grades. Heavy liquidation of steers last year, and the slightly reduced numbers in feedlots now, have contributed to the improvement this spring in finished cattle prices. On the other hand, net increases in the 1953 cow and calf inventory are being reflected in the continued weakness of cow and light-cattle prices as outlined above.

Western range conditions are a critical element in the cattle picture this year. Despite recent rains, drought again poses a threat which could force heavy liquidation and consequent further disruption of markets.

Even with something akin to normal weather, there are indications that the long predicted downturn in cattle numbers will begin to materialize by the year's end. "Heifer slaughter" last year was in excess of numbers actually reaching this state of growth, and thus limited the extent to which discarded beef cows might be replaced.

## Crops

So far in 1954, of the crops most prominent in Fourth District agriculture, *soybeans* alone have been traded freely at a price which is well above support levels and which has been determined independently of government support activity. A shorter than expected crop last year (due to drought) coupled with strong domestic and foreign demand have boosted prices to levels seldom before enjoyed by farmers. April prices averaged $3.57 per bushel in Ohio — a 26 percent increase from the year before.

*Wheat* and *corn*, unlike soybeans, are heavily indebted to the price-support program for their current price position. Both of these crops showed substantial seasonal price declines last summer and fall, but have since recovered nearly all of the losses. April prices in both instances were within a few cents of year-ago levels.

Wheat stocks on the July 1 close of the current marketing year are expected to total about 875 million bushels — well over a third above the previous record high inventory of

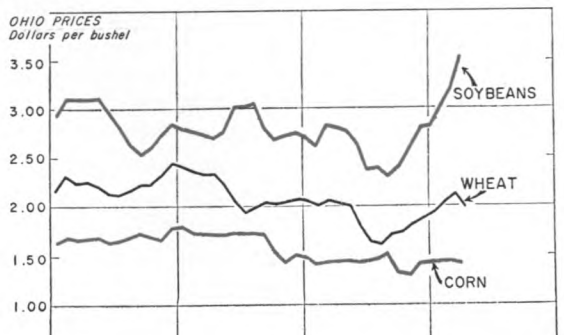
1942. A carryover of this magnitude would be somewhat in excess of a full year's export and domestic consumption needs at 1953 rates of use. Furthermore, it is expected by the U. S. Department of Agriculture that almost all of this carryover of wheat will be held in Commodity Credit Corporation inventories or under reseal programs.

Besides a high rate of production, the growing wheat glut is complicated during 1953-1954 by the lowest disappearance rate since the early years of World War II. This weakness stems primarily from the loss of export demand.

*Corn* inventories on April 1, nearly six months before a new harvest, were more than 10 percent greater than a year ago. An estimated two-fifths of these stocks were under price-support loan and purchase agreements; however, most of the price-support stocks were inventories of grain acquired prior to the 1953 crop. Substantial quantities of the old inventories have recently been offered for sale at a reduced price.

At the close of the current crop year on October 1, a corn inventory of 900 million bushels is considered plausible by the U. S. Department of Agriculture. These stocks, about one-sixth larger than last October 1, would nearly all be under loan or owned by the Commodity Credit Corporation.

***Corn and wheat prices are near early 1953 positions, but soybean prices have soared to new heights.***




Among the other crops important to the Fourth District are *oats,* the prices of which have held stable throughout the winter and spring. Current selling prices are within a penny or so per bushel of last year's quotations.

Selling prices of *burley tobacco* for the auction season which ended in February were at a record high.

Price support levels for major district crops are indicated in the following table.

## U. S. Average Support Prices

| | Price | | % of Parity | |
|---|---|---|---|---|
| | 1954 | 1953 | 1954 | 1953 |
| Wheat, bu. . . . . | $2.20* | $2.21 | 90% | 90% |
| Corn, bu. . . . . | 1.62* | 1.60 | 90 | 90 |
| Soybeans, bu. . . . . | 2.22 | 2.56 | 80 | 90 |
| Burley tobacco, lb. . . . | .46* | .47 | 90 | 90 |
| Barley, bu. . . . . | 1.15 | 1.24 | 85 | 85 |
| Oats, bu. . . . . | .75 | .80 | 85 | 85 |
| Mfg. milk, cwt. . . . . | 3.14 | 3.74 | 75 | 90 |
| Butterfat, lb. . . . . | .56 | .67 | 75 | 90 |
| Cheddar cheese, lb. . . . | .32 | .37 | 75 | 90 |
| Nonfat dry milk solids (spray), lb. . . | .15 | .16 | 75 | 90 |

*Minimum forward price, may be increased as marketing season approaches.

Source of data: Commodity Credit Corporation.

## Crop Plantings

In view of decided surpluses of wheat and corn, the Department of Agriculture has announced production controls on 1954 crops as a prerequisite to price-support aid. Also, marketing quotas were declared for wheat so as to place a penalty upon excess plantings. The actual cut in seeded wheat acreage will amount to an estimated 19 percent.

For corn, no clear indication was given by the March 1 planting-intentions report. Allotments had called for a 17 percent smaller acreage, but farmer plans at that time were for practically no change. The assignment of allotments to individual farms since March 1 is expected to cause some significant acreage reduction in corn. Due to the limited incentives afforded by the support program to farmers who feed rather than sell most of their corn, however, it is doubtful whether corn plantings will be cut as

drastically as the allotment program suggests.

An expansion in acreages of soybeans, oats and barley was indicated by the March 1 planting intentions report. Much of the increase for these crops has been on acreages diverted from wheat.

A perplexing problem faced by crop farmers generally is how to divert acres from crops in surplus without creating new market gluts for other products. Larger acreages of grass appear prominent in this respect, as a widely recommended opportunity.

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## EXPANSION IN STEEL

*(Continued from Page 4)*

### Canadian Ores

Although eastern mills will be the main recipients of Venezuelan ores, steel mills on the Lower Lakes will use most of the high and medium grade ores from the new Labrador field. Some Labrador ore will begin moving to East Coast ports later this summer and shipments to Lake Erie ports will start in 1955. The iron ore will be moved the first 360 miles over a new railroad built to link the Labrador field with Seven Islands on the St. Lawrence River. Large ocean-going carriers will then take the ore upriver to Montreal, where it will be transshipped to a fleet of 40 to 50 small lake freighters that can navigate the present locks and canal system. Completion of the St. Lawrence Seaway will enable the large ore carriers to make the complete 1,100-mile trip from Seven Islands to the Lower Lakes.

Large deposits of medium and lower grade ores have also been discovered in the Ungava Bay region of northern Quebec. Although easily accessible — the deposits have been described as being located practically on the shoreline with no overburden to remove — the nearest markets are in Europe. Opening the St. Lawrence River to large ocean-going freighters may make the Quebec ores competitive with Lake Superior and Labrador ores at Lower Lakes ports.

In addition to the recent and prospective developments in Canadian ores, account should be taken of the strides made in the processing of lower-grade domestic ores.

On the Upper Lakes, large reduction mills are under construction to process low-grade taconite into high-grade concentrates. The 1954 ore shipping season on the Great Lakes was opened by a boat carrying 18,000 tons of taconite pellets. It was the first large shipment of concentrates to come down the lakes. The pellets, processed during the winter at Babbit, Minnesota, were destined for blast furnaces in Middletown.

Also on the Upper Lakes, a new mine is being developed in the Steep Rock area of Ontario. Thus, it would appear that there will continue to be an abundant supply of iron ore available to steel mills in the Lower Lakes area for many years to come.

### Types of Furnaces

Another facet of the steel industry's recent expansion program is the changes that have occurred since 1947 in the three major kinds of steel-making furnaces — open hearth, Bessemer and electric. In the last six years, electric-furnace capacity was nearly doubled, open-hearth capacity about equaled the national rate of increase, but *rated* Bessemer capacity was contracted, thus continuing a trend that has persisted since the turn of the century. In the Fourth District, percentage gains in open-hearth and electric-furnace capacity were about half that of the rest of the country while, contrary to the national trend, Bessemer capacity was expanded.

At the beginning of 1948, electric furnaces

comprised 5.7 percent of the nation's steel capacity, on a tonnage basis, as against 8.4 percent (or 10.4 million net tons) this year. Although still a relatively small proportion of the total, electric furnaces have shown the most rapid growth in the postwar period, expanding 94 percent in the last six years. The reasons are not hard to find.

Electric furnaces can produce most known grades of steel, although they excel in the production of stainless and special alloy steels. Not only has the demand for these special steels skyrocketed, but, assuming location in a favorable scrap-producing area with low power rates, the electric furnace can produce carbon steels at costs comparable with, or sometimes even below, that of open-hearth steel.

With the increased emphasis being placed upon furnace location nearer to steel-consuming markets, this factor, along with the electric furnace's advantages in producing alloy steels, has stimulated its development. It is not surprising, then, to find that electric-furnace capacity in the Fourth District increased only about half as rapidly during the last six years as that of the rest of the country.

The open hearth remains the dominant furnace, however, accounting for about 88 percent of all steel ingot capacity in the United States. Nearly 85 percent of the capacity added in the country since 1947, or 25.5 million net tons, has been in open-hearth furnaces.

The open hearth has several major advantages over the other two types of furnaces. First, the ratio of scrap to pig iron may be varied over wide limits in charging the open hearth, whereas electric furnaces

## STEEL CAPACITY BY TYPE OF FURNACE

**(Capacity figures in thousands of net tons as of January 1st)**

| Area and Furnace | CAPACITY | | NET INCREASE 1948-1953 | | PERCENTAGE OF TOTAL | |
|---|---|---|---|---|---|---|
| | 1954 | 1948 | Tons | Pct | 1954 | 1948 |
| TOTAL U. S. | 124,330 | 94,233 | 30,097 | 31.9 | 100.0 | 100.0 |
| Open Hearth | 109,095 | 83,611 | 25,484 | 30.5 | 87.7 | 88.7 |
| Bessemer | 4,787 | 5,226 | —439 | —8.4 | 3.9 | 5.5 |
| Electric | 10,449 | 5,397 | 5,052 | 93.6 | 8.4 | 5.7 |
| FOURTH DISTRICT | 50,538 | 42,435 | 8,103 | 19.1 | 100.0 | 100.0 |
| Open Hearth | 42,353 | 35,847 | 6,506 | 18.2 | 83.8 | 84.5 |
| Bessemer | 3,951 | 3,824 | 127 | 3.3 | 7.8 | 9.0 |
| Electric | 4,234 | 2,764 | 1,470 | 53.2 | 8.4 | 6.5 |
| OTHER U. S. | 73,792 | 51,799 | 21,994 | 42.5 | 100.0 | 100.0 |
| Open Hearth | 66,741 | 47,764 | 18,978 | 39.7 | 90.4 | 92.2 |
| Bessemer | 836 | 1,402 | —566 | —40.4 | 1.1 | 2.7 |
| Electric | 6,215 | 2,633 | 3,582 | 136.0 | 8.4 | 5.1 |

Compiled from reports of American Iron and Steel Institute. Details may not add to totals because of rounding.

use practically all scrap and Bessemer converters require about 95 percent pig iron. Since from 25 to 30 percent of the ingots produced in a mill are reduced to scrap in the finishing operations, the ability to use this scrap is important. Secondly, open hearths can be built much larger than either the electric furnaces or Bessemer converters. The open hearth's ability to produce large quantities of steel under easily controlled conditions and to take advantage of relative changes in the cost of scrap and pig iron by varying their ratio in the furnace charge have made the open hearth the dominant process in the steel industry.

One major point of difference between Fourth District and other U. S. mills during the 1948-1953 period has been the expansion of Bessemer capacity in the District and its contraction in the rest of the country, as previously noted. More than four-fifths of the nation's *rated* Bessemer capacity is located in the Fourth District. The figures on Bessemer capacity (shown in the adjoining table) are somewhat misleading, however, since they do not show the country's *potential* Bessemer capacity. About a third of the Bessemer converters in the country (10 out of 33) are used solely to provide blown metal for open hearth charges and their tonnage is not included in total capacity.

The modern Bessemer shop is located near the open hearth furnaces to take advantage of the duplex process; e.g., using hot-blown metal from the converters as part of the pig-iron charge for the open hearth. This speeds up considerably the open-hearth operation by shortening the time of the heat and lengthening the life of the open hearth. An open hearth, which averages 15 heats per week using scrap-pig or scrap-ore charges will average 40 heats using the duplex process. The process does not require much scrap, an advantage when scrap is scarce and costly.

Bessemer steel is interchangeable with open hearth steel in many mill operations. The converter provides a quick, cheap means of converting pig iron into steel. Its main drawbacks are that it generates more scrap than it consumes and that the conversion occurs so quickly (a blow takes only 10 to 15 minutes) that it is difficult to control the chemical changes to obtain steels of varied chemical composition. Today, Bessemer steel is principally used for butt-welded and seamless pipe, wire, free-machining bars, flat-rolled products and castings.

# Better Jets Through Ceramic Materials

By CLYDE WILLIAMS, *President and Director, Battelle Memorial Institute*

THE TURBOJET ENGINE, relatively unknown before World War II, now dominates the field of high-performance military aviation, and is invading the field of commercial transportation. The flight speeds and altitudes of which turbojet-powered aircraft are capable represent substantial advances above those for conventional reciprocating-engine aircraft. Jet fighters have reached speeds above 750 miles per hour, and a jet bomber has flown at an altitude above 63,000 feet. The first U. S. jet transport is scheduled to begin trial flights this fall.

Jet propulsion has been compared, in principle, to the behavior of a toy balloon. When a balloon is filled with air and the opening sealed, the balloon is incapable of motion unless it is propelled by some external force such as a gust of wind. Open the seal, however, and the rush of the compressed air out of the opening sends the balloon zooming away in a direction opposite from that towards which the air is expelled. This is a homely illustration of the principle that, for every action, there is an equal and opposite reaction.

For practical application of this principle in the turbojet power plant, it has been found that the aircraft gas turbine must operate at a temperature of about 1550 F. It is also known that turbine performance increases tremendously with increases in operating temperature. Therefore, to achieve higher speeds and better performance, aeronautical engineers are now seeking materials for the construction of turbine parts that will withstand a temperature of 2500 F. Their studies show that such materials would permit design for 60 per cent more thrust or jet power from an engine of the same size and air-flow capacity; or, conversely, that present power output could be achieved with considerable reduction in aircraft size and weight.

The search for better heat-resistant materials is proceeding in three principal directions. First, without changes in engine design, efforts are being made to increase the safe operating temperature of severely stressed turbine parts by 100 F, or up to 1650 F. This may be done by improving the properties of presently used nickel- and cobalt-base alloys. Second, considerable research is in progress that may lead to coatings or other means of protecting molybdenum against oxidation at elevated temperatures. When such protection is achieved, molybdenum may find use at temperatures up to 2000 F. This range is usually considered the maximum useful service temperature limit for known metals in adequate supply to meet mass-production needs. Third, ceramic materials and ceramic-metal combinations, or "cermets," are being extensively investigated for service at temperatures up to and beyond 1800 F. Although difficulties are still to be overcome, ceramic materials and cermets may eventually prove the best solution to realizing the maximum performance of the turbojet power plant.

Ceramic materials offer real promise because they have excellent corrosion resistance, and a wide variety of them far exceed most metals and metal alloys in their ability to withstand very high temperatures. In one tabulation, seventy-seven different ceramic materials are listed with melting points ranging from 3000 F to 7500 F. Also an attractive feature of many ceramic materials is their relative lightness, which minimizes centrifugal stress in parts rotating at high speed. Furthermore, ceramic materials are generally in much greater supply than metals and metal alloys now being used, or being considered for use in turbojet applications. In common with some metals, although to a more pronounced degree, the main shortcoming of ceramic materials is their brittleness. This may cause "brittle fracture" under conditions of severe stress.

One approach to the use of ceramic materials under such conditions is to fit the materials to meet the engineering requirements of the present aircraft gas turbine. This is being done through the development of ceramic-metal combinations. These attempt to combine the high-temperature and corrosion-resistance properties of ceramic materials with the greater stress and shock resistance properties of metals. Progress is well advanced on the development of turbine blades made from combinations of titanium carbide and such metals as nickel and cobalt. Many opportunities still exist for investigating combinations of metals with oxides, carbides, nitrides, silicides, and other refractory ceramic materials.

Another approach to the use of ceramic materials in the turbojet engine is to explore the possibilities of redesigning the turbine to reduce the severity of stress concentrations and thermal shock to which ceramic parts are subjected. Proper engineering design has already proven a major factor in the successful use of ceramic materials as linings in the combustion chambers of rocket motors. This experience, together with more knowledge about the conditions encountered in turbines and of the mechanism of brittle fracture of ceramic materials, could play an important part in the development of ceramic parts for use in the turbojet power plant.

To evaluate and use ceramic materials, close cooperation is required between industrial ceramists and gas turbine engineers. With this close cooperation today, ceramic parts might well be developed that will set the standards of speed and performance for tomorrow's aircraft power plants.

Editor's Note—While the views expressed on this page are not necessarily those of this bank, the *Monthly Business Review* is pleased to make this space available for the discussion of significant developments in industrial research.