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IN THIS ISSUE

**THE ALUMINUM
INDUSTRY:**

**ITS PROBLEMS
AND PROGRESS**

FEDERAL RESERVE BANK OF CLEVELAND

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THE ALUMINUM INDUSTRY: ITS PROBLEMS AND PROGRESS

THE TOTAL production of primary aluminum in the United States ranks second only to steel in the production of all primary metals. From 1950 through 1963, domestic production of primary aluminum increased by more than three times as much as total industrial production, while the combined output of other primary metals (steel, copper, lead, magnesium and zinc) was virtually unchanged.¹

The expansion of the aluminum industry

¹ Primary aluminum refers to aluminum produced from bauxite ore. Secondary aluminum is recovered from scrap and is not freely substitutable for the primary product because of impurities. Primary producers account for more than 80 percent of total production in the United States as well as for the bulk of the capital invested in the aluminum industry.

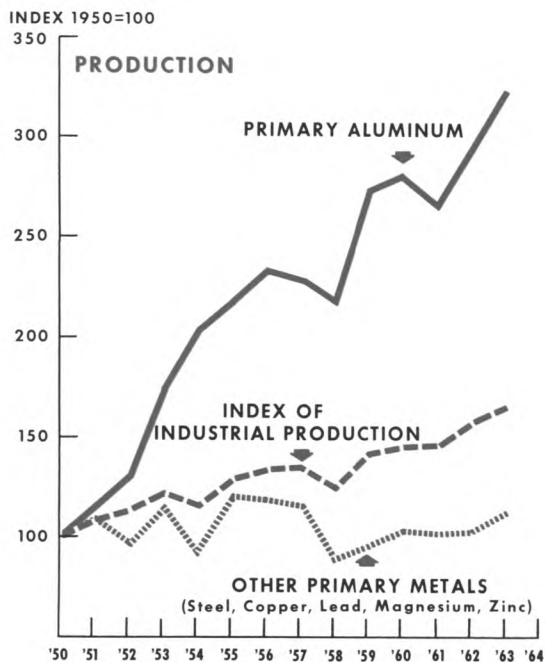
has not taken place without problems. Recently, for example, the industry has had to cope with excess capacity, unstable prices, and relatively low profits. These problems are being overcome in part by the improvement of existing markets and the development of new ones. In fact, steadily increasing consumption of aluminum may bring about renewed expansion of productive capacity.

This article surveys the aluminum industry. It discusses various technical aspects of aluminum, geographical factors, and the structure of the industry. The article also considers the relationship of capacity to production, the behavior of aluminum prices and profits, expanding markets, world trade in aluminum, and international expansion of the industry.

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From 1950 to 1963 the production of primary aluminum increased more than three times as much as total industrial production whereas the output of other primary metals showed little change.

1.



Sources of data: U. S. Department of the Interior;
Aluminum Association;
Board of Governors of the Federal
Reserve System

THE PRODUCTION PROCESS

Primary aluminum is obtained commercially from bauxite ore, which is essentially aluminum in chemical combination with oxygen and water plus other materials regarded as impurities.² Bauxite is found in large quantities in many parts of the world.

² High grade bauxite contains from 50 to 60 percent alumina (aluminum oxide), 15 to 32 percent water, 2 to 7 percent silica (silicon dioxide), 2 to 20 percent iron oxide, and 2 to 4 percent titanium oxide. Traces of a number of other minerals are usually present.

Because of a shortage of high grade sources in the U. S., four-fifths of the aluminum industry's supply of bauxite has to be imported from Jamaica, Surinam, Dominican Republic, Haiti, and British Guiana. The other one-fifth is mined domestically, primarily in Arkansas. Inasmuch as bauxite is found near the surface of the earth, it is mined with large power shovels. After being crushed and dried, it is shipped to refining plants located in the Gulf Coast region of the United States (Texas, Arkansas, Louisiana, Mississippi, and Alabama).

In the refining process, bauxite is mixed with a solution of caustic soda. When the mixture is heated under pressure, the hydrated alumina contained in the bauxite dissolves. After being precipitated from the solution and washed, the hydrated alumina is dried in large kilns. The resultant white powder (pure alumina) is shipped to reduction plants.

In the reduction process pure alumina is smelted in large electrolytic furnaces called cells or pots and separated into its component parts—aluminum and oxygen. In each cell, a direct electrical current is passed through a solution of alumina and cryolite. The electrical current passes out of the furnace through the carbon lining of the pot. The current causes metallic aluminum to be deposited on the lining where it settles to the bottom of the cell. At intervals the aluminum is siphoned from the pots and the molten metal then is cast into ingots of various forms and sizes. From ingot form, the metal is rolled, extruded, forged, or cast into semi-fabricated shapes required by manufac-

turers that fashion them into a myriad of finished products.³

GEOGRAPHICAL LOCATION AND ELECTRIC POWER

Because the production of primary aluminum requires large quantities of electrical power, the industry has located reduction plants where inexpensive electric power is available. As shown in the Map low-cost hydroelectric power attracted the industry to the St. Lawrence river valley early in the century. A shortage of electric power in northern New York, however, soon caused an increase in its cost, and the industry began to move to areas with lower costs.

During World War I the industry expanded in the Tennessee and Yadkin River Valleys, where it was able to obtain electric power from falling water. The industry developed its own facilities many years prior to the purchase of electric power from the Tennessee Valley Authority.

During World War II, vast quantities of aluminum were needed for the aircraft industry located in the Pacific Coast region. To encourage aluminum production in that region, the Federal government subsidized the development of hydroelectric power sites in Washington and Oregon. The combination of government subsidies and the wartime demand for large quantities of aluminum was a major influence in the aluminum industry's decision to locate in the Pacific Northwest.

³ Semifabricated shapes include sheet and plate, rod and bar, extruded and drawn products, tubing, castings and forgings, wire and cable, foil, and powder and paste.

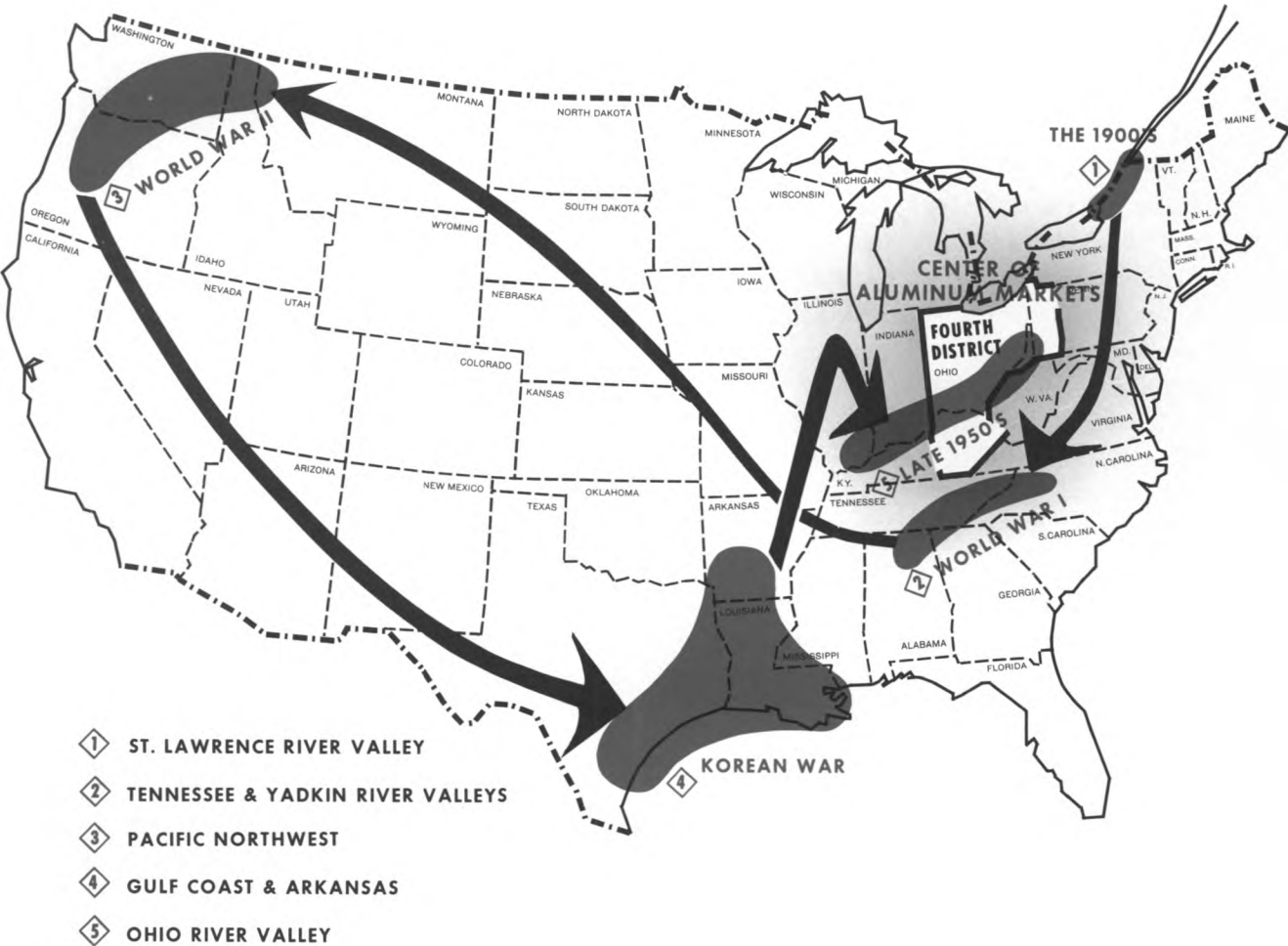
The Korean War brought about another surge in demand for aluminum. Because of a shortage of hydroelectric sites in the nation, the industry expanded to the Gulf Coast and Arkansas where electrical energy could be derived from natural gas. By 1955, however, it became apparent that low-cost gas could not be relied on in the long-range expansion plans of the aluminum industry. The widespread use of gas as a source of domestic heating led to the rapid construction of gas transmission lines; it also committed large gas reserves to be used for the eastern and midwestern states. The increasing cost and potential shortage of natural gas caused by this market expansion forced the aluminum industry to search elsewhere for an alternative source of cheap and abundant electrical power.

Because coal is another source of fuel that may be used for producing electric power, and a fuel of which this nation has a relative abundance, the industry considered the possibility of producing primary aluminum in the Ohio River Valley, where vast deposits of bituminous coal are located nearby.⁴ (A portion of the Ohio River Valley lies within the Fourth Federal Reserve District.)

The combination of substantial coal reserves, the mechanization of coal mining, and innovations in steam generating plants reduced the cost of producing electric power in the Ohio River Valley. Although electrical power rates in this area are greater than rates in the Pacific Northwest and in most other areas of primary aluminum production, the

⁴ The Ohio River Valley consists of a portion of six states (Ohio, Indiana, Illinois, Kentucky, West Virginia, and Pennsylvania) that border on the Ohio River.

GEOGRAPHICAL AREAS OF ALUMINUM PRODUCTION



Source of data: U. S. Department of the Interior

The aluminum industry has located reduction plants in regions where inexpensive electrical power is available. Initially, the industry built facilities in the St. Lawrence River Valley. Later, it developed in the Tennessee and Yadkin River Valleys. During World War II, the industry expanded in the Pacific Northwest. Plants were constructed on the Gulf Coast and in Arkansas during the Korean War. Since 1957, the Ohio River Valley has experienced a rapid growth in the production of primary aluminum.

Ohio River Valley is located closer to aluminum consuming firms (aluminum fabricators). In fact, approximately 70 percent of the total aluminum market is within 500 miles of the Ohio River Valley. In addition, the basic raw material (alumina) is transported inexpensively from the Gulf Coast to the Ohio River Valley by rail or via the Mississippi and Ohio Rivers. The net overall saving in the transportation cost of alumina and primary aluminum apparently more than offsets the difference in the cost of electrical power.

Since 1957, the Ohio River Valley has become the third largest area of primary aluminum production in the United States. This area accounts for approximately 20 percent of the nation's primary aluminum output as compared with 27 percent for the Pacific Northwest and 30 percent for the Gulf Coast and Arkansas.

INDUSTRY STRUCTURE

For more than 50 years after the start of aluminum production, only one firm produced primary aluminum in the United States. In 1941, however, a second firm, with an established reputation in the output of aluminum foil, began to produce primary aluminum in anticipation of heavy defense needs. During World War II, the Federal government also constructed additional facilities to meet the increasing demand for aluminum. At the end of the war, the Federal government sought to encourage additional competition in the industry by selling some of its plants to firms who wished to enter the industry. As a result, a third company entered the industry in 1946. Three more firms

in the 1950's started to produce primary aluminum to supply their own fabricating operations and to obtain a share of total capacity. In 1963 a foreign-owned corporation began to produce primary aluminum in the United States. The industry now has seven producers engaged in both the production of primary aluminum and in a number of semifabricated shapes. Nevertheless, the three largest producers account for 80 percent of primary aluminum production and 65 percent of the production of semifabricated shapes.

A high degree of vertical and horizontal integration characterizes the operation of the three largest producers. That is to say, each firm has established facilities at all stages of aluminum production, from the mining of bauxite to the final sale of aluminum products (vertical integration). Each firm also has extensive control over an increasing number of operations at any one stage of its production and sales (horizontal integration).

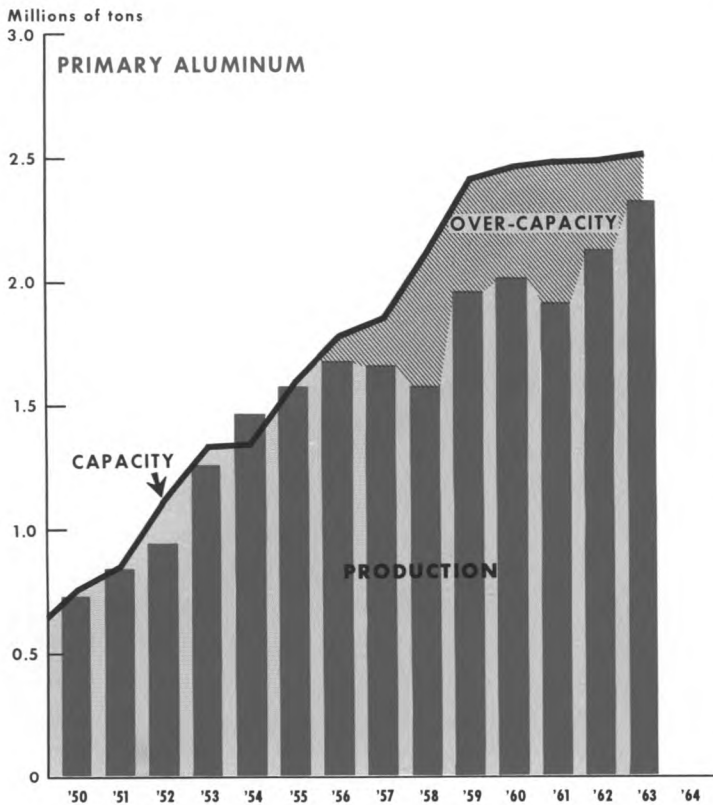
In addition to the major producers, there are several thousand foundries that produce aluminum castings and more than 200 fabricators making semifabricated shapes exclusively.

CAPACITY AND PRODUCTION

From 1950 through 1963 primary aluminum capacity in the United States more than tripled, with the increase occurring at an uneven pace. In 1963 capacity was estimated at approximately 2.5 million tons of primary aluminum (see Chart 3). The increase in capacity represents a considerable capital outlay because the investment per

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3.



Source of data: U. S. Department of the Interior

ton of basic aluminum capacity is much larger than for any other metal. Integrated facilities for producing primary aluminum from bauxite are estimated to cost from \$1,000 to \$1,400 per ton of capacity, depending upon the size of the plant; this compares, for example, with \$100 to \$150 per ton for producing steel.

The early phase of the expansion in capacity was partly in response to encouragement by the Federal government. To induce rapid investment, the government offered to the aluminum industry both accelerated depreciation allowances for new facilities and

stepped-up purchases for the Federal government stockpile of aluminum. Another incentive was the privilege of selling large quantities of aluminum to the government at a fixed price, if future markets were unable to absorb all of the metal produced.⁵

Production kept pace with the expansion in capacity from 1950 through 1956. In 1957, however, a decline in production marked the beginning of a five-year period when the output-capacity relationship was below the desired ratio (see Chart 3). Because of excess capacity, the construction of new plant facilities was curtailed as quickly as possible, so that capacity showed only a slight increase in 1959-63. Resumption of capacity expansion is scheduled by some of the large producers in the face of rising output, which is approaching full capacity utilization.

The causes of excess capacity are easily identified. During the early 1950's a large portion of primary aluminum production, instead of being consumed in military or civilian products, was allocated to the Federal government's strategic stockpile. Hence, from 1950 through 1956, the shortage of aluminum was probably caused by the strong demand for stockpile purposes. Because of govern-

⁵ This provision is known as "put rights", under which the industry sold approximately 900 thousand tons of aluminum ingot to the government from 1956 to 1963.

mental incentives and because of inaccurate forecasting of demand, the industry expanded facilities in excess of demand. In addition, several major commercial markets for aluminum, notably residential construction, home appliances, and automobiles, also experienced slack demand in 1957-58 and in 1960-61. The combination of these circumstances burdened primary aluminum producers with excess capacity, particularly in 1958 and 1961. A sharp rise in exports in 1960, however, allowed primary aluminum production to rise slightly from the 1959 level.

THE BEHAVIOR OF PRICES AND PROFITS

The rate of capacity at which the industry operates has a strong influence on the price of primary aluminum. Historically, the price has increased less rapidly than wholesale prices.⁶ From 1950 to 1957, however, the price of primary aluminum increased faster than wholesale prices as illustrated in Chart 4. The rapid increase in the price of primary aluminum reflected shortages when the industry was operating near full capacity. During the period of excess capacity that

⁶ Aluminum prices have been more stable and have risen less than the prices of other metals.

⁷ Although the price of primary aluminum increased in October 1963, the average price of primary aluminum for 1963 was lower than that for 1962. The decline was caused by the sharp decrease in the price of primary aluminum from 24 cents per pound to 22½ cents in December 1962.

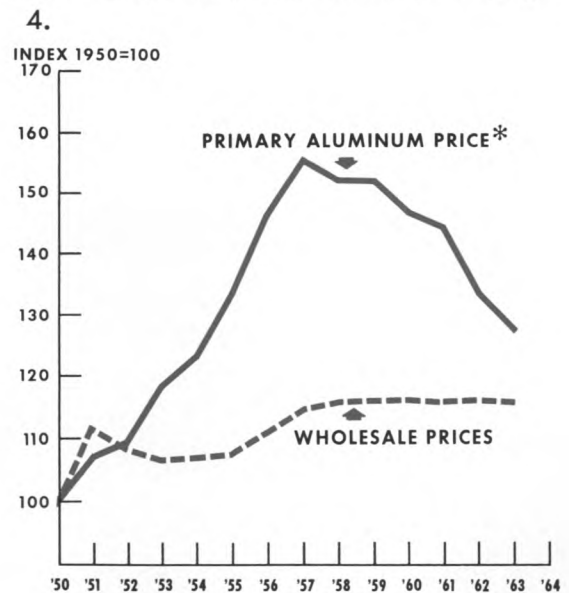
⁸ The prices of some semifabricated shapes have been adjusted upward to eliminate the practice of so-called "commodity pricing", i.e., selling a standard product for a specific application at a price lower than the published price.

started in 1957 primary producers competed vigorously for orders to activate their idle capacity, and the price of primary aluminum as well as prices of semifabricated shapes declined sharply, while wholesale prices remained steady.

Since October 1963 the industry has once again been operating near full capacity, and at the close of March 1964 the price of primary aluminum had increased from 22½ cents per pound to 23½ cents.⁷ The prices of a wide range of semifabricated shapes also have increased during this period.⁸

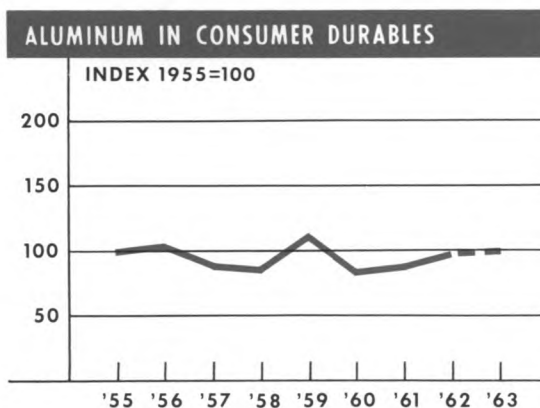
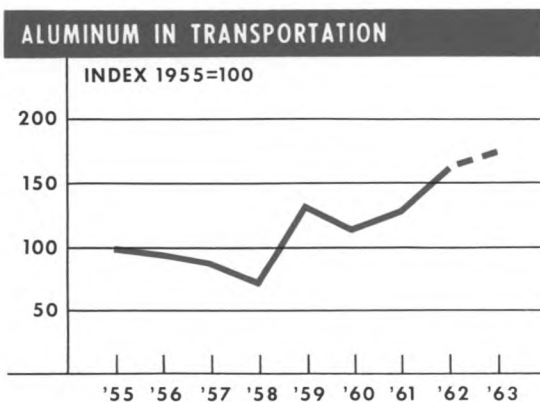
Partially because of declining prices, profits after taxes for the three largest producers fell

The price of primary aluminum increased faster than wholesale prices from 1950 to 1957. Commencing in 1957, however, the price of primary metal declined rapidly while wholesale prices remained steady.



*Unalloyed ingot
Sources of data: Bureau of Labor Statistics;
Aluminum Association

5.



Sources of data: Estimates by the Aluminum Association and by the aluminum industry

sharply from 1957 to 1960. Although the average price of primary aluminum continued to decline from 1961 to 1963, profits after taxes for the three largest producers did improve slightly.

MARKETS FOR ALUMINUM

The aluminum industry recognized that the solution to its problems depended in part on its success in increasing the demand for aluminum through expanding existing markets and creating new uses for the metal. In developing new uses for aluminum, the industry has utilized the advantages of aluminum, i.e., lightness, resistance to corrosion, machinability, appearance, electrical conductivity and ease of fabrication.

Existing markets for aluminum are comprised of five major industries, namely, construction, transportation, consumer durables, electrical equipment, and packaging, as well as other uses of aluminum. In 1963 these users consumed approximately 6,250 million pounds of aluminum.

The construction industry is one of the largest users of aluminum. It consumed about 1,440 million pounds or almost one-fourth of total aluminum shipments in 1963. As shown in Chart 5, the size of this market has increased more than 50 percent during the past five years. The increasing use of aluminum in construction reflects the wide acceptance of curtain wall construction for office buildings and the expanded use of aluminum in residential housing.⁹ Bridges,

⁹ The average new house consumed 230 pounds of aluminum in 1962 compared with 80 pounds in 1955.

highway accessories, and the general construction field are other important outlets.

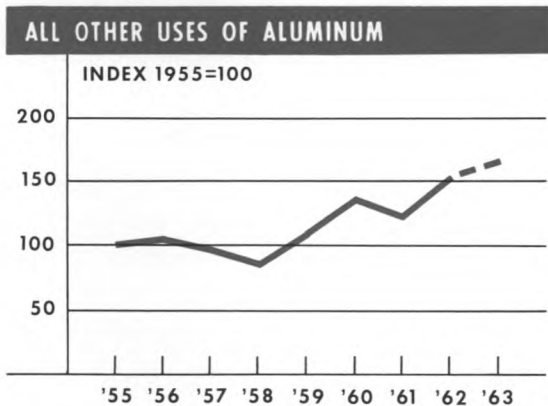
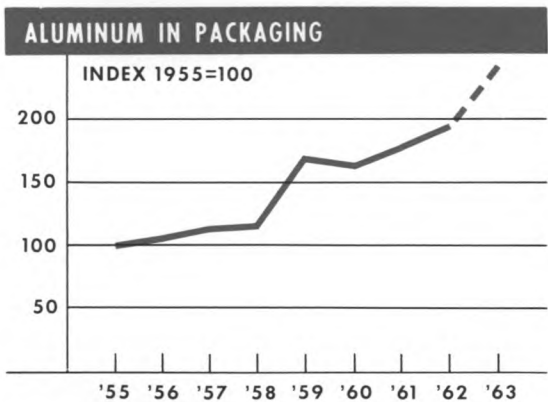
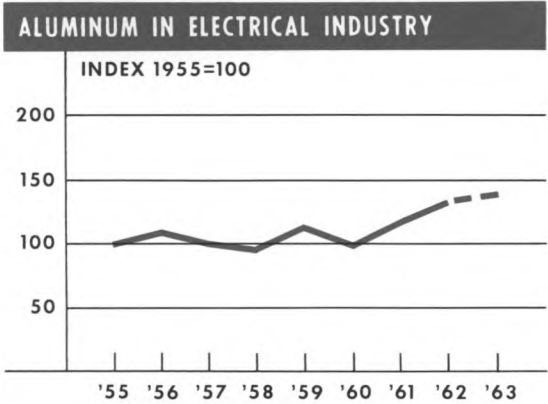
The transportation industry is another important market for aluminum. Although its use of the metal declined in 1955-58 because of the reduction in military aircraft production (see Chart 5), the transportation industry has been the largest expanding market for aluminum since 1958. In 1963 it consumed about the same quantity of aluminum as the construction industry. The use of aluminum for transportation applications has more than doubled since 1958, partly because of record consumption by the automotive industry.¹⁰ Other important uses for aluminum in transportation are: commercial aircraft, railroad cars, cargo containers, ships, and mobile homes.

The amount of aluminum used in consumer durables showed little change from 1955 through 1963 (see Chart 5). This market consumed approximately 650 million pounds of aluminum or more than 10 percent of total shipments in 1963.

The electrical equipment industry's consumption of aluminum increased more than 40 percent in 1960-63 (see Chart 6). In 1963 the demand for aluminum by this industry was equivalent to the amount used by manufacturers of consumer durables. Increased aluminum consumption by the electrical equipment industry is a result of many new applications ranging from light bulb bases

¹⁰ The average amount of aluminum used in passenger vehicles increased from 52 pounds per car in 1958 to 70 pounds in 1963.

6.



Sources of data: Estimates by the Aluminum Association and by the aluminum industry

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to cross-country transmission cables. Producers of electronic equipment (automatic controls, computers, and communications systems) have relied heavily on aluminum's properties: electrical conductivity, corrosion resistance, ease of fabrication, and nonmagnetic quality. Large quantities of aluminum are used in the production of wire and cable, conduit, lighting fixtures, motors and generators, and transformers.

The use of aluminum by the packaging industry more than doubled from 1958 through 1963 (see Chart 6). The sharp rise in 1959 was caused by the increased use of aluminum for flexible foil packaging and semi-rigid foil containers. In the past three years, the gain has been stimulated by the increasing consumption of aluminum for cans, foil containers, and household foil. In 1963 packaging consumed about 480 million pounds of aluminum or approximately 7 percent of total aluminum shipments.

The total of all other uses of aluminum has doubled during the past five years, as illustrated by Chart 6. The gain has resulted from a wide variety of uses: e.g., industrial equipment, irrigation pipe, rocket fuel, and deoxidants, as well as for export purposes.

EXPORTS AND IMPORTS

Exports of primary aluminum increased from 56.0 million pounds in 1957 to 570.0 million pounds in 1960, an all-time high (see Chart 7). This overall advance was in large part an outgrowth of the acquisition of foreign facilities by U. S. manufacturing firms that consumed large quantities of aluminum from the United States. In 1960 a sharp rise in exports represented a buildup in inventories

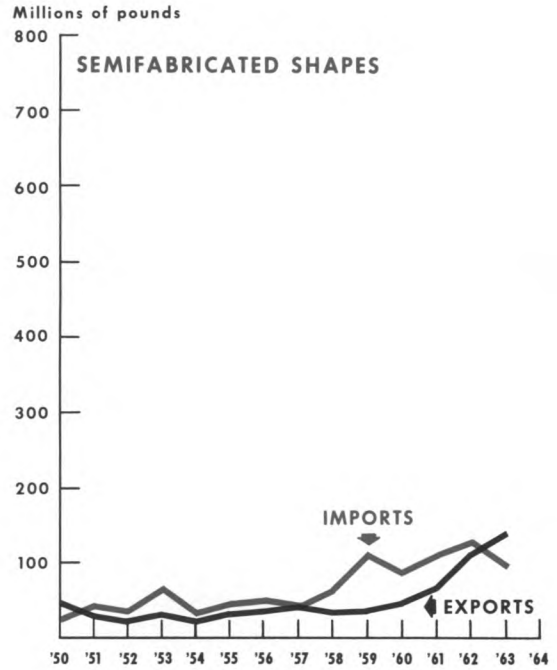
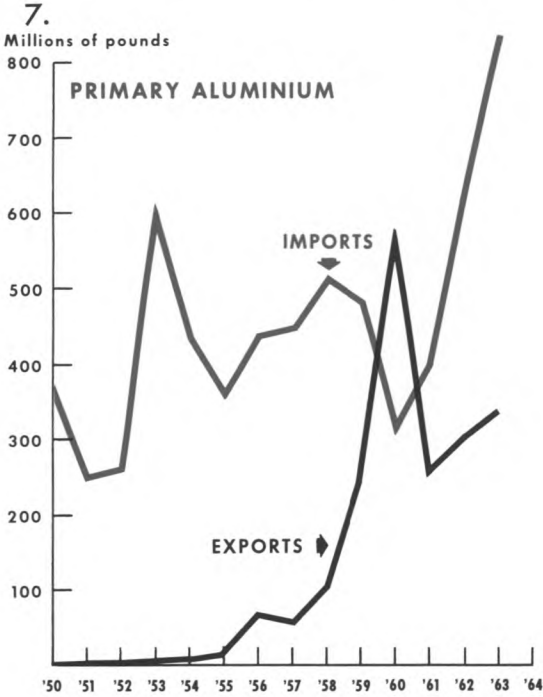
at the newly acquired foreign facilities. After declining sharply to 257.7 million pounds in 1961, exports of aluminum have increased steadily. Exports of primary aluminum amounted to approximately 330.7 million pounds in 1963. The United Kingdom, West Germany, Italy, Argentina and France were the principal destinations of these exports.

Despite the overall improvement in primary aluminum exports, imports of aluminum have exceeded exports by a substantial amount for a number of years, with the exception of 1960. In 1963 imports of primary aluminum amounted to about 831.2 million pounds. More than 65 percent of these imports came from Canada, with Norway and France supplying about 21 percent and 8 percent, respectively.

Imports of primary aluminum remain at a high level because the price from Canada and several other foreign countries is less than, or competitive with, the price of similar domestic products, even after payment of a 5 percent tariff on imports of primary aluminum into this country. In addition, because the large aluminum fabricators also produce primary aluminum there is a tendency on the part of other fabricators in the United States to purchase their aluminum abroad rather than from their competitors.

In attempting to sell aluminum in other markets, U. S. exporters of aluminum are confronted by obstacles and hindrances similar to those that face exporters of other nations, e.g., the ad valorem tariff on aluminum imposed by other major countries is more than in the United States. (It should be remembered that the ad valorem tariff is determined as a percent of price, and country-

Exports of primary aluminum expanded rapidly from 1957 to 1960. After a sharp decline in 1961, these exports increased steadily. Imports of primary aluminum, however, have exceeded exports by a substantial amount for a number of years. Exports and imports of semifabricated shapes remain at a low level.



Sources of data: Aluminum Association; U. S. Department of Commerce

to-country comparisons are especially difficult to make because of price variations.) To expand foreign trade, the U. S. aluminum industry is arguing for "equal opportunity" in free world aluminum markets. That is to say, U. S. firms advocate the reduction of foreign tariffs on primary metal and semifabricated shapes to the levels of those of the United States. If this goal cannot be achieved, U. S. producers advocate raising the U. S. tariff to the same level as those maintained by other countries.

Aluminum scrap is not subjected to a similar tariff situation and has become an

important product in international trade. Foreign producers demand large quantities of aluminum scrap because many semifabricated shapes may be produced at a lower cost by the remelting of imported scrap rather than by the importing of primary metal. The countries in which these foreign producers are located include West Germany, Italy, and Japan, all of which have a deficiency of primary aluminum capacity. Consequently, aluminum scrap has been exported from the United States in increasing amounts, expanding from 36.3 million pounds in 1957 to 142.1 million pounds in 1963.

WORLD-WIDE EXPANSION

The U. S. aluminum industry already had extensive overseas interests prior to 1957 inasmuch as large quantities of bauxite were mined in foreign countries. In the late 1950's, additional aluminum firms were acquired in England. Following the acquisition of these facilities, the industry acquired many plants in Western Europe. In the past few years, U. S. aluminum producers also have established additional facilities in South America, Africa, Asia, and Australia.

The purpose of developing an overseas network of plants is to serve the expanding world aluminum market. At the present time, aluminum consumption in the United States is about 28.5 pounds per capita; this compares with 10.8 pounds per capita in the European Common Market countries, 10.0 pounds in

Australia, 4.4 pounds in Japan, less than 1.0 pounds in Africa, India, and South America. Such a comparison suggests that aluminum consumption may increase in many nations.

CONCLUSION

The recent problems experienced by the aluminum industry are being overcome for the most part by aggressive marketing policies. Such policies are indispensable to the expansion of the aluminum industry in the face of competition both here and abroad.

Following several years of virtually no change in capacity, the steadily increasing consumption of aluminum suggests that the industry again may be on the verge of a new period of expansion. If such an expansion occurs, the Ohio River Valley may be a beneficiary because of its locational and resource advantages.

THE FEDERAL RESERVE SYSTEM : PURPOSES AND FUNCTIONS

The fifth edition of THE FEDERAL RESERVE SYSTEM: PURPOSES AND FUNCTIONS commemorates the fiftieth anniversary of the signing of the Federal Reserve Act by President Woodrow Wilson on December 23, 1913.

The new edition has been expanded to include chapters on the organization of the Federal Reserve System for policy making, on the open market policy process, and on the balance of payments. These and other changes that have been made throughout the text are designed to clarify the System's role and functioning in light of changes that have occurred in the national and world economies and in light of further advances in monetary knowledge.

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