UNITED STATES TARIFF COMMISSION

# SUMMARIES OF TRADE AND TARIFF INFORMATION

Prepared in Terms of the Tariff Schedules of the United States (TSUS)

Schedule 6

Metals and Metal Products
(In 11 volumes)

Volume 1

Nonferrous Metals I

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UNITED STATES TARIFF COMMISSION

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# F O R E W O R D

In an address delivered in Boston on May 18, 1917, Frank W. Taussig, distinguished first chairman of the Tariff Commission, delineated the responsibility of the newly established Commission to operate as a source of objective, factual information on tariffs and trade. He stated that the Commission was already preparing a catalog of tariff information--

> designed to have on hand, in compact and simple form, all available data on the growth, development and location of industries affected by the tariff, on the extent of domestic production, on the extent of imports, on the conditions of competition between domestic and foreign products.

The first such report was issued in 1920. Subsequently three series of summaries of tariff information on commodities were published--in 1921, 1929, and 1948-50. The current series, entitled Summaries of Trade and Tariff Information, presents the information in terms of the tariff items provided for in the eight tariff schedules of the Tariff Schedules of the United States (TSUS), which on August 31, 1963, replaced the 16 schedules of the Tariff Act of 1930.

Through its professional staff of commodity specialists, economists, lawyers, statisticians, and accountants, the Commission follows the movement of thousands of articles in international commodity trade, and during the years of its existence, has built up a reservoir of knowledge and understanding, not only with respect to imports but also regarding products and their uses, techniques of manufacturing and processing, commercial practices, and markets. Accordingly, the Commission believes that, when completed, the current series of summaries will be the most comprehensive publication of its kind and will present benchmark information that will serve many interests. This project, although encyclopedic, attempts to conform with Chairman Taussig's admonition to be "exhaustive in inquiry, and at the same time brief and discriminating in statement."

This series is being published in 62 volumes of summaries, each volume to be issued as soon as completed. Although the order of publication may not follow the numerical sequence of the items in the TSUS, all items are to be covered. As far as practicable, each volume reflects the most recent developments affecting U.S. foreign trade in the commodities included.

SUMMARIES OF TRADE AND TARIFF INFORMATION

SCHEDULE 6

Volume 1

C O N T E N T S

## Numerical List of TSUS Items in This Volume

# INTRODUCTION

This volume is one of a series of 11 volumes of summaries of trade and tariff information on metals and metal products. It covers some of the nonferrous metal-bearing materials provided for in part 1 of schedule 6 of the Tariff Schedules of the United States (TSUS), all of the products provided for in subpart 2D (aluminum), and some of the nonferrous metal products provided for in subparts 2J and 2K of that schedule. This volume is identified by the number 6:1.1/ It contains information on 18 nonferrous metals classified under 59 TSUS items listed on p. v of this volume. Volumes 6:2 and 6:3 cover the other nonferrous metal-bearing materials and nonferrous metal products provided for in parts 1 and 2 of schedule 6. Together, the three volumes embrace almost all of the nonferrous metals--in metal-bearing ores and other metal-bearing materials, in waste and scrap, and in unwrought and wrought forms (both unalloyed and alloyed)--as these terms are defined in the TSUS. Nonferrous metals in more advanced manufactured articles, not necessarily identified by the principal component metal, are classifiable in parts 3 to 6 of schedule 6 and in some parts of schedule 7.

A few metallic elements and all chemical compounds are classified in schedule 4. These include the alkali metals cesium, potassium, and sodium (item 415.10), lithium (item 415.30), and rubidium (item 415.40) --metals that are highly reactive chemically and valuable for the preparation of chemical compounds and uses other than as structural materials. A few other metallic elements and isotopes (except natural thorium and uranium) which are usefully radioactive are also classified in schedule 4 (in item 494.50). On the other hand, certain elements that exhibit metallic or nonmetallic properties under certain conditions (e.g., arsenic and boron, covered in this volume) are included as base metals in schedule 6.

In 1967 the value of imports covered by volume 6:1 amounted to $490 million--about 14 percent less than the value of imports in 1966 ($566 million) and slightly less than that in 1965 ($495 million). Aluminum items (bauxite, aluminum waste and scrap, and unwrought and wrought aluminum products) accounted for about 81 percent of the total value of U.S. imports during the two years 1966 and 1967. During these years, the value of imports of the principal other metals covered by this volume, listed in order of magnitude, were chromium (almost 6 percent of the total), cobalt (4 percent), mercury (a little more than 2 percent), and bismuth, antimony, cadmium, tantalum, and columbium (each 1 to 2 percent). These imports came from more than 30 countries, but the 4 principal sources--Canada, Jamaica, Surinam, and Norway--supplied about two-thirds of the total value of imports in 1966 and 1967.

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1/ For this and other summary volumes, the number to the left of the colon designates the TSUS schedule involved and the number to the right of the colon indicates the sequence of the volume in the series for that schedule, as listed on p. ii in this volume for schedule 6. Volumes published heretofore are listed on the inside of the back cover.

With few exceptions, U.S. imports greatly exceeded exports of the products discussed in this volume; in 1966 the exceptions were aluminum mill products, aluminum waste and scrap, magnesium metal, and tantalum metal.

Of the metals covered by this volume, the United States is the world's largest consumer of aluminum, antimony, beryllium, chromium, cobalt, columbium, tantalum, mercury, cadmium, magnesium, bismuth, and calcium. It is also the world's largest producer of aluminum, beryllium, columbium, tantalum, cadmium, and magnesium metals. The United States imports the bulk of its requirements for bauxite (aluminum ore), beryllium ore, chrome ore, columbium ore, tantalum ore, cadmium-bearing flue dust or fume, and cobalt metal; to encourage imports, these materials are entered free of duty. Although the duty on bauxite is suspended until July 16, 1968, it is scheduled for complete elimination by January 1, 1972, as a result of a concession granted by the United States in the sixth round of trade negotiations under the General Agreement on Tariffs and Trade (GATT).

The aggregate value added in U.S. production of the metal products summarized in this volume is estimated at about $1.6 billion for 1966. The value-added concept eliminates duplication in the aggregate value of shipments by domestic producers which results from the use of products for some establishments as material inputs for others. The value added in U.S. production of aluminum products, considered alone, probably amounted to about $1.5 billion.

Appendix A to this volume reproduces pertinent segments of the Tariff Schedules of the United States Annotated (TSUSA-1968) relating to the items covered by this volume. It includes the general headnotes to the TSUS, the headnotes to schedule 6, the headnotes to parts 1 and 2 and the relevant subparts of part 2, and the individual product descriptions; the interpretive headnotes clarify the relationships between the various tariff items and define many of the terms used in the descriptions. Appendix A also gives the rates of duty applicable to the individual TSUS items including the staged annual rate modifications that resulted from concessions granted by the United States in the sixth (Kennedy) round of trade negotiations under the GATT. Notes in the appendix also document changes in the legal text of the tariff schedules after these schedules went into effect on August 31, 1963, including items affected by temporary legislation as indicated in the "Appendix to the Tariff Schedules," and in the statistical annotations of items. Appendix A reproduces all of part 1 of schedule 6, all of the subparts of part 2 of that schedule that contain TSUS items treated in this volume, and a part of the appendix to the tariff schedules. The shaded parts of headnotes and TSUS items not covered by this volume are included so that their relationship to the items covered may be seen.

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Appendix B to this volume provides data on the value of the U.S. imports in 1967 by TSUS items included in the individual summaries of this volume. Data also show the percentage changes in imports from 1966 and the three principal countries which supplied imports in 1967. Official statistics on U.S. imports in 1967 were received early in February 1968--too late for inclusion in the individual summaries completed mostly in December 1967.

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| Commodity | TSUS item |
|---|---|
| Antimony: | |
| Ore | 601.03 |
| Needle or liquated | 603.10 |
| Other antimony-bearing materials | 603.70 (pt.) |
| Metal, unwrought, and waste and scrap | 632.02 |
| Alloys, unwrought | 632.60, -.62 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

U.S. consumption of antimony, the largest in the world, is almost entirely supplied from imported material, mostly in the form of ores. U.S. production of antimony metal, derived principally from imported ores, is substantial, and since 1963 has been larger than imports of such metal. Exports have been very small.

## Description and uses

The most common antimony ore mineral is stibnite, a sulfide. U.S. imports of ore include both sulfide ore, primarily from South Africa and Bolivia, and oxide ore, mainly from Mexico; the ores are used to make antimony oxide and other antimony compounds (items 417.50 to 417.54), and metal. The antimony compounds are used for a variety of products including flameproofing chemicals and compounds, ceramics and glass, plastics, pigments, and rubber products. Antimony needle, or liquated antimony, a product containing about 70 percent antimony, is obtained by melting (i.e., liquating) antimony sulfide ore; this liquated product is used in the manufacture of pigments, rubber, safety matches, percussion caps, and fireworks.

Antimony metal is a lustrous white metal with a low melting point; it is a poor conductor of heat and electricity, somewhat harder than copper, and so brittle that it can be easily reduced to powder. The metal, also called "regulus," is used principally in making lead-base alloys, to which it imparts hardness, rigidity, mechanical strength, and corrosion resistance. The most important of such alloys is antimonial lead (usually with 3 to 5 percent antimony content, by weight), used chiefly in making grids (plates) for automobile storage batteries. Antimony metal is also alloyed with lead and tin for use in babbitt bearings, solders, foil, collapsible tubes, small arms bullets, and type metal.

Alloys of antimony are provided for as follows: those containing 83 percent or more of antimony, in item 632.60; other alloys of antimony, in item 632.62. Although an alloy for tariff purposes, the material imported under item 632.60 has consisted of a refinery product, some of which was processed for the extraction of the antimony and other constituents (mainly lead), and some of which was used in the production of lead-base alloys. The products under item 632.62 include antimony alloyed with indium and with gallium, which are used for making semiconductors.

The summary on inorganic compounds of antimony (items 417.50, 417.52, and 417.54) is included in volume 4:2, and that on antimonial lead (item 624.03), in volume 6:2.

In this summary all quantities are expressed in terms of short tons (2,000 pounds).

## U.S. tariff treatment

The column 1 (or trade-agreement) rates of duty applicable to imports (see general headnote 3 in the TSUSA-1968) are as follows:

| TSUS item | Commodity | Prior rate | U.S. concessions granted in 1964-67 trade conference (Kennedy Round) | |
|---|---|---|---|---|
| | | | First stage, effective Jan. 1, 1968 | Final stage, effective Jan. 1, 1972 |
| | Antimony: | | | |
| 601.03 | Ore | Free | 1/ | 1/ |
| 603.10 | Needle or liquated | 0.25¢ per lb. | 0.2¢ per lb. | 0.1¢ per lb. 2/ |
| 603.70 | Other antimony-bearing materials. | 15% ad val. | 13% ad val. | 7.5% ad val. |
| 632.02 | Metal, unwrought, and waste and scrap. | 2¢ per lb. | 1.8¢ per lb. | 1¢ per lb. |
| | Alloys, unwrought: | | | |
| 632.60 | Containing, by weight 83 percent or more of antimony. | 2¢ per lb. | 1.8¢ per lb. | 1¢ per lb. |
| 632.62 | Other | 18% ad val. | 16% ad val. | 9% ad val. |

1/ Duty-free status not affected by trade conference.
2/ The final rate for this item will become effective Jan. 1, 1970, in the 3d stage.

The tabulation above shows the column 1 rates of duty in effect prior to January 1, 1968, and modifications therein as a result of concessions granted by the United States in the sixth round of trade negotiations under the General Agreement on Tariffs and Trade (GATT). Only the first and final stages of the annual rate modifications are shown above (see the TSUSA-1968 for the intermediate staged rates).

The prior rates of duty on items 601.03, 603.10, 632.02, and 632.60 are those provided in the original Tariff Act of 1930; the prior rate on item 603.70 had become effective January 1, 1948, and that on item 632.62, on July 1, 1963, as a result of concessions made by the United States in the GATT. All prior rates continued unchanged under the TSUS from August 31, 1963, through December 31, 1967. Before the effective date of the TSUS on August 31, 1963, alloys classifiable under item 632.62 were provided for in paragraph 397 of the Tariff Act of 1930, under other manufactures of metal, not specially provided for; under the TSUS, such alloys were established as a separate item.

As a result of further concessions granted by the United States in the GATT concluded on June 30, 1967, the rates of duty are to be reduced about 50 percent on all the aforementioned articles of antimony except antimony ore, item 601.03; on item 601.03, a concession was not granted in the trade negotiations mentioned above. The 50-percent reduction is to be put into effect in three annual stages for item 603.10 and in five annual stages for all other affected items; in all cases, as indicated above, the first stage reduction is effective January 1, 1968.

The duty on antimony waste and scrap (part of item 632.02) has been suspended almost continuously from March 1942 by acts of Congress; the latest act in the series (Public Law 90-45) extended the suspension to June 30, 1969. Antimony waste and scrap, however, has not been a significant article of commerce.

The average ad valorem equivalents of the specific rates of duty in effect on December 31, 1967, based on dutiable imports during 1966, were as follows:

| TSUS item | Percent |
|---|---|
| 603.10 | 0.8 |
| 632.02 | 5.4 |
| 632.60 | 6.8 |

U.S. consumption

Annual U.S. consumption of primary antimony (that produced from ores rather than from scrap) increased generally during 1959-66 (table 1). In 1966, consumption was about 17,800 short tons, 72 percent larger than in 1958; thus, the average annual rate of growth of consumption during 1959-66 was about 7 percent. In most of the years 1958-66, less than 6 percent of the quantity consumed was obtained from ores mined domestically. The bulk of the antimony consumed consisted of antimony in metal or compounds produced in the United States from imported antimony ores (table 2). A part of the antimony metal consumed was supplied by imports.

Of the total consumption of primary antimony in 1966, 37 percent went into metal products and 63 percent went into nonmetal products (table 3); during 1958-65 the antimony consumed in making metal products ranged from 44 to 49 percent of the total. In 1966 most of the primary antimony consumed in the metal products group was used in making antimonial lead, bearings, and type metal, and most of that consumed in the nonmetal products group was used in making flameproofing materials, ceramics and glass, and plastics. The quantity of primary antimony consumed in making antimonial lead (used principally in storage batteries) constituted about two-thirds of the total for metal products, and that consumed in making flameproofing chemicals and compounds, almost one-third of the total for nonmetal products.

In addition to the foregoing, large amounts of antimony are consumed each year as a minor constituent of various alloys provided for under TSUS items not covered by this summary. The bulk of such alloys, consisting principally of antimonial lead, are produced from secondary materials, mostly scrapped automobile batteries. During 1962-66, annual U.S. production of these alloys increased from 21,500 to 26,100 tons (antimony content), most of which was consumed domestically.

Because of increased consumption in world markets, by 1964 the supply of antimony had become tight. As a consequence, prices of antimony increased; for example, in the United States the quoted price per pound of domestic antimony metal (99.5 percent pure, f.o.b. Laredo, Tex., in bulk lots) increased from 32.5 cents in January 1964 to 44 cents by June 23, 1964, at which level it remained to the end of 1966. To help relieve the domestic supply situation, the U.S. Government was authorized in October 1964 to sell 5,000 tons of antimony from the national stockpile (Public Law 88-615) for domestic use. Government sales of such antimony totaled 2,250 tons during 1964-65 and 61 tons during 1966. Partly because of the sales of Government stocks and an increase in the supply of secondary antimony that had

been stimulated by the increases in prices, the tight domestic supply situation was eased beginning in early 1965 and continuing throughout 1966.

## U.S. producers

Several small mines in Idaho, Nevada, and Alaska have been producing antimony ore in recent years; their production, however, has been sporadic and very small. The National Lead Co. is the major domestic producer of primary antimony metal--in its refinery in Laredo, Tex.; this concern produces the metal at this plant from antimony ores (mostly low-grade) imported from Mexico, including some from mines that are partly owned by the company. However, the company sells only a small portion of its output of primary antimony; the bulk of it is used for the production of antimonial lead by several subsidiary secondary smelters (i.e., smelters that process scrap, primarily) situated in various parts of the country. In addition, very small quantities of ultrapure (99.999 percent) antimony metal are produced as a byproduct by the Bunker Hill Co., at Kellogg, Idaho.

Other domestic producers of primary antimony metal are: the Sunshine Mining Co., of Kellogg, Idaho, which produces a low-grade impure antimony cathode as a byproduct from refining silver-lead-bearing ores, and two other companies in Idaho, the Hecla Mining Co. and the Antimony Gold Ores Co., which produce a similar byproduct cathode but in much smaller quantities.

The sale of primary antimony metal is a minor source of income to the National Lead Co., the major domestic producer of such metal. This is a large, diversified firm, whose wholly or partly owned domestic subsidiaries produce a large variety of paints, paint materials, and chemicals, and also metal products (of lead, zinc, and other nonferrous metals). Foreign affiliates of the company, some of which produce like products, are dispersed among many countries, including Canada, the United Kingdom, and others in Europe, South America, and east Asia. The sale of antimony is likewise a minor source of income for the remaining domestic producers of primary antimony.

## U.S. production

U.S. output of antimony from ores was small throughout 1958-66, ranging from about 630 to 930 tons of antimony content (table 1). All or most of the primary output each year has been in the form of cathodes of impure antimony obtained as a byproduct of refining lead-silver ores; the remainder consisted of antimony ore. Annual U.S. smelter output of antimony metal increased from about 2,800 tons in

1958, to 4,600 tons in 1961; during 1962-66 it fluctuated, ranging from 4,200 to 4,600 tons. Virtually all of the smelter production of antimony metal was obtained from imported antimony ores.

In 1964-66 the domestic supply of antimony was augmented somewhat by sales from the national stockpile, which had been accumulated under various programs. On March 31, 1964, the Office of Emergency Planning set the national stockpile objective for antimony (for conventional warfare) at 25,500 tons. On June 30, 1964, the quantity of antimony held by the U.S. Government totaled 52,985 tons (in antimony metal and ores), or nearly 27,500 tons more than the objective. On October 2, 1964, the General Services Administration was authorized under Public Law 88-615, to sell 5,000 tons of the antimony in Government stocks to help meet the domestic supply requirements. By December 31, 1966, the GSA had sold about 2,300 tons, and Government stocks of antimony totaled about 49,400 tons.

## U.S. exports

U.S. exports of antimony in recent years have been small in relation to production or imports (table 1). Total annual exports of antimony in unwrought metal and alloys 1/ varied sharply during 1958-66, ranging from 14 tons (valued at $18,000) in 1965 to 556 tons (valued at $376,000) in 1964 (table 4). During 1958-66, the principal markets for U.S. exports of antimony were Belgium-Luxembourg, Japan, France, and West Germany.

## U.S. imports

From 1958 to 1963, total annual U.S. imports of antimony, in various forms, more than doubled in both quantity (antimony content) and value; during 1964-66 the quantity imported was smaller each year than it had been in 1963, but the value of imports was larger in two of the three years, reflecting a rise in unit value (table 5). The increase in the unit values of imports of antimony ore and unalloyed

1/ The data for 1958-64 cover both (a) unwrought metal and (b) ores (with the antimony content estimated at 40 percent of the reported quantities); a study of export documents disclosed, however, that probably most exports reported as ores consisted of metal. The data for 1965-66 cover only unwrought metal.

metal from 1960 to 1966 is shown in the following tabulation of annual averages (in cents per pound of antimony content):

| Year | Unit value of-- Antimony ore | Antimony metal |
|---|---|---|
| 1960 | 9.4 | 22.9 |
| 1961 | 10.3 | 23.9 |
| 1962 | 12.6 | 24.4 |
| 1963 | 13.7 | 26.0 |
| 1964 | 15.4 | 38.9 |
| 1965 | 20.8 | 39.9 |
| 1966 | 19.1 | 36.7 |

By 1966, the quantity of antimony contained in imports was about 15,500 tons, or 99 percent larger than that in 1958, and the foreign value of imports was $7.0 million, or 171 percent larger than that in 1958. Annual duty-free imports of antimony entered for U.S. Government use, which accounted for 23 percent of the total quantity imported in 1958, were nil or negligible in 1964-66.

The composition of the imports of antimony changed substantially during 1958-66 (table 5). Of the total quantity imported (antimony content), the proportion made up of ores increased from 44 percent in 1958 to 80 percent in 1966, while that consisting of antimony metal decreased from 55 to 18 percent. Similarly, the value of ores imported increased from 25 percent of the total value of imports in 1958 to 68 percent in 1966, while that of metal imported decreased from 73 percent of the total to 29 percent. Antimony needle and alloys made up the small remainder of total imports. During 1958-66, minor quantities of antimony waste and scrap were imported, and imports of antimony-bearing materials under item 603.70 were probably nil.

The increase in the average unit values of imports, previously noted, was reflected in increased U.S. price quotations for imported antimony. The quoted price (at New York) for imported high grade ore (65 percent antimony content) increased from about $3.20 per short ton unit (STU), i.e., 20 pounds of antimony content (the equivalent of 16 cents per pound), at the beginning of 1958 to about $8.60 per STU (or 43 cents per pound) at the beginning of 1965. During the same period, the quoted price (duty paid, New York, 5-ton lots) for imported antimony metal (99.5 percent pure) rose from 26 cents to about 54 cents. By the end of 1966, however, as a consequence of a decrease in demand, the corresponding prices declined somewhat--the price of the ore to about $5.60 per STU (or 28 cents per pound of antimony content), and the price of the metal to about 42 cents per pound.

The bulk of the quantity of antimony imported by the United States throughout most of 1958-66 came from Mexico and the Republic of South Africa, and most of the remainder came from Yugoslavia and Bolivia (table 6). South Africa, Bolivia, mainland China, and perhaps the U.S.S.R., have the world's largest reserves of antimony ore and are the world's leading suppliers of primary antimony.

Table 1.--Primary antimony: U.S. production, imports for consumption, exports of domestic merchandise, and industrial consumption, 1958-66

(In short tons of antimony content)

| Year | U.S. production | | Imports 3/ | Exports 4/ | Industrial consumption 5/ |
|---|---|---|---|---|---|
| | Mine output 1/ | Smelter output 2/ | | | |
| 1958 | 705 | 2,833 | 7,804 | 58 | 10,384 |
| 1959 | 678 | 2,667 | 11,012 | 75 | 12,147 |
| 1960 | 635 | 3,665 | 11,909 | 398 | 12,615 |
| 1961 | 689 | 4,558 | 11,634 | 36 | 10,974 |
| 1962 | 631 | 4,407 | 13,334 | 39 | 13,339 |
| 1963 | 645 | 4,160 | 16,042 | 65 | 15,026 |
| 1964 | 632 | 4,418 | 14,005 | 556 | 14,147 |
| 1965 | 845 | 4,216 | 13,026 | 14 | 15,530 |
| 1966 | 927 | 4,567 | 15,525 | 29 | 17,848 |

1/ Almost entirely impure antimony metal (recovered in the form of cathodes), a byproduct of processing U.S. silver-lead ores.

2/ Virtually all produced from imported antimony ores.

3/ Principally antimony ore and metal, with much smaller amounts of antimony alloys and needle antimony (details in table 5).

4/ Consisting of metal, mainly, and some ores in 1958-64, and of metal entirely, in 1965-66 (details in table 4).

5/ Antimony content of antimony ore (except that consumed in producing antimony metal and antimony compounds), metal, compounds, and residues (details in table 3).

Source: Imports and exports compiled from official statistics of the U.S. Department of Commerce; consumption, as compiled by the U.S. Bureau of Mines from reports by industrial consumers other than primary smelters producing antimony metal and compounds.

Table 2.--Primary antimony: U.S. industrial consumption, by classes of material consumed, 1958-66

(In short tons of antimony content)

| Year | Ore 1/ | Metal 2/ | Oxide 2/ | Sulfide | Residues | Total |
|---|---|---|---|---|---|---|
| 1958 | 515 | 4,179 | 5,283 | 88 | 319 | 10,384 |
| 1959 | 270 | 5,420 | 5,948 | 79 | 430 | 12,147 |
| 1960 | 226 | 5,892 | 6,033 | 78 | 386 | 12,615 |
| 1961 | 106 | 4,994 | 5,450 | 69 | 355 | 10,974 |
| 1962 | 137 | 6,126 | 6,642 | 68 | 366 | 13,339 |
| 1963 | 266 | 7,124 | 7,173 | 71 | 392 | 15,026 |
| 1964 | 252 | 6,050 | 7,325 | 73 | 447 | 14,147 |
| 1965 | 404 | 6,992 | 7,847 | 81 | 206 | 15,530 |
| 1966 3/ | 450 | 6,269 | 10,829 | 81 | 219 | 17,848 |

1/ Antimony ore consumed for purposes other than the production of antimony metal and oxide.
2/ Produced mainly from imported antimony ore.
3/ Preliminary.

Source: Compiled from official statistics of the U.S. Bureau of Mines.

Note.--Compared with the respective totals shown above, much larger quantities of antimony have been consumed each year as a constituent of antimonial lead, the bulk of which had been recovered from scrap.

Table 3.--Primary antimony: U.S. industrial consumption, by uses, average 1958-62, annual 1963-66

(In short tons of antimony content)

| Use | Average 1958-62 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|
| Metal products: | | | | | |
| Ammunition | 1/ | 1/ | 15 | 36 | 154 |
| Antimonial lead 2/3/ | 3,175 | 4,956 | 4,260 | 4,993 | 4,452 |
| Bearing metal and bearings | 750 | 992 | 804 | 821 | 731 |
| Cable covering | 153 | 101 | 49 | 68 | 164 |
| Castings | 71 | 49 | 50 | 76 | 63 |
| Collapsible tubes and foil | 45 | 72 | 53 | 49 | 44 |
| Sheet and pipe | 190 | 81 | 99 | 104 | 107 |
| Solder | 122 | 188 | 149 | 244 | 155 |
| Type metal 2/ | 644 | 652 | 513 | 642 | 515 |
| Other metal products | 1/ 170 | 1/ 199 | 167 | 214 | 219 |
| Total | 5,320 | 7,290 | 6,159 | 7,247 | 6,604 |
| Nonmetal products: | | | | | |
| Ammunition | 12 | 15 | 17 | 16 | 27 |
| Fireworks | 27 | 36 | 47 | 46 | 50 |
| Flameproofing chemicals and compounds | 1,064 | 1,601 | 1,626 | 1,971 | 3,188 |
| Ceramics and glass | 1,461 | 1,465 | 1,649 | 1,853 | 2,074 |
| Matches | 13 | 5 | 4/ | 4/ | 4/ |
| Pigments | 1,101 | 1,009 | 1,173 | 855 | 832 |
| Plastics | 1,077 | 1,352 | 1,289 | 1,469 | 2,224 |
| Rubber products | 293 | 597 | 492 | 477 | 870 |
| Other nonmetal products | 1,523 | 1,656 | 4/ 1,695 | 4/ 1,596 | 4/ 1,980 |
| Total | 6,571 | 7,736 | 7,988 | 8,283 | 11,245 |
| Grand total | 11,891 | 15,026 | 14,147 | 15,530 | 17,849 |

1/ Figure for "ammunition" included with that for "other metal products" to avoid disclosing data for individual companies.

2/ Imported antimonial lead consumed in this product is included in the data for 1958-63, but not in those for 1964-66.

3/ Antimony content of byproduct antimonial lead is excluded.

4/ Figure for "matches" included with that for "other nonmetal products" to avoid disclosing data for individual companies

Source: Compiled from official statistics of the U.S. Bureau of Mines.

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Table 4.--Antimony: U.S. exports of domestic merchandise, by principal markets, 1958-66

| Year | Venezuela | France | West Germany | Japan | Belgium and Luxembourg | All other | Total |
|---|---|---|---|---|---|---|---|
| | Quantity (short tons) | | | | | | |
| 1958 | - | - | 17 | - | 19 | 1/ 22 | 58 |
| 1959 | 2 | - | - | - | - | 2/ 73 | 75 |
| 1960 | - | 3/ | - | 79 | 258 | 61 | 398 |
| 1961 | 10 | 1 | 1 | - | - | 4/ 24 | 36 |
| 1962 | 14 | 1 | 1 | - | - | 5/ 23 | 39 |
| 1963 | - | 3/ | 1 | 3 | 37 | 24 | 65 |
| 1964 | 2 | 246 | 15 | 111 | 74 | 6/108 | 556 |
| 1965 | 1 | 5 | 1 | 3/ | - | 7/ 7 | 14 |
| 1966 | 4 | 4 | 1 | - | - | 8/ 20 | 29 |
| | Value (1,000 dollars) | | | | | | |
| 1958 | - | - | 7 | - | 8 | 1/ 16 | 31 |
| 1959 | 1 | - | - | - | - | 2/ 40 | 41 |
| 1960 | - | 13 | 9/ | 28 | 52 | 35 | 128 |
| 1961 | 6 | 2 | 4 | - | - | 4/ 18 | 30 |
| 1962 | 7 | 1 | 5 | - | - | 5/ 13 | 26 |
| 1963 | - | 9/ | 3 | 3 | 43 | 37 | 66 |
| 1964 | 2 | 48 | 22 | 125 | 72 | 6/107 | 376 |
| 1965 | 1 | 5 | 1 | 9/ | - | 7/ 11 | 18 |
| 1966 | 5 | 4 | 1 | - | - | 8/ 14 | 24 |

1/ Includes 22 tons, valued at 15 thousand dollars, to Korea.
2/ Includes 66 tons, valued at 37 thousand dollars, to India.
3/ Less than one-half ton.
4/ Includes 8 tons, valued at 7 thousand dollars, to Guatemala.
5/ Includes 15 tons, valued at 5 thousand dollars, to United Kingdom.
6/ Includes 60 tons, valued at 51 thousand dollars, to Pakistan.
7/ Includes 2 tons, valued at 3 thousand dollars, to United Kingdom.
8/ Includes 3 tons, valued at 5 thousand dollars, to South Vietnam and 1 ton, valued at 2 thousand dollars, to Brazil.
9/ Less than $500.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note.--The 1958-64 data cover (a) metal, mainly, and (b) ores (with antimony content estimated at 40 percent of the published quantities); export documents suggest, however, that probably most exports reported as ores consisted of metal. The data for 1965-66 cover only metal.

Table 5.--Antimony: U.S. imports for consumption, by type, 1958 and 1961-66

| Year | Ores (item 601.03) | Needle 1/ (item 603.10) | Metal 2/ (item 632.02) | Alloys (items 632.60 and 632.62) | Total |
|---|---|---|---|---|---|
| | Quantity (short tons of antimony content) 3/ | | | | |
| 1958 | 3,427 | 4/ 95 | 4,282 | 5/ | 7,804 |
| 1961 | 6,713 | 9 | 4,912 | 5/ | 11,634 |
| 1962 | 8,602 | 12 | 4,720 | 5/ | 13,334 |
| 1963 | 9,784 | 15 | 5,717 | 6/526 | 16,042 |
| 1964 | 10,676 | 22 | 2,911 | 396 | 14,005 |
| 1965 | 10,360 | 16 | 2,456 | 194 | 13,026 |
| 1966 | 12,460 | 44 | 2,767 | 254 | 15,525 |
| | Value (1,000 dollars) | | | | |
| 1958 | 643 | 4/ 58 | 1,871 | 5/ | 2,572 |
| 1961 | 1,389 | 6 | 2,347 | 5/ | 3,742 |
| 1962 | 2,168 | 8 | 2,300 | 5/ | 4,476 |
| 1963 | 2,676 | 11 | 2,968 | 6/238 | 5,893 |
| 1964 | 3,294 | 21 | 2,263 | 218 | 5,796 |
| 1965 | 4,311 | 18 | 1,962 | 149 | 6,440 |
| 1966 | 4,754 | 42 | 2,031 | 150 | 6,977 |

1/ Also called "liquated antimony." The antimony content was estimated at 70 percent of the gross quantities reported.

2/ The data for 1958 and 1966 include small quantities of waste and scrap. For 1958 and 1961-63, the figures include duty-free imports for U.S. Government use as tabulated below (such imports were nil or negligible in 1964-66):

| Year | Short tons | 1,000 dollars | Year | Short tons | 1,000 dollars |
|---|---|---|---|---|---|
| 1958 | 1,750 | 765 | 1962 | 487 | 208 |
| 1961 | 1,147 | 529 | 1963 | 634 | 358 |

3/ Except for alloys (mainly of antimony), which are in gross quantities.

4/ Includes 78 short tons, valued at 47 thousand dollars, entered free for U.S. Government use.

5/ Not available.

6/ Estimated on the basis of data for September-December.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

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Table 6.--Antimony: U.S. imports for consumption, by principal sources, 1958 and 1962-66

| Source | 1958 | 1962 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|---|
| | Quantity (short tons of antimony content) 1/ | | | | | |
| Mexico | 1,702 | 4,339 | 4,337 | 4,290 | 4,052 | 4,250 |
| Republic of South Africa | 1,069 | 3,668 | 4,010 | 3,951 | 3,387 | 4,006 |
| Bolivia | 781 | 847 | 1,003 | 2,393 | 2,310 | 3,489 |
| Yugoslavia | 1,425 | 1,193 | 2,569 | 1,595 | 1,404 | 1,391 |
| United Kingdom | 1,615 | 954 | 1,482 | 490 | 482 | 434 |
| Peru | 95 | 524 | 613 | 605 | 392 | 287 |
| Belgium | 743 | 1,523 | 1,115 | 302 | 131 | 507 |
| All other | 374 | 286 | 913 | 379 | 868 | 1,161 |
| Total | 7,804 | 13,334 | 16,042 | 14,005 | 13,026 | 15,525 |
| | Value (1,000 dollars) | | | | | |
| Mexico | 420 | 816 | 864 | 860 | 828 | 971 |
| Republic of South Africa | 243 | 1,132 | 1,369 | 1,454 | 1,901 | 2,001 |
| Bolivia | 143 | 307 | 326 | 1,009 | 1,290 | 1,576 |
| Yugoslavia | 608 | 582 | 1,347 | 1,274 | 1,135 | 1,024 |
| United Kingdom | 700 | 486 | 776 | 399 | 403 | 305 |
| Peru | 26 | 221 | 237 | 304 | 263 | 185 |
| Belgium | 309 | 796 | 609 | 278 | 115 | 391 |
| All other | 123 | 136 | 365 | 218 | 505 | 524 |
| Total | 2,572 | 4,476 | 5,893 | 5,796 | 6,440 | 6,977 |

1/ The quantities shown are the sums of the antimony content of antimony ore, needle (estimated at 70 percent of the gross quantities reported), metal, and--beginning with 1963--the gross quantity of antimony alloys. Data on imports of antimony alloys were not reported separately for 1958-62. Imports of antimony alloys during 1958-62, if any, probably were negligible.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

| Commodity | TSUS item |
|---|---|
| Bauxite | 601.06 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

The United States, the world's largest consumer of bauxite, is dependent upon imports for approximately 85 percent of its total annual consumption.

## Description and uses

Bauxite is the ore from which virtually all the alumina (aluminum oxide) used in the production of aluminum is obtained. Bauxite is a generic term applied to a naturally occurring mixture of minerals which are rich in hydrated aluminum oxides. Commercial grade bauxite ore contains approximately 45 to 60 percent aluminum oxide, together with various impurities such as compounds of silicon, iron, and titanium.

The physical characteristics of bauxite vary considerably with its chemical composition. Bauxite is generally an amorphous, clay-like substance that ranges in color from reddish brown to an off white, although green and blue varieties also occur. The fact that bauxite is highly porous accounts for the significant differences between the density of wet and dry ore.

Bauxite deposits are formed by the weathering of aluminous rocks over periods ranging from hundreds of thousands to hundreds of millions of years; consequently, the chief deposits are found in tropical or subtropical regions where climatic conditions have intensified the weathering processes. Most of the large commercially developed deposits are found near the earth's surface and are mined by open-pit methods, although higher cost shaft mining is frequently employed in Europe and certain other areas.

The great bulk of the bauxite consumed in the United States is chemically converted into alumina for subsequent use in the production of aluminum. About 4 tons of bauxite are required to produce 2 tons of alumina and 3 tons of alumina are required to produce 1 ton of aluminum. Other important uses of bauxite are in the manufacture of synthetic abrasives, chemicals, and high-alumina refractories and in other applications such as in petroleum refining and in the purification of water supplies. These manufactured articles as well as the

intermediate products--alumina and calcined bauxite, are included in other summaries such as alumina (item 417.12) and aluminum compounds (417.10 to 417.18, 426.08, and 490.32) in volume 4:2; aluminum metal except waste and scrap (items 618.01 to 618.06 and 618.45) in 6:1; aluminum mill products (items 618.15 to 618.48) in 6:1; abrasives (items 519.21 and 519.37) in 5:1; calcined bauxite (item 521.17) in 5:2; and refractories (items 531.11, -27, -31, and -39) in 5:3.

Although aluminum is the most abundant metallic element in the earth's crust, no satisfactory substitute has been found for bauxite as an ore for aluminum. The technology of producing alumina from domestic clays has been worked out, but costs of such production are significantly higher than those of production from bauxite. Aluminum producers have also conducted extensive research on processes which would bypass the production of alumina and produce aluminum directly from bauxite or other aluminum-bearing ores. At least one such process has been developed, and continuous pilot-plant facilities were operated to determine whether this process would be economical if applied to large volume production. Recent reports, however, indicate that problems encountered have caused an indefinite postponement of the commercial adoption of this process.

In this summary all quantities are expressed in long tons (2,240 pounds).

## U.S. tariff treatment

The column 1 (trade-agreement) rate of duty (see general headnote 3 in the TSUSA-1968) applicable to imports of bauxite (item 601.06) is shown below:

| | Rate of duty |
|---|---|
| Prior rate (before the concessions noted below) | 50¢ per long ton. |
| Concessions granted by the United States in the 1964-67 trade conference (Kennedy Round): | |
| First stage, effective Jan. 1, 1968 | 40¢ per long ton. |
| Fifth and final stage, effective Jan. 1, 1972 | Free. |

The rate of 50 cents per long ton became effective January 1, 1948, as a result of a concession granted by the United States in the General Agreement on Tariffs and Trade (GATT). This was the column 1 rate under the Tariff Schedules of the United States from August 31, 1963, through the end of 1967. As a result of a further concession granted by the United States in the sixth round of trade negotiations

under the GATT, the duty is being eliminated in five annual stages; the first stage, a reduction to 40 cents per long ton, became effective January 1, 1968 (see the TSUSA-1968 for the intermediate staged rates).

The duty on bauxite has been suspended since July 16, 1954--the suspension having been extended for successive 2-year periods by acts of the Congress; the latest act (Public Law 89-440) extended the suspension through July 15, 1968 (see item 911.05 of the appendix to the tariff schedules).

Based on imports during 1966, the average ad valorem equivalent of the specific rate of duty of 50 cents per long ton (the rate that would have been imposed if the duty had not been suspended) was about 4 percent. 1/

U.S. consumption

Annual domestic consumption of bauxite has doubled in recent years, increasing from 7.0 million long dry tons in 1958 to 14.2 million tons in 1966 (table 1). In this period foreign sources supplied from 81 to 87 percent of the total quantity consumed (table 2). The increase in consumption is attributed principally to the growth in demand for alumina for use in the manufacture of aluminum products. Between 1958 and 1966 the quantity of bauxite used for the production of alumina increased from 6.5 million long tons to 13.1 million and accounted for 93 percent of the total quantity consumed. A continuing increase in consumption of bauxite for the production of alumina is anticipated in view of the rapidly expanding demand for aluminum products.

U.S. producers

In 1966 six companies were engaged in the mining and milling of bauxite. The companies operated 12 mines located in Arkansas, Alabama and Georgia. The mine value of mine output in that year was approximately $20 million.

1/ Computed on a dry-weight basis. In 1953, the U.S. Bureau of Customs ruled that imports of crude bauxite are entitled to an allowance for excessive moisture, i.e., any free moisture in excess of 3 percent, upon compliance with sec. 15.7 of the Customs Regulations, and sec. 507 of the Tariff Act of 1930.

Mines in Arkansas were the source of 96 percent of the domestic output of bauxite in 1966. The great bulk of this output was mined by two large, fully integrated aluminum-producing companies (Aluminum Co. of America and Reynolds Metals Co.). Bauxite mined by these two companies was converted to alumina at plants located near the mining operations. Both of these companies have acquired additional bauxite reserves in recent years by purchasing small and in some instances low-grade or marginal properties adjacent to their existing holdings. These acquisitions are partly responsible for the decline in the number of establishments mining and milling bauxite.

The annual average number of workers employed in mining and milling bauxite declined from 705 in 1958 to an estimated 500 in 1966, while mine production increased. The increase in productivity is believed to be attributable in part to the increased use of large and more efficient mining equipment and the elimination of certain small marginal establishments. Productivity may also have been affected by management decisions to mine deposits that were near the surface or readily accessible rather than those that required the removal of extensive overburden.

Bauxite mining and transportation costs in the United States and elsewhere have been reduced in recent years by the utilization of larger and more efficient stripping units, draglines, power shovels, trucks, conveyors, railroad hopper cars, and ore-carrying ships. Transportation costs have also been reduced by locating plants for producing alumina either near bauxite sources or on deep water ports and by drying bauxite prior to shipment to remove free moisture.

## U.S. production

Annual production of bauxite in the United States during 1958-66 increased from 1.3 million to 1.8 million long dry tons (table 1). Domestic production accounted for 15 percent of the total consumption during this period.

Since the known bauxite reserves of commercial grade are limited, it is unlikely that there will be any significant increase in the output of domestic mines in the foreseeable future. It is estimated that the reserves in Saline and Pulaski Counties, Ark. are adequate to last about 30 years if they continue to be mined at a rate comparable to that in 1966. The availability of high-grade imported ore, which is mined more economically than Arkansas ore, also suggests that it is unlikely that domestic ore will be used to supply alumina plants other than those adjacent to the Arkansas mines.

U.S. exports

Exports of bauxite are believed to have been negligible during 1958-66. Such exports are not reported separately in the official statistics but are included in a class entitled "bauxite and aluminum concentrates." Exports in this class totaled 61,717 long tons, valued at $4.3 million, in 1966. The high unit value of these exports, i.e., $69.27 per long ton in 1966, indicates that the great bulk of the total probably consists of refined materials used in the manufacture of abrasives. Canada received most of these exports during 1958-66.

U.S. imports

Annual imports of bauxite increased irregularly during 1958-66, from a low of 7.9 million long dry tons in 1958 to a high of 11.5 million tons in 1966 (table 3). Imports during 1958 and 1960-62 exceeded total domestic consumption because substantial quantities of imported bauxite were shipped to Government stockpiles during these years. On December 31, 1966, U.S. Government stocks of metal-grade bauxite (accumulated over the preceding 25 years) aggregated 16.7 million long dry tons, or the equivalent of 1.2 years' supply based on the 1966 rate of consumption. This level of stocks, however, far exceeded the stockpile objectives for conventional warfare (10,300,000 long dry tons) or for nuclear warfare (1,450,000 long dry tons), and legislation was introduced in 1966 to authorize the disposal of 5,400,000 long tons.

The value of imports, amounting to $70 million in 1958, reached a record high of $147 million in 1966. During the 1958-66 period, the average unit value of imports f.o.b. foreign port increased from $8.86 per long dry ton in 1958 to $12.78 in 1966. Since imports consisted almost entirely of shipments from foreign mining subsidiaries to their parent companies, and since the duty was suspended, the computed average unit values of imports may not reflect market values in the country of origin.

The principal sources of imports have been Jamaica and Surinam (table 3); these two countries supplied 58 and 31 percent, respectively, of total imports in 1966. The remainder was supplied largely by the Dominican Republic, Haiti, and Guyana (formerly British Guiana). Annual imports of bauxite are expected to increase during the next few years. The rate of increase of imports, however, may be retarded by the policy of many of the bauxite-producing countries of encouraging the establishment of alumina and aluminum plants in their own countries--through lease provisions or through the granting of tax benefits or other considerations as inducements to aluminum companies.

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In 1966 approximately 98 percent of all imported bauxite entered the United States through the New Orleans, Galveston, and Mobile customs districts--the areas in which the alumina plants are located.

Imported bauxite is generally of a higher grade than domestic bauxite. In addition to having a higher alumina content, imported ore is often low in silicon and other impurities; accordingly, the cost of converting imported ore to alumina is generally lower than that of converting domestic ore.

## Foreign production and trade

World production of bauxite increased from about 21 million long tons in 1958 to a record high of slightly over 40 million long tons in 1966 (table 4). Jamaica, with an output of about 9 million tons, was the largest producer in 1966, followed by the U.S.S.R., Surinam, the Republic of Guinea, Guyana, France, and Yugoslavia.

Output in the Western Hemisphere--the source of U.S. supplies--during 1958-66 increased from 11.9 million long tons to 19.4 million long tons. In 1966 the Western Hemisphere's proportion of total world production amounted to 48 percent, compared with 51 percent in 1965 and 57 percent in 1958. The decline in the relative share of the total resulted principally from the expansion of the industry in 1958-66 in the Republic of Guinea (from 343,000 long tons to over 3.1 million long tons and in Australia (from 7,000 long tons to almost 1.8 million long tons).

In 1963 the U.S. Geological Survey estimated that world reserves of bauxite totaled 5.7 billion long tons, with an additional 8.7 billion tons of marginal resources. Countries having the largest known reserves are Australia, Guinea, Jamaica, Surinam, and Ghana. U.S. and foreign aluminum producers are developing mining operations in the above-mentioned countries to meet the increasing world demand for aluminum. As these and other sources are further developed, many shifts in world trade patterns are likely to occur, but the United States will continue to be largely dependent upon imports for the bulk of its bauxite requirements.

Table 1.--Bauxite: U.S. production, imports for consumption, and reported consumption, 1958-66

(Quantity in thousands of long tons, dried equivalent; value in thousands of dollars)

| Year | Production | Imports 1/ | Reported consumption | | Ratio (percent) of foreign ores consumed to total |
|---|---|---|---|---|---|
| | | | Total | Foreign ores | |
| | Quantity | | | | |
| 1958 | 1,311 | 7,915 | 7,034 | 5,685 | 80.8 |
| 1959 | 1,700 | 8,149 | 8,619 | 6,943 | 80.6 |
| 1960 | 1,998 | 8,739 | 8,883 | 7,270 | 81.8 |
| 1961 | 1,228 | 9,210 | 8,621 | 7,592 | 88.1 |
| 1962 | 1,369 | 10,575 | 10,577 | 8,997 | 85.1 |
| 1963 | 1,525 | 9,170 | 11,318 | 9,640 | 85.2 |
| 1964 | 1,601 | 10,180 | 12,546 | 10,820 | 86.2 |
| 1965 | 1,654 | 11,400 | 13,534 | 11,731 | 86.7 |
| 1966 | 1,796 | 11,529 | 14,084 | 12,089 | 85.8 |
| | Value | | | | |
| 1958 | 12,815 | 70,107 | 2/ | 2/ | 3/ |
| 1959 | 17,725 | 73,549 | 2/ | 2/ | 3/ |
| 1960 | 21,107 | 78,024 | 2/ | 2/ | 3/ |
| 1961 | 13,937 | 88,848 | 2/ | 2/ | 3/ |
| 1962 | 15,609 | 121,888 | 2/ | 2/ | 3/ |
| 1963 | 17,234 | 114,077 | 2/ | 2/ | 3/ |
| 1964 | 17,875 | 128,787 | 2/ | 2/ | 3/ |
| 1965 | 18,632 | 142,989 | 2/ | 2/ | 3/ |
| 1966 | 20,095 | 147,335 | 2/ | 2/ | 3/ |

1/ Official import statistics of the U.S. Bureau of the Census adjusted to dry equivalent weights (see footnote 2 to table 3).
2/ Not available.
3/ Not applicable.

Source: Compiled from official statistics of the U.S. Bureau of Mines, except as noted.

Note.--Exports of bauxite, if any, were small or negligible during 1958-66.

Table 2.--Bauxite: U.S. consumption, by industries, 1958-66

(In thousands of long tons, dried equivalent)

| Year | Total | Quantity used for the production of-- | | | | |
|---|---|---|---|---|---|---|
| | | Alumina | Abrasives 1/ | Chemicals | Refractories | Other uses |
| 1958 | 7,034 | 6,511 | 185 | 220 | 60 | 58 |
| 1959 | 8,619 | 8,027 | 217 | 238 | 82 | 55 |
| 1960 | 8,883 | 8,141 | 284 | 303 | 94 | 61 |
| 1961 | 8,621 | 8,034 | 188 | 234 | 112 | 53 |
| 1962 | 10,577 | 9,878 | 261 | 244 | 138 | 56 |
| 1963 | 11,318 | 10,596 | 230 | 249 | 179 | 64 |
| 1964 | 12,546 | 11,769 | 241 | 255 | 219 | 62 |
| 1965 | 13,534 | 12,622 | 266 | 261 | 298 | 87 |
| 1966 | 14,084 | 13,108 | 297 | 294 | 313 | 72 |

1/ Data include consumption by Canadian abrasives industry; they exclude the quantities of domestic bauxite consumed during 1964-66 since publication would disclose individual company confidential data.

Source: Compiled from official statistics of the U.S. Bureau of Mines.

Table 3.--Bauxite: U.S. imports for consumption, by sources of origin, 1958-66

| Year | Jamaica | Surinam 1/ | Dominican Republic | Guyana 2/ | Haiti | Other | Total |
|---|---|---|---|---|---|---|---|
| | Quantity (1,000 long tons, dried equivalent 3/) | | | | | | |
| 1958 | 4,950 | 2,425 | - | 223 | 317 | 4/ | 7,915 |
| 1959 | 4,220 | 3,078 | 384 | 160 | 307 | - | 8,149 |
| 1960 | 4,175 | 3,256 | 632 | 330 | 341 | 5 | 8,739 |
| 1961 | 4,936 | 2,912 | 722 | 320 | 289 | 31 | 9,210 |
| 1962 | 5,986 | 2,858 | 719 | 560 | 437 | 15 | 10,575 |
| 1963 | 5,239 | 2,518 | 729 | 335 | 328 | 21 | 9,170 |
| 1964 | 5,792 | 3,070 | 640 | 253 | 396 | 29 | 10,180 |
| 1965 | 6,602 | 3,369 | 976 | 87 | 330 | 36 | 11,400 |
| 1966 | 6,665 | 3,563 | 653 | 326 | 283 | 39 | 11,529 |
| | Value (1,000 dollars) | | | | | | |
| 1958 | 46,739 | 19,046 | - | 1,561 | 2,760 | 1 | 70,107 |
| 1959 | 40,135 | 24,733 | 4,890 | 1,114 | 2,677 | - | 73,549 |
| 1960 | 39,597 | 25,150 | 7,960 | 2,258 | 3,034 | 25 | 78,024 |
| 1961 | 46,717 | 27,136 | 9,533 | 2,313 | 2,720 | 429 | 88,848 |
| 1962 | 75,459 | 28,172 | 8,901 | 5,128 | 4,097 | 131 | 121,888 |
| 1963 | 72,388 | 25,879 | 9,401 | 3,010 | 3,143 | 256 | 114,077 |
| 1964 | 82,575 | 30,101 | 9,187 | 2,253 | 4,308 | 363 | 128,787 |
| 1965 | 94,343 | 31,953 | 11,704 | 881 | 3,592 | 516 | 142,989 |
| 1966 | 96,040 | 34,529 | 9,916 | 3,219 | 3,079 | 552 | 147,335 |

1/ Data include imports from Trinidad because the reported imports from Trinidad consisted of "reexports" of Surinam bauxite.

2//Formerly British Guiana; became independent on May 26, 1966.

3/ The reported data for imports from Jamaica, Haiti, and the Dominican Republic were converted to dry weight by deducting the following percentages to allow for the free moisture content: for Jamaica and Haiti, 13.6 percent and for the Dominican Republic, 17.7 percent. The data for other imports, which are virtually all dried, were included as reported.

4/ Less than 500 tons.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

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Table 4.--Bauxite: World production by countries, 1958 and 1964-66

(In thousands of long tons)

| Country | 1958 | 1964 | 1965 | 1966 1/ |
|---|---|---|---|---|
| North America: 2/ | | | | |
| Dominican Republic 3/ | - | 748 | 927 | 820 |
| Haiti | 280 | 430 | 377 | 356 |
| Jamaica | 5,722 | 4/ 7,811 | 4/ 8,514 | 4/ 8,929 |
| United States | 1,311 | 1,601 | 1,654 | 1,796 |
| South America: | | | | |
| Brazil | 69 | 130 | 154 | 5/ 155 |
| Guyana 6/ | 1,586 | 2,468 | 2,873 | 5/ 2,863 |
| Surinam | 2,941 | 3,930 | 4,291 | 4,513 |
| Europe: | | | | |
| Austria | 23 | 4 | - | - |
| France | 1,788 | 2,394 | 2,620 | 2,761 |
| Germany, West | 4 | 4 | 4 | 5/ 4 |
| Greece | 843 | 1,046 | 1,237 | 5/ 1,181 |
| Hungary | 1,032 | 1,453 | 1,455 | 1,406 |
| Italy | 294 | 248 | 241 | 250 |
| Rumania | 72 | 7 | 5/ 79 | 5/ 197 |
| Spain | 8 | 7 | 7 | 5/ 7 |
| U.S.S.R. 5/ | 2,710 | 4,232 | 4,626 | 4,724 |
| Yugoslavia | 721 | 1,273 | 1,549 | 1,857 |
| Africa: | | | | |
| Ghana | 207 | 246 | 314 | 318 |
| Guinea, Republic of | 343 | 1,652 | 1,840 | 3,150 |
| Mozambique | 5 | 6 | 6 | 5/ 5 |
| Rhodesia (formerly Southern) | - | 2 | 2 | 7/ |
| Sierra Leone | - | 151 | 204 | 268 |
| Asia: | | | | |
| China (diasporic) 5/ | 150 | 394 | 394 | 394 |
| India | 166 | 582 | 695 | 5/ 738 |
| Indonesia | 338 | 638 | 677 | 689 |
| Malaya | 262 | 464 | 843 | 940 |
| Sarawak | 136 | 158 | 135 | 5/ 138 |
| Turkey | - | 4 | 10 | 31 |
| Oceania: Australia | 7 | 841 | 1,158 | 1,795 |
| World total 5/ 8/ | 21,020 | 32,926 | 36,883 | 40,283 |

1/ Preliminary; partly estimated.
2/ Data represent dried equivalent of crude ore.
3/ Data represent shipments.
4/ Bone dry equivalent of bauxite shipments and bauxite converted into alumina. 5/ Estimated. 6/ Formerly British Guiana; became independent on May 26, 1966. 7/ Not available. 8/ Data do not add to totals shown because of rounding (metric tons) where estimated figures are included in the detail.

Source: Compiled from official statistics of the U.S. Bureau of Mines.

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| Commodity | TSUS item |
|---|---|
| Aluminum: | |
| Dross and skimmings | 603.05 |
| Waste and scrap | 618.10 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

The United States, the leading world producer and consumer of aluminum products, has been a net exporter of aluminum scrap since 1956. The U.S. trade surplus was reduced sharply in 1965-66, years of strong domestic demand, when imports increased substantially and exports declined appreciably.

## Description and uses

Aluminum dross and skimmings are aluminum-bearing materials skimmed or otherwise recovered from molten aluminum in reduction plants, foundries, and other plants that melt aluminum. These materials generally contain significant quantities of metallic oxides and other impurities and are low in aluminum content. Dross and skimmings are used primarily as a raw material in the production of secondary aluminum and in the manufacture of chemicals.

There are two basic classes of aluminum scrap: old and new. Old scrap consists of aluminum that has been used in end products and is collected for metal recovery after the products have been worn out or discarded. Sources of such scrap include pots and pans, pistons, and wrecked or obsolete aircraft. New scrap consists of clippings from aluminum sheets, borings, turnings, and other forms which are generated in aluminum fabricating plants and also of rejected semi-fabricated and manufactured items. The term "waste," which is not generally used in the domestic aluminum industry, is used in many foreign countries to refer to what is identified as new scrap in the United States. Approximately 75 percent of all scrap (both old and new) is used in the production of aluminum ingots by secondary smelters, and approximately 6 to 12 percent is used by producers for blending with primary aluminum. Primary aluminum is produced from alumina (which is recovered from processing bauxite ore), in contrast with secondary aluminum, which is recovered from scrap; see summaries on unwrought aluminum, items 618.01 et al., and aluminum mill products, items 618.15 et al., all in volume 6:1). The remainder of the scrap

aluminum is used for direct conversion into castings, chemicals, and fabricated products without being first converted into ingot.

In this summary all quantities are expressed in pounds.

U.S. tariff treatment

The column 1 (trade-agreement) rates of duty (see general headnote 3 in the TSUSA-1968) applicable to imports of aluminum dross and skimmings (item 603.05) and aluminum waste and scrap (item 618.10) are shown below:

| | Item 603.05 | Item 618.10 |
|---|---|---|
| Prior rate (before the concessions noted below). | Free | 1.5¢ per lb. |
| Concessions granted by the United States in the 1964-67 trade conference (Kennedy Round): | | |
| First stage, effective Jan. 1, 1968--- | 1/ | 1.3¢ per lb. |
| Fifth and final stage, effective Jan. 1, 1972---------- | 1/ | 0.7¢ per lb. |

1/ Duty-free status not affected by the trade conference.

The duty-free status of aluminum dross and skimmings (item 603,05), established in the Tariff Act of 1930, as originally enacted, was bound in a concession granted by the United States in the General Agreement on Tariffs and Trade (GATT) in 1951. The rate of 1.5 cents per pound on aluminum waste and scrap (item 618.10) reflects a concession granted by the United States in the GATT, effective January 1, 1948. The above tariff status for these items remained unchanged under the TSUS from August 31, 1963 through 1967. However, as a result of a further concession granted by the United States in the sixth round of trade negotiations under the GATT, the rate on aluminum waste and scrap is being reduced to 0.7 cent per pound in five annual stages; the first stage, a reduction to 1.3 cents per pound, became effective January 1, 1968 (see the TSUSA-1968 for the intermediate staged rates).

The duty on aluminum waste and scrap has been suspended almost continuously since March 14, 1942, pursuant to various public laws. The latest (Public Law 90-45) extends the suspension through June 30, 1969. 1/

Based on imports during 1966, the average ad valorem equivalent of the specific rate of duty of 1.5 cents per pound (the rate that would have been imposed if the duty had not been suspended on aluminum waste and scrap) was 9.4 percent.

U.S. consumption

Approximately 20 percent of all the aluminum consumed in the United States is obtained from scrap. Actual consumption of aluminum scrap including dross and skimmings, as reported by the U.S. Bureau of Mines increased sharply from 751 million pounds (gross weight) in recession year 1958 to 1,793 million pounds in 1966 (table 1), or by 139 percent. New scrap, including dross and skimmings, accounted for approximately 75 percent of total consumption in 1958-66, although consumption of both old and new scrap increased at about the same rate. Statistics of the U.S. Bureau of Mines on scrap consumption do not include mill-run-around scrap (which is generated and melted in the same plant), nor does it cover substantial quantities of scrap that are shipped by fabricators to aluminum smelters, which convert this material into ingot on a "toll" or service-charge basis.

Consumption of aluminum scrap increased during 1958-66 largely because of the overall growth in demand for aluminum products. The increased demand for aluminum die castings which represent the largest single market for secondary aluminum was of particular importance. Furthermore, many producers of wrought aluminum products have increased their use of secondary aluminum as a raw material because the quality of this material has been upgraded in recent years as a result of closer quality control and metallurgical advances. The consumption of secondary aluminum is expected to continue its upward trend; however, there may be significant fluctuations from year to

1/ Since the duty on aluminum waste and scrap has been suspended for an extended period of time, the question has arisen whether certain scrap, which had been melted and poured into ingots, was dutiable as ingot or duty-free as scrap. Customs practice is to classify as scrap the material which has been remelted and poured into ingots solely for convenience in handling and transportation provided such ingots are not suitable for commercial use unless they are melted and "sweetened" with higher purity aluminum or blended with alloying constituents (T.D. 54999(17)).

year depending on the relative prices of primary and secondary aluminum. The prices of secondary aluminum are generally more sensitive to changes in demand than those of primary aluminum. Another factor that could affect the future trend in consumption will be the availability of waste and scrap. Since the generation of new scrap is tied closely to the level of activity in the aluminum producing and fabricating industries, it is likely that supplies of new scrap will increase as demand for aluminum products increases. In addition, the potential supply of old scrap is increasing rapidly as the volume of aluminum products in the hands of consumers continues to rise. The collection of such scrap, however, will depend in part upon the prices offered for it.

## U.S. producers

There are approximately 20,000 to 30,000 aluminum fabricators in the United States that generate new aluminum scrap in their operations. These fabricators have plants in all regions of the United States, although there is a concentration of fabricating facilities in the East North Central States. Most scrap-generating companies have only small operations and generally find it convenient to sell their scrap to nearby scrap collectors or junk dealers. Of the large scrap producers that account for the bulk of the output, many have facilities for melting scrap for their own use or have another firm convert the scrap into ingot for them, while others sell the material directly to primary or secondary aluminum producers.

## U.S. exports

During 1958-66 the quantity of annual exports of aluminum scrap, including dross and skimmings, was equal to about one-tenth of domestic consumption. Exports increased sharply, from 38 million pounds in 1958 to 164 million pounds in 1961, a 4-year period when domestic capacity to produce unwrought aluminum grratly exceeded domestic demand and there was a strong foreign demand for both unwrought aluminum and scrap. Exports were relatively stable during 1962-64, averaging 137 million pounds a year (table 2). In 1965-66, when there was a strong domestic demand for aluminum scrap, exports declined to 77 and 97 million pounds, respectively. The unit value of U.S. exports during the 1958-66 period ranged between 14.8 cents a pound in 1958 and 16.9 cents a pound in 1960. No distinction is made in the official statistics between exports of scrap and of dross and skimmings; the high unit values of exports indicate, however, that they consist predominantly of scrap. West Germany, Italy, Japan, and the United Kingdom have been the principal export markets.

U.S. exporters of aluminum scrap have benefited from the fact that many foreign aluminum-consuming countries permit aluminum waste and scrap to enter duty free or at a much lower rate than that applicable to unwrought aluminum. Another factor that is believed to have contributed to the high level of exports is shipments from U.S. primary aluminum producers to the fabricating plants of their foreign affiliates.

U.S. imports

The annual average of U.S. imports of aluminum scrap (not including aluminum dross and skimmings) declined from almost 21 million pounds during 1958-59 to almost 12 million pounds during 1960-62, and then rose to more than 67 million pounds in 1966 (table 3). The unit value of imports (based on reported value) fluctuated between 12.4 cents a pound in 1963 and 16 cents in 1966. Canada has been the dominant supplier, accounting for more than 90 percent of the total quantity imported during 1958-64; however, in 1965-66 Canada's share declined to 55 percent while Japan, the U.S.S.R., the United Kingdom, and the Netherlands became significant suppliers.

Annual imports of aluminum dross and skimmings in 1964-66, the only years for which data are available, averaged 18.7 million pounds, valued at $553,700. The unit value of dross and skimmings imported in 1966 was 2.8 cents a pound, compared with unit values of 16 cents a pound for imports of waste and scrap and 20.3 cents a pound for imports of unwrought aluminum in ingots. The much lower prices for dross and skimmings than for scrap are indicative of the lower quality of dross and skimmings, which contain many impurities and a significantly lower percentage of recoverable aluminum.

The bulk of U.S. imports of aluminum dross, skimmings, waste and scrap enter the United States through ports on the Great Lakes, which are convenient to Canadian exporters as well as to the numerous aluminum producers and foundries that are concentrated in the East North Central States.

Table 1.--Aluminum dross, skimmings, waste, and scrap: U.S. consumption, imports for consumption, and exports of domestic merchandise, 1958-66

| Year | Reported Consumption | | | Imports | Exports | Ratio of imports to consumption |
|---|---|---|---|---|---|---|
| | New scrap | Old scrap | Total | | | |
| | Million pounds | Million pounds | Million pounds | Million pounds | Million pounds | Percent |
| 1958 | 568.4 | 182.7 | 751.1 | 1/ | 37.8 | 1/ |
| 1959 | 727.9 | 224.0 | 951.9 | 1/ | 64.8 | 1/ |
| 1960 | 702.0 | 181.0 | 883.0 | 1/ | 159.0 | 1/ |
| 1961 | 670.1 | 326.1 | 996.2 | 1/ | 164.0 | 1/ |
| 1962 | 848.8 | 340.9 | 1,189.7 | 1/ | 131.1 | 1/ |
| 1963 | 986.7 | 308.3 | 1,295.0 | 1/ | 142.1 | 1/ |
| 1964 | 1,094.0 | 330.5 | 1,424.5 | 35.4 | 137.2 | 2.5 |
| 1965 | 1,205.7 | 427.5 | 1,633.2 | 72.3 | 77.1 | 4.4 |
| 1966 | 1,428.4 | 364.3 | 1,792.7 | 85.9 | 97.3 | 4.8 |

1/ Complete data on imports of the articles included are not available for the period prior to August 31, 1963. For data on imports of aluminum waste and scrap only during 1958-66, see table 3.

Source: Consumption compiled from official statistics of the U.S. Bureau of Mines; imports and exports compiled from official statistics of the U.S. Department of Commerce.

Table 2.--Aluminum dross, skimmings, waste, and scrap: U.S. exports of domestic merchandise, by principal markets, 1958-66

| Year | West Germany | Italy | Japan | United Kingdom | Canada | Other | Total |
|---|---|---|---|---|---|---|---|
| | Quantity (million pounds) | | | | | | |
| 1958 | 22.2 | 9.3 | 4.1 | 0.8 | 0.7 | 0.7 | 37.8 |
| 1959 | 28.0 | 10.5 | 16.7 | 6.6 | .9 | 2.0 | 64.8 |
| 1960 | 57.5 | 45.5 | 32.3 | 18.1 | 1.8 | 3.8 | 159.0 |
| 1961 | 70.9 | 25.8 | 49.7 | 8.9 | 2.3 | 6.4 | 164.0 |
| 1962 | 48.9 | 38.3 | 22.0 | 8.7 | 2.2 | 11.0 | 131.1 |
| 1963 | 53.1 | 43.5 | 28.8 | 8.9 | 3.2 | 4.6 | 142.1 |
| 1964 | 63.9 | 18.7 | 30.7 | 15.1 | 3.7 | 5.1 | 137.2 |
| 1965 | 28.7 | 6.7 | 10.7 | 11.5 | 5.6 | 1/13.9 | 77.1 |
| 1966 | 30.5 | 20.8 | 33.7 | .4 | 4.2 | 7.7 | 97.3 |
| | Value (1,000 dollars) | | | | | | |
| 1958 | 3,304 | 1,339 | 590 | 141 | 95 | 126 | 5,595 |
| 1959 | 4,506 | 1,501 | 2,913 | 1,062 | 134 | 369 | 10,485 |
| 1960 | 9,219 | 7,919 | 5,696 | 3,142 | 219 | 710 | 26,905 |
| 1961 | 10,830 | 3,801 | 8,932 | 1,569 | 338 | 982 | 26,452 |
| 1962 | 7,455 | 5,531 | 3,673 | 1,642 | 307 | 1,575 | 20,183 |
| 1963 | 7,466 | 6,711 | 4,697 | 1,493 | 419 | 583 | 21,369 |
| 1964 | 9,192 | 2,926 | 5,248 | 2,641 | 677 | 792 | 21,476 |
| 1965 | 4,201 | 1,134 | 1,932 | 2,121 | 1,038 | 1/2,026 | 12,452 |
| 1966 | 4,897 | 3,300 | 5,831 | 60 | 823 | 1,328 | 16,239 |

1/ Includes 11.8 million pounds, valued at 1,697 thousand dollars, exported to the Netherlands.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 3.--Aluminum waste and scrap (item 618.10): U.S. imports for consumption from Canada and from all other countries, 1958-66

| Year | Canada | All other countries | Total |
|---|---|---|---|
| | Quantity (million pounds) | | |
| 1958 | 18.1 | 1.7 | 19.8 |
| 1959 | 18.2 | 3.6 | 21.8 |
| 1960 | 8.8 | 1.3 | 10.1 |
| 1961 | 11.9 | .1 | 12.0 |
| 1962 | 12.5 | .5 | 13.0 |
| 1963 | 17.0 | 1.6 | 18.6 |
| 1964 | 15.7 | .6 | 16.3 |
| 1965 | 23.5 | 30.6 | 54.1 |
| 1966 | 43.3 | 23.9 | 67.2 |
| | Value (1,000 dollars) | | |
| 1958 | 2,722 | 247 | 2,969 |
| 1959 | 2,691 | 608 | 3,299 |
| 1960 | 1,393 | 205 | 1,598 |
| 1961 | 1,722 | 16 | 1,738 |
| 1962 | 1,782 | 82 | 1,864 |
| 1963 | 2,079 | 228 | 2,307 |
| 1964 | 1,963 | 75 | 2,038 |
| 1965 | 3,431 | 1/ 5,051 | 8,482 |
| 1966 | 6,742 | 2/ 4,040 | 10,782 |

1/ Includes 13.7 million pounds, valued at 2,140 thousand dollars, imported from Japan, and 6.7 million pounds, valued at 1,002 thousand dollars, from the U.S.S.R.

2/ Includes 11.1 million pounds, valued at 1,967 thousand dollars, from the United Kingdom, and 3.8 million pounds, valued at 646 thousand dollars, from the Netherlands.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note.--Imports of aluminum dross and skimmings (item 603.05) were not reported separately before Aug. 31, 1963; such imports amounted to 19.1 million pounds, valued at 553 thousand dollars, in 1964, 18.3 million pounds, valued at 577 thousand dollars in 1965, and 18.7 million pounds, valued at 531 thousand dollars, in 1966.

| Commodity | TSUS item |
|---|---|
| Unwrought aluminum: | |
| Of uniform cross-section and meeting other dimensional requirements, in coils | 618.01 |
| Other, nonalloyed | 618.02 |
| Aluminum silicon | 618.04 |
| Other, alloyed | 618.06 |
| Pipes, tubes, and blanks of aluminum: | |
| Hollow cast extrusion ingot | 618.45 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

The United States is the world's largest producer, consumer, and importer of unwrought aluminum. In the years 1962-66, U.S. imports, which were substantially larger than exports, supplied 11 to 14 percent of annual domestic consumption. World trade in unwrought aluminum is greatly influenced by the international operations of United States, Canadian, and European aluminum producers, which control extensive aluminum producing and fabricating plants in numerous foreign countries.

## Description and uses

Aluminum is a silver-white, malleable metal noted for its lightness, conductivity, and resistance to oxidation. Its weight per unit of volume is about one-third that of steel or copper.

Unwrought aluminum is generally marketed in the form of ingot, although other forms include shot, slab, and molten metal. These unwrought products are available either as nonalloyed aluminum (generally referred to commercially as pure aluminum and which for tariff purposes in item 618.02 contains a minimum of 99.0 percent aluminum by weight), or in a wide variety of alloys (items 618.04 and 618.06). Elements which are frequently alloyed with aluminum in varying combinations and quantities are copper, iron, magnesium, manganese, nickel, silicon, and zinc. Alloys of aluminum under the tariff schedules contain by weight, less than 99.0 percent aluminum, but not less than any other metallic element; aluminum silicon (item 618.04) is an alloy of aluminum, which contains not less than 25 percent silicon. (See headnote 2 to part 2D of schedule 6 of the TSUSA-1968.)

Item 618.01 provides for unwrought aluminum of uniform cross-section throughout its length, the least cross-sectional dimension of which is not greater than 0.375 inch, in coils (alloyed or nonalloyed).

Imports of this item have been nil or negligible although it is possible that technological developments may lead to significant imports.

Hollow cast extrusion ingot (item 618.45) is a cylindrically shaped ingot (alloyed or nonalloyed) with a hole running through the center of the ingot perpendicular to the circular cross-section. It is used in producing tubular products.

Unwrought aluminum is used principally as a raw material in the production of castings and wrought products such as sheet, plate, rod, bar, wire, pipe, tube, and extruded shapes; see summary on aluminum mill products (items 618.15 et al., in volume 6:1). New applications for these products and expanding usage in existing markets are expected to result in a continuing increase in the demand for unwrought aluminum. Particularly promising growth markets are for products for use in transportation equipment, products for the electrical industry, architecthral products, and containers. Other metals, plastics and wood compete with aluminum in the aforementioned markets, but aluminum's unique combination of properties, the ease with which it can be fabricated by all known metalworking methods, and its availability in large quantities at relatively stable prices make it a preferred material for many applications.

There are two classes of unwrought aluminum: primary and secondary. Primary aluminum (which accounts for approximately 85 percent of domestic production) is electrolytically reduced from alumina that is recovered from processing the aliminum-bearing ore bauxite. Alumina (item 417.12) is discussed in a separate summary in volume 4:2. Appromimately 4 pounds of bauxite are required to extract 2 pounds of alumina, which, in turn, yields 1 pound of aluminum. In addition, 0.6 pound of carbon, a small amount of sodium aluminum fluoride, and about 8 kilowatt hours of electricity are required to produce a pound of aluminum. Secondary aluminum is recovered from scrap (see summaries on bauxite (item 601.06) and on aluminum dross, skimmings, waste, and scrap (items 603.05 and 618.10) elsewhere in volume 6:1). Primary and secondary aluminum may be used interchangeably for numerous applications; however, where high-purity metal is needed for such uses as a catalyst in oil refining and for fabricating into products requiring high electrical conductivity or a bright decorative finish, primary aluminum is preferred.

Aluminum producers in the United States, Canada, and France have successfully produced aluminum directly from ore on a laboratory scale, thus bypassing the intermediate product, alumina. Recent press reports indicate, however, that the direct-reduction pilot plants operated by two producers are encountering difficulties which are likely to cause an indefinite postponement of commercial adoption of the process. If the pilot plants prove successful, the capital

investment required to produce aluminum from ore will be reduced substantially by elimination of the need for high-cost chemical plants for extracting alumina from bauxite.

In this summary, all quantities are expressed in terms of pounds.

U.S. tariff treatment

The column 1 (trade-agreement) rates of duty applicable to imports (see general headnote 3 in the TSUSA-1968) are as follows (in cents per pound):

| TSUS item | Commodity | Prior rate | U.S. concessions granted in 1964-67 trade conference (Kennedy Round) | |
|---|---|---|---|---|
| | | | First stage, effective Jan. 1, 1968 | Final stage, effective Jan. 1, 1972 |
| | Unwrought aluminum: | | | |
| 618.01 | Of uniform cross-section throughout its length, the least cross-sectional dimension of which is not greater than 0.375 inch, in coils. | 2.5¢ | 2.2¢ | 1.2¢ |
| | Other: | | | |
| 618.02 | Aluminum other than alloys of aluminum. | 1.25¢ | 1.2¢ | 1/ 1¢ |
| | Alloys of aluminum: | | | |
| 618.04 | Aluminum silicon- | 2.125¢ | 1.5¢ | 1/ 1¢ |
| 618.06 | Other---------- | 1.25¢ | 1.2¢ | 1/ 1¢ |
| | Pipes and tubes and blanks therefor, pipe and tube fittings, all the foregoing of aluminum: | | | |
| 618.45 | Hollow cast extrusion ingots--- | 1.25¢ | 1.1¢ | 0.6¢ |

1/ Final rate for this item will become effective Jan. 1, 1970, at the 3d stage.

The tabulation above shows the column 1 rates of duty in effect prior to January 1, 1968, and modifications therein as a result of concessions granted by the United States in the sixth round of trade negotiations under the General Agreement on Tariffs and Trade (GATT). Only the first and final stages of the annual rate modifications are shown above (see the TSUSA-1968 for the intermediate staged rates).

The prior rates of duty for all of the articles listed were derived from rates which became effective June 30, 1958 as a result of concessions granted by the United States in the GATT. However, the changeover from the schedules of the Tariff Act of 1930 to the revised schedules, effective August 31, 1963, resulted in changes in the rates of duty applicable to a very small volume of trade in certain aluminum alloys. In the previous tariff schedules aluminum alloys in paragraph 374 were those in which aluminum was the component material of chief value, whereas under the revised schedules they are defined as alloys in which aluminum is the predominant element by weight. Thus certain aluminum alloys which had been dutiable under paragraphs 302 and 397 of the previous schedules at various rates became dutiable under item 618.06 at 1.25 cents per pound.

The concessions granted by the United States in the Kennedy Round negotiations amounted to a reduction of about 50 percent in the rates of duty for items 618.01, 618.04, and 618.45, and a reduction of 20 percent in the rates for items 618.02 and 618.06. The concessions are being effected in five annual stages for items 618.01 and 618.45; for the remaining three items the concessions will go into effect in three stages--the final one on January 1, 1970.

The average ad valorem equivalents of the specific rates of duty in effect prior to January 1, 1968, based on dutiable imports during 1966, were as follows:

| TSUS item | Percent |
|---|---|
| 618.02 | 6.2 |
| 618.06 | 5.8 |
| 618.45 | 5.0 |

Recent imports entered under items 618.01 and 618.04 have been too small for the computation of meaningful ad valorem equivalents. Moreover, the negligible amount of trade reported for these items is believed to have resulted, at least in part, from statistical classification errors.

U.S. consumption

Apparent U.S. consumption of unwrought aluminum increased from 4.1 billion pounds in 1958 to a record high of almost 8 billion pounds in 1966, representing an increase of 94 percent (table 1). U.S. consumption averaged approximately 38 pounds per capita during 1965, compared with an average of 21 pounds per capita in the United Kingdom, 13 pounds per capita in the EEC countries, and less than 1 pound per capita in many of the less developed countries of the world.

During 1958-66 the annual rate of growth of aluminum consumption in the United States was faster (7.6 percent) than that of its gross national product (6.4 percent). The U.S. Department of Commerce estimates that the growth of U.S. consumption of aluminum will continue to exceed that of the gross national product in 1967-70.

U.S. producers

Primary aluminum in the United States was produced at the end of 1966 by 8 companies, which operated 24 plants with a combined rated capacity of 6.3 billion pounds a year; an additional 658 million pounds of capacity was under construction. The three largest producers (Aluminum Co. of America, Reynolds Metals Co., and Kaiser Aluminum & Chemical Corp.) accounted for 80 percent of the capacity existing at the end of 1966 and for 67 percent of the capacity under construction in that year. At the end of 1966, these three producers also owned outright, or jointly with foreign partners, aluminum-producing plants in at least 11 foreign countries and aluminum-fabricating plants in about 23 foreign countries.

Since primary aluminum reduction requires substantial quantities of electric power, facilities for such reduction are located principally in upper New York State, in the Tennessee Valley, and in the Pacific Northwest, where hydroelectric power is available, and in the Gulf States and the Ohio Valley, where power is generated from local reserves of natural gas and coal.

Total employment in the U.S. primary aluminum industry increased from 17,381 employees in 1958 to an estimated 18,000 in 1966, whereas production during the same period increased from 3.1 billion to 5.9 billion pounds. This small increase in employment (3.5 percent) and substantial increase in production (90 percent) indicate a significant improvement in labor productivity. The increase in output per employee can be partly attributed to the fact that the industry was operating at a depressed level in 1958 and at a high level in 1966.

Secondary aluminum is produced by some 80 U.S. companies operating about 90 establishments. Production facilities were concentrated in the East North Central States and in California where they are favorably situated with respect to plants that generate aluminum scrap, the principal raw material for secondary aluminum. Many establishments that produce such aluminum also include facilities for the production of aluminum castings or wrought products (particularly extrusions). A few establishments reclaim other metals from scrap, in addition to aluminum, but the establishments that account for the bulk of domestic production of secondary aluminum are believed to be engaged solely in that activity.

Data on employment in the secondary aluminum industry are not separately reported in official statistics, but it is believed that employment increased significantly during 1958-66.

U.S. production

The United States is the world's largest producer of unwrought aluminum, accounting for approximately 48 percent of total free-world production in 1966. Total U.S. production (primary and secondary) increased from 3.7 billion pounds in 1958 to 7.3 billion pounds in 1966, representing an increase of 97 percent (table 1). Production is expected to continue to increase rapidly in 1967-70 in order to meet the increasing domestic demand.

The share of total production of unwrought aluminum accounted for by primary aluminum in the 1958-66 period varied from 86.0 percent in 1960 to 81.1 percent in 1966. When the market for aluminum is weak, as in 1960, the output of primary aluminum increases relative to that of secondary aluminum, whereas when the market is strong, as in 1966, the reverse is true.

During the 1958-66 period, published prices for 99.5 percent pure aluminum ingot, delivered to customers' plants, ranged downward between 28.1 cents per pound (in 1958) and 22.5 cents per pound (in 1963). The sharp decline in prices occurred during a period when there was considerable idle production capacity and imports were increasing. Prices strengthened during 1963-64, when demand for aluminum improved substantially. At the end of 1966 the price for 99.5 percent pure ingot was 24.5 cents a pound.

Shipments of unwrought aluminum to U.S. Government stocks under contracts that were negotiated during 1950-54 were completed during 1963. On December 31, 1966, U.S. Government stocks totaled 3.1 billion pounds. As of that date, such stocks represented an excess of approximately 2.2 billion pounds over the revised stockpile objective for conventional warfare that was announced by the Office of Emergency

Planning in January 1967. Officials of the U.S. Government and major U.S. aluminum producers reached an agreement in November 1965 on a long-range program for the orderly disposal of the entire excess.

## U.S. exports

U.S. exports of unwrought aluminum, consisting almost entirely of primary aluminum ingot (both pure and alloyed), increased irregularly from 105 million pounds, valued at $24 million, in 1958, to 377 million pounds, valued at $90 million, in 1966 (table 2). In 1960, when exports were at a record high of 570 million pounds, valued at $128 million, they accounted for 14 percent of total U.S. production of primary aluminum. The United States exported unwrought aluminum to more than 50 countries in 1966. Major export markets were the United Kingdom, Japan, Brazil, France, and West Germany.

The growth in U.S. exports of unwrought aluminum has been due in part to the extensive fabricating facilities that U.S. producers of primary aluminum have acquired in foreign countries. U.S. producers, or companies in which they own a substantial interest, have acquired a significant share of the total aluminum-fabricating capacity in the United Kingdom, Japan, West Germany, Australia, and many of the less developed countries of the free world. Although U.S. companies are continuing to expand and acquire new fabricating facilities abroad, the outlook for a continuing increase in exports is not promising for several reasons. U.S. demand for unwrought aluminum is increasing so rapidly that only limited quantities are likely to be available for export. Furthermore, U.S. producers are establishing plants for producing primary aluminum in less developed countries that have only a limited market for aluminum, and it is likely that part of the foreign demand will be supplied from these facilities, which otherwise would not be operated on a profitable basis.

## U.S. imports

The United States is the world's leading importer of unwrought aluminum. The trend of imports has been upward in recent years; imports amounted to 511 million pounds, valued at $117 million in 1958, and to 1,044 million pounds, valued at $218 million, in 1966 (table 3). If the U.S. Government had not disposed of approximately 715 million pounds of aluminum from Government stocks during 1966, imports would have shown an even greater increase. The share of domestic consumption supplied by imports that consisted almost entirely of primary ingot ranged between 7 and 14 percent during 1958-66.

In 1966 the percentage distribution of the total quantity of imports under the items included in this summary was as follows: Unwrought aluminum, nonalloyed (618.02), 51.6 percent; unwrought aluminum, alloyed (618.06), 48.2 percent; and hollow cast extrusion ingot (618.45), 0.2 percent. The negligible amount of trade reported for items 618.01 and 618.04 is believed to have resulted, at least in part, from statistical classification errors.

Canada, Norway, and France supplied 93 percent of total U.S. imports of unwrought aluminum in 1958-66. Canada has historically been the predominant supplier although its share of annual U.S. imports declined from 84 percent in 1958 to 74 percent in 1966, while Norway's share increased from 9 percent to 15 percent in the same period. The large quantity of imports from Canada in recent years is partly due to a large Canadian producer's acquiring aluminum-fabricating facilities in the United States. Imports from France may have been similarly affected by a French producer's purchase of an interest in a large U.S. fabricator. This fabricator, the French producer, and another U.S. firm built a primary-aluminum plant in the United States which commenced production in 1966, thereby reducing the U.S. fabricator's dependence on purchased raw material requirements.

Norway's share of U.S. imports of unwrought aluminum has grown at an exceptionally fast rate, increasing from 44 million pounds in 1958 to 157 million pounds in 1966 (table 3). The increase in imports from Norway reflects in part increased imports from a Norwegian firm that is 50 percent owned by a U.S. aluminum producer. Norway's share of the U.S. market will probably continue to grow during 1967-70, in view of the fact that another American producer and another Norwegian firm are jointly building an aluminum-reduction plant in Norway that is slated to have a capacity of 264 million pounds a year and expected to market a significant part of its production in the United States.

Aside from considerations of price, quality, and service, certain domestic consumers have been induced to import unwrought aluminum because, having experienced shortages of domestic material on several occasions, they are concerned about the possibility of recurring shortages. The concern of these consumers is underscored by their knowledge that the domestic producers of primary aluminum have a substantial excess of fabricating capacity over metal-producing capacity. On the other hand, Canada and Norway, which are the principal sources of imports, have much greater aluminum-producing capacity than fabricating capacity. Also, many independent fabricators are reluctant to be entirely dependent on domestic producers for their raw material requirements when they must compete with these same concerns in marketing their fabricated products. Independent fabricators have contended

before congressional committees that the prices for both unwrought aluminum and aluminum mill products of the integrated domestic producers were at levels which prevented the independent fabricators from realizing an adequate profit on their operations.

The relative importance of imports in supplying domestic requirements for unwrought aluminum in the future will depend largely on where U.S. producers locate new production facilities. The economic location of primary-aluminum-production plants involves balancing three factors: (1) the availability of large quantities of low-cost electric power, (2) the availability of bauxite, and (3) the distance between the producing point and the market for the unwrought aluminum. No one of these factors is necessarily overriding, and the final selection of location results from weighing the economic importance of each factor. Another important consideration in locating aluminum-producing plants in foreign countries is the political stability of the foreign government and the risk of possible nationalization of high-cost plants. If U.S. producers continue the trend apparent in 1960-66 of locating more and more of their new production capacity in countries that do not have adequate markets for the new production, such as Australia, Ghana, and Norway, it is virtually certain that imports will capture an increasing share of the growing U. S. market.

Table 1.--Unwrought aluminum: U.S. production, imports for consumption, exports of domestic merchandise, and apparent consumption, 1958-66

(Quantity in millions of pounds; value in millions of dollars)

| Year | Production | | | Imports | Exports | Apparent consumption 2/ | Ratio (percent) of imports to consumption |
|---|---|---|---|---|---|---|---|
| | Primary | Secondary 1/ | Total | | | | |
| | Quantity | | | | | | |
| 1958 | 3,132 | 580 | 3,712 | 511 | 105 | 4,118 | 12 |
| 1959 | 3,908 | 720 | 4,628 | 480 | 242 | 4,866 | 10 |
| 1960 | 4,028 | 658 | 4,686 | 309 | 570 | 4,425 | 7 |
| 1961 | 3,808 | 680 | 4,488 | 398 | 258 | 4,628 | 9 |
| 1962 | 4,236 | 924 | 5,160 | 620 | 302 | 5,478 | 11 |
| 1963 | 4,626 | 1,012 | 5,638 | 831 | 331 | 6,138 | 14 |
| 1964 | 5,106 | 1,104 | 6,210 | 788 | 417 | 6,581 | 12 |
| 1965 | 5,508 | 1,282 | 6,790 | 1,055 | 407 | 7,438 | 14 |
| 1966 | 5,936 | 1,386 | 7,322 | 1,044 | 377 | 7,989 | 13 |
| | Value | | | | | | |
| 1958 | 774 | 143 | 917 | 117 | 24 | 1,010 | 12 |
| 1959 | 955 | 176 | 1,131 | 111 | 54 | 1,188 | 9 |
| 1960 | 1,030 | 168 | 1,198 | 76 | 128 | 1,146 | 7 |
| 1961 | 950 | 169 | 1,119 | 91 | 58 | 1,152 | 8 |
| 1962 | 998 | 218 | 1,216 | 130 | 67 | 1,279 | 10 |
| 1963 | 1,040 | 227 | 1,267 | 163 | 72 | 1,358 | 12 |
| 1964 | 1,196 | 259 | 1,455 | 163 | 92 | 1,526 | 11 |
| 1965 | 1,338 | 311 | 1,649 | 218 | 93 | 1,774 | 12 |
| 1966 | 1,446 | 338 | 1,784 | 218 | 90 | 1,912 | 11 |

1/ The values of secondary production were estimated by applying the unit value of primary production in the corresponding years.

2/ Computed by adding total production and net imports.

Source: Production compiled from official statistics of the U.S. Bureau of Mines; imports and exports compiled from official statistics of the U.S. Department of Commmerce.

Table 2.--Unwrought aluminum: U.S. exports of domestic merchandise, by principal markets, 1958, 1960 and 1962-66

| Market | 1958 | 1960 | 1962 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|---|---|
| | Quantity (million pounds) | | | | | | |
| United Kingdom | 52.0 | 236.2 | 75.0 | 104.5 | 82.6 | 88.9 | 55.2 |
| Japan | .2 | 17.5 | 4.8 | 6.2 | .8.2 | 9.1 | 46.9 |
| Brazil | 1.3 | 1.9 | 9.7 | 9.8 | 4.8 | 30.5 | 46.0 |
| France | - | 21.0 | 5.3 | 13.3 | 44.4 | 50.1 | 41.3 |
| West Germany | 3.3 | 151.3 | 32.6 | 37.9 | 81.7 | 56.1 | 31.4 |
| India | 1.4 | 1.8 | 19.7 | 8.3 | 3.8 | 5.1 | 16.6 |
| Argentina | .5 | 12.5 | 22.9 | 10.3 | 15.1 | 30.0 | 13.0 |
| Canada | 22.6 | 1.4 | 8.4 | 3.0 | 4.4 | 13.2 | 10.9 |
| Philippine Republic | 4.6 | 6.4 | 3.0 | 8.6 | 8.2 | 4.7 | 10.4 |
| Netherlands | 1.6 | 16.5 | 5.6 | 8.1 | 24.1 | 18.6 | 8.8 |
| Sweden | - | 1/ | .2 | 4.6 | 2.8 | 4.1 | 8.8 |
| Other | 17.9 | 103.5 | 115.3 | 116.1 | 137.1 | 96.9 | 87.2 |
| Total | 105.4 | 570.0 | 302.5 | 330.7 | 417.2 | 407.3 | 376.5 |
| | Value (million dollars) | | | | | | |
| United Kingdom | 11.9 | 53.8 | 16.6 | 22.5 | 18.8 | 21.3 | 13.2 |
| Japan | 2/ | 3.8 | 1.1 | 1.4 | 2.0 | 2.1 | 11.6 |
| Brazil | .3 | .4 | 2.1 | 2.0 | 1.1 | 5.5 | 10.5 |
| France | - | 4.7 | 1.2 | 2.8 | 9.4 | 10.1 | 9.1 |
| West Germany | .9 | 33.2 | 7.2 | 9.3 | 17.5 | 12.7 | 7.2 |
| India | .3 | .4 | 4.2 | 1.6 | .8 | 1.3 | 4.1 |
| Argentina | .1 | 2.8 | 2.2 | 3.1 | 6.3 | 6.9 | 2.9 |
| Canada | 5.2 | .5 | 2.1 | .9 | 1.2 | 3.6 | 3.0 |
| Philippine Republic | 1.2 | 1.5 | .7 | 1.8 | 1.8 | 1.1 | 2.5 |
| Netherlands | .3 | 3.8 | 1.3 | 1.8 | 5.2 | 4.1 | 2.1 |
| Sweden | - | 2/ | 2/ | 1.0 | .7 | 1.0 | 2.2 |
| Other | 4.0 | 23.3 | 27.9 | 23.7 | 27.4 | 22.8 | 21.6 |
| Total | 24.2 | 128.2 | 66.6 | 71.9 | 92.2 | 92.5 | 90.0 |

1/ Less than 50,000 pounds.
2/ Less than $50,000.

Source: Compiled from official statistics of the U.S. Department of Commerce.

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Table 3.--Unwrought aluminum: U.S. imports for consumption by principal sources, 1958-66

| Year | Canada | Norway | France | All other | Total |
|---|---|---|---|---|---|
| | Quantity (million pounds) | | | | |
| 1958 | 427.8 | 43.6 | 23.8 | 15.5 | 510.7 |
| 1959 | 333.6 | 65.1 | 24.7 | 56.6 | 480.0 |
| 1960 | 208.1 | 62.9 | 20.4 | 18.0 | 309.4 |
| 1961 | 238.0 | 75.6 | 80.4 | 4.4 | 398.4 |
| 1962 | 419.8 | 98.8 | 76.0 | 25.4 | 620.0 |
| 1963 | 545.8 | 174.2 | 69.3 | 42.0 | 831.3 |
| 1964 | 519.1 | 187.8 | 29.7 | 51.7 | 788.3 |
| 1965 | 688.9 | 182.0 | 67.4 | 116.2 | 1,054.5 |
| 1966 | 774.8 | 157.4 | 20.4 | 91.4 | 1,044.0 |
| | Value (million dollars) | | | | |
| 1958 | 97.9 | 11.2 | 4.9 | 3.3 | 117.3 |
| 1959 | 77.6 | 16.0 | 5.4 | 12.2 | 111.2 |
| 1960 | 51.2 | 15.7 | 4.9 | 4.1 | 75.9 |
| 1961 | 55.0 | 17.4 | 17.8 | 1.0 | 91.2 |
| 1962 | 88.6 | 20.7 | 15.2 | 5.1 | 129.6 |
| 1963 | 108.5 | 33.5 | 13.3 | 8.1 | 163.4 |
| 1964 | 109.1 | 37.3 | 6.3 | 10.1 | 162.8 |
| 1965 | 143.0 | 37.8 | 13.9 | 23.5 | 218.2 |
| 1966 | 161.6 | 33.0 | 4.3 | 18.6 | 217.5 |

Source: Compiled from official statistics of the U. S. Department of Commerce.

Table 4.--Unwrought aluminum: U.S. imports for consumption, by tariff classification (identified by TSUS item numbers), 1964-66

| Year | Aluminum in coils (618.01) | Aluminum in ingots (618.02) | Aluminum alloys: Aluminum silicon (618.04) | Aluminum alloys: Other (618.06) | Hollow cast extrusion ingots (618.45) | Total |
|---|---|---|---|---|---|---|
| | Quantity (1,000 pounds) | | | | | |
| 1964 | 1/ | 448,731 | - | 337,034 | 2,557 | 788,322 |
| 1965 | 10 | 637,844 | 18 | 411,680 | 4,980 | 1,054,532 |
| 1966 | 100 | 538,953 | - | 502,823 | 2,100 | 1,043,976 |
| | Value (1,000 dollars) | | | | | |
| 1964 | 2/ | 89,949 | - | 72,229 | 575 | 162,753 |
| 1965 | 2 | 128,800 | 18 | 88,313 | 1,104 | 218,237 |
| 1966 | 25 | 109,332 | - | 107,621 | 524 | 217,502 |

1/ Less than 500 pounds
2/ Less than $500

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note.--The negligible amount of trade reported for items 618.01 and 618.04 is believed to have resulted, at least in part, from statistical classification errors.

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| Commodity | TSUS item |
|---|---|
| Aluminum: | |
| Wrought rods | 618.15 |
| Wrought angles, shapes, and sections | 618.17 |
| Wire | 618.20, -.22 |
| Wrought bars, plates, sheets, and strip | 618.25, -.27, -.29 |
| Flakes | 618.40 |
| Powders | 618.42 |
| Pipes, tubes, and blanks; pipe and tube fittings | 618.47, -.48 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

The United States is the world's largest producer, consumer, and importer of aluminum mill products. Annual imports of these products, however, accounted for less than 5 percent of the quantity of U.S. consumption in the 1958-66 period. Owing to a marked rise in exports, the U.S. balance of trade in the aluminum mill products considered here shifted from a deficit of 81 million pounds in 1959 to a surplus of 42 million pounds in 1964; in 1966, however, the trade balance shifted to a deficit because of a sharp increase in domestic consumption.

## Description and uses

The articles enumerated above are the principal aluminum mill products produced in the United States with the exception of foil (items 644.06 to 644.12), and electrical cable and insulated wire (items 688.06 to 688.25); these excepted products are discussed in separate summaries in volumes 6:5 and 6:11, respectively.

Sheet, plate, and strip account for about half of the U.S. consumption of the products covered by this summary; they are products of solid rectangular cross section that are generally produced by rolling unwrought aluminum (see summary on aluminum metal except waste and scrap, elsewhere in volume 6:1, items 618.01 et al.). Sheet, strip, plate, and bar are included in this summary whether or not cut, pressed, or stamped to nonrectangular shapes and whether not clad (item 618.25), clad, wholly of aluminum (item 618.27), or clad with some other metal (618.29). The term "clad" is defined in headnote 3(d), part 2, schedule 6 of the TSUSA-1968.

Sheet and strip are fabricated into such diverse products as roofing, siding, awnings, boat hulls, refrigerator shelves, aircraft and trailer skins, automotive trim, cans, and cooking utensils. Building products constitute the largest single market outlet for sheet and strip. Plate is used extensively in the construction of ships, aircraft, military vehicles, railroad cars, and tanks.

Rod and bar are solid products which are generally produced by rolling or extruding processes. Rod of round cross section and bar of rectangular, hexagonal, or octagonal cross section are used principally as forging stock, screw-machine stock, and redraw rod. Forging stock is converted into aircraft and ordnance components and other articles which require a certain combination of mechanical properties. Screw-machine stock is machined into fasteners, gears, knobs, bushings and the like. Redraw rod is drawn into wire for use as an electrical conductor, or it is further fabricated into such products as welding electrodes, rivets, nails, screening, and fencing.

Angles, shapes, and sections are solid products generally produce by the extrusion process or by roll forming. These products consist largely of structural shapes used primarily in architectural applications (such as windows, doors, and curtain walls) and in transportation equipment (truck-trailer flooring, aircraft wing spars, automobile grilles, and so forth).

Aluminum powder is a fine granular material that is made by disintegrating (atomizing) a stream of molten metal with a blast of steam or air. Such powder is used for producing shaped articles by means of powder metallurgy techniques and for producing pyrotechnics, explosive or aluminum flakes. In making flakes, the powder is mixed with mineral spirits and stearic acid and processed in ball mills to form a slurry containing aluminum flakes. The excess mineral spirits are removed by filtration leaving a filter cake which is either dried and polished to produce flake (also known as aluminum bronze powder when alloyed) or thinned with mineral spirits to produce paste (see summary on item 473.88 in volume 4:10). Flake and paste are used principally in the manufacture of paints.

Aluminum pipes and tubes are produced both with and without seams The seamless type and tube blanks (blooms) are generally produced by the extrusion process from solid or hollow cast extrusion ingots; some seamless tube is produced by drawing extruded tube to final size in order to meet close dimensional tolerances. Roll-formed and welded tubes are produced from sheet stock. Aluminum pipe and tube are used, for example, in irrigation systems, bridge railing, lawn and beach furniture, and electrical conduit.

The use of aluminum mill products has increased rapidly in recent years owing to the exploitation of their favorable mechanical and physical properties and vigorous sales promotion. For example, the high strength-to-weight ratio of aluminum products has contributed to their use in transportation equipment; the high electrical conductivity and light weight of aluminum has led to its extensive use in electrical transmission lines; and its resistance to corosion, high reflectivity, and attractive appearance have been partly responsible for its increased use in architectural and decorative applications. Technological advances such as the development of improved alloys, new joining techniques, and new finishes, have also contributed significantly to increased use of these products. Other important factors have been the relative price stability of aluminum products; new availabilities, e.g., wider sheets and larger extrusions; and the ease with which these products can be further fabricated. An example of the latter is aluminum sheet which responds readily to bending, drawing, spinning, stamping, embossing, stretch-forming, and roll-forming.

In this summary, all quantities are expressed in terms of pounds.

U.S. tariff treatment

The column 1 (or trade-agreement) rates of duty applicable to imports (see general headnote 3 in the TSUSA-1968) are as follows (in percent ad valorem and cents per pound):

| TSUS item | Commodity | Prior rate | U.S. concessions granted in 1964-67 trade conference (Kennedy Round) | |
|---|---|---|---|---|
| | | | First stage, effective Jan. 1, 1968 | Final stage, effective Jan. 1, 1972 |
| | Aluminum mill products: | | | |
| 618.15 | Wrought rods | 2.5¢ | 2.4¢ | 1/ 2¢ |
| 618.17 | Wrought angles, shapes, and sections. | 19% | 17% | 9.5% |
| 618.20 | Wire, not coated or plated with metal. | 12.5% | 11% | 6% |
| 618.22 | Wire, coated or plated with metal. | 0.1¢ +12.5% | 0.09¢ + 11% | 0.05¢ + 6% |
| 618.25 | Wrought bars, plates, sheets, and strip, 2/ not clad. | 2.5¢ | 2.4¢ | 1/ 2¢ |
| 618.27 | Wrought bars, plates, sheets, and strip, 2/ clad wholly of aluminum. | 2.5¢ | 2.4¢ | 1/ 2¢ |
| 618.29 | Wrought bars, plates, sheets, and strip, 2/ clad with other than aluminum. | 24% | 21.5% | 12% |
| 618.40 | Flakes | 5.1¢ | 4.5¢ | 2.5¢ |
| 618.42 | Powders | 19% | 17% | 9.5% |
| 618.47 | Pipes and tubes and blanks therefor, pipe and tube fittings. | 19% | 17% | 9.5% |
| 618.48 | Pipes and tubes, etc., if Canadian article and original automotive equipment. | Free | 3/ | 3/ |

1/ The final rate will become effective Jan. 1, 1971, at the 4th stag
2/ Whether or not cut, pressed, or stamped to nonrectangular shapes.
3/ Duty status not affected by trade conference.

The use of aluminum mill products has increased rapidly in recent years owing to the exploitation of their favorable mechanical and physical properties and vigorous sales promotion. For example, the high strength-to-weight ratio of aluminum products has contributed to their use in transportation equipment; the high electrical conductivity and light weight of aluminum has led to its extensive use in electrical transmission lines; and its resistance to corosion, high reflectivity, and attractive appearance have been partly responsible for its increased use in architectural and decorative applications. Technological advances such as the development of improved alloys, new joining techniques, and new finishes, have also contributed significantly to increased use of these products. Other important factors have been the relative price stability of aluminum products; new availabilities, e.g., wider sheets and larger extrusions; and the ease with which these products can be further fabricated. An example of the latter is aluminum sheet which responds readily to bending, drawing, spinning, stamping, embossing, stretch-forming, and roll-forming.

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|---|---|---|---|---|
| | | | First stage, effective Jan. 1, 1968 | Final stage, effective Jan. 1, 1972 |
| | Aluminum mill products: | | | |
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| 618.17 | Wrought angles, shapes, and sections. | 19% | 17% | 9.5% |
| 618.20 | Wire, not coated or plated with metal. | 12.5% | 11% | 6% |
| 618.22 | Wire, coated or plated with metal. | 0.1¢ +12.5% | 0.09¢ + 11% | 0.05¢ + 6% |
| 618.25 | Wrought bars, plates, sheets, and strip, 2/ not clad. | 2.5¢ | 2.4¢ | 1/ 2¢ |
| 618.27 | Wrought bars, plates, sheets, and strip, 2/ clad wholly of aluminum. | 2.5¢ | 2.4¢ | 1/ 2¢ |
| 618.29 | Wrought bars, plates, sheets, and strip, 2/ clad with other than aluminum. | 24% | 21.5% | 12% |
| 618.40 | Flakes | 5.1¢ | 4.5¢ | 2.5¢ |
| 618.42 | Powders | 19% | 17% | 9.5% |
| 618.47 | Pipes and tubes and blanks therefor, pipe and tube fittings. | 19% | 17% | 9.5% |
| 618.48 | Pipes and tubes, etc., if Canadian article and original automotive equipment. | Free | 3/ | 3/ |

1/ The final rate will become effective Jan. 1, 1971, at the 4th stage.
2/ Whether or not cut, pressed, or stamped to nonrectangular shapes.
3/ Duty status not affected by trade conference.

The tabulation above shows the column 1 rates of duty in effect prior to January 1, 1968, and modifications therein as a result of concessions granted by the United States in the sixth round of trade negotiations under the General Agreement on Tariffs and Trade (GATT). Only the first and final stages of the annual rate modifications are shown above. (See the TSUSA-1968 for the intermediate staged rates.)

All of the prior rates of duty shown above reflect concessions granted by the United States in the GATT. The rates applicable to items 618.20 and 618.22 had been in effect since June 30, 1951; those applicable to items 618.15, 618.17, 618.25, 618.27, 618.40, 618.42, and 618.47 had been in effect since June 30, 1958; and tha rate applicable to item 618.29 had been in effect since July 1, 1963. All of the rates above remained unchanged under the TSUS from August 31, 1963, through the end of 1967. Item 618.48 (formerly part of item 618.47) was established as a result of the Automotive Products Trade Agreement with Canada as to articles entered on and after January 18, 1965.

Except for item 618.48, which was not among the articles listed for negotiation in the Kennedy Round, concessions amounting to reductions in duty ranging from 16 to 44 percent were granted by the United States on all other items considered here. The rates are being reduced in five annual stages for all items except items 618.15, 618.25, 618.27, and 618.29, for which the rates are being reduced in four stages--the fourth and final reduction to go into effect January 1, 1971.

In recent years the great bulk of the imports considered herein have consisted of the lower rate articles provided for under items 618.15, 618.25, and 618.27. The average ad valorem equivalents of the specific rates of duty in effect on December 31, 1967, based on dutiable imports in 1966, were as follows:

| TSUS item | Percent |
|---|---|
| 618.15 | 6.9 |
| 618.22 | 1/ |
| 618.25 | 8.3 |
| 618.27 | 6.6 |
| 618.40 | 9.8 |

1/ There were no imports of the articles provided for under item 618.22 on which to compute a representative ad valorem equivalent.

In addition to the aforementioned duty provisions for aluminum mill products, the TSUS also provides for duties on certain domestically manufactured articles which have been processed abroad. Item 806.30 1/ for instance, provides that the rate of duty on any such article when imported shall be based upon the value of the processing outside the United States rather than on the total value of the article. 2/

1/ Item 806.30 refers to articles of metal (except precious metal) manufactured or subjected to a process of manufacture in the United States, which are exported for further processing, and after such processing outside the United States are returned to this country for additional processing.

2/ For example, the duty on imported sheet made from foreign ingot is 2.4 cents a pound in 1968. Imported sheet made from U.S. produced ingot, however, would be assessed at a lower rate; thus assuming that the total value of such imported sheet is 32 cents a pound (of which 24 cents represents the value of the U.S. ingot used in making the sheet, and 8 cents the value of the processing abroad) such sheet would be dutiable at about 0.6 cent a pound. The latter figure is equivalent to the ratio of the value per pound of the processing abroad to the full value per pound of the imported sheet as applied to the duty imposed on wholly foreign-made sheet.

U.S. consumption

Apparent domestic consumption of aluminum mill products increased from 2.1 billion pounds in 1958 to 5.3 billion pounds in 1966 (table 1)--representing an increase of 146 percent. All of the aluminum mill products shared in the increase in consumption; however, for sheet and extruded angles, shapes, and sections--products which in 1966 accounted for 84 percent of the consumption of all aluminum mill products--the increase was unusually rapid. The growth in U.S. consumption of aluminum mill products is expected to continue at a rapid pace as new uses for these products are developed and existing markets are more fully exploited.

There are numerous examples of markets that offer considerable potential for wider application of aluminum mill products; the metal can market is representative of one where the use of aluminum has increased substantially in recent years and where there are opportunities for further growth. In 1961, 49 million pounds of aluminum was used in fabricating cans, whereas in 1966, consumption of aluminum for this application was 249 million pounds. In spite of this rapid growth, aluminum accounted for only 2.4 percent, by weight, of the material used in the manufacture of metal cans in the United States in 1966.

U.S. producers

In 1966 the aluminum mill products herein considered (except pipe and tube fittings) were produced by approximately 205 concerns, many of which produced more than one class of these products. The number of producers of these products was as follows:

| | | | |
|---|---|---|---|
| Sheet | 40 | Wire | 33 |
| Plate | 12 | Angles, shapes and sections and extruded rod, bar, pipe, and tube | 140 |
| Rolled rod and bar | 12 | | |
| Drawn tube | 17 | | |
| Welded tube | 22 | Powder and flake | 10 |

Production facilities are located in all regions of the United States, but they are concentrated in the North Central and Middle Atlantic States. Approximately 33 of the aforementioned producers make aluminum mill products (predominantly sheet and extruded shapes) for their own consumption and not for sale. These captive producers consist principally of companies that make architectural products such as siding, doors, windows and curtain walls.

Aluminum mill products are produced by integrated concerns (companies that produce both primary aluminum and aluminum mill products) and nonintegrated producers. Data gathered by the U.S. Department of

Commerce show that in 1964 (the latest period for which data are available) eight integrated producers accounted for 76 percent of the total quantity of U.S. shipments of sheet and plate, 60 percent of the shipments of uninsulated wire, and 39 percent of the shipments of extruded angles, shapes and sections, extruded rod and bar, extruded pipe and tube, and drawn tube. Data are not available on the integrated producers' share of shipments of rolled rod and bar, powder, flake, and welded tube, since publication would disclose the operations of individual companies; however, it is known that integrated producers accounted for the bulk of the total shipments of these products.

The integrated aluminum producers are all large companies with multi-plant operations, whereas nonintegrated producers are generally small, single-plant companies with limited product lines. The number of nonintegrated fabricators has grown in recent years; however, their share of total U.S. shipments of aluminum mill products has remained virtually unchanged owing to an accompanying trend toward vertical integration. This integration has resulted both from the acquisition of large independent fabricating plants by integrated producers and from the expansion of large producers of fabricated products into primary aluminum production. The trend toward vertical integration of production is expected to continue; for example, two large nonintegrated domestic producers and a foreign concern built a jointly owned primary aluminum plant which commenced production in 1966. This development resulted in a significant increase in the fabricating capacity of the integrated producers with a corresponding reduction in the capacity of the nonintegrated sector of the industry.

The considerable extent to which production of aluminum mill products has become internationalized is indicated by the fact that in 1965 integrated U.S. aluminum producers owned outright, or in partnership with foreign interests, aluminum fabricating plants in 23 foreign countries (the United Kingdom, Japan, Germany, Australia, India, Mexico, Venezuela, and others); moreover, in some countries the U.S. concerns had multi-plant operations. Likewise, Canadian, French, Swiss, and German aluminum producing companies have acquired facilities for producing aluminum mill products in the United States.

According to the Census of Manufactures, 151 of the 211 U.S. establishments engaged primarily in the rolling, drawing, and extruding of aluminum in 1963 had 20 or more employees. Total employment in this industry was 55,247 in 1963, compared with 46,879 in 1958. The establishments covered in the Census of Manufactures, however, are not fully comparable with the establishments that produce the products covered by this summary. The census data, which relate to only those establishments that are primarily engaged in "rolling, drawing, and extruding aluminum," include the rolling of foil covered in a separate summary (in item 644.06 et al., discussed in volume 6:5), but exclude the production of powder, flake, and pipe and tube fittings, covered in this summary.

U.S. production

U.S. producers' shipments of the products considered here (except pipe and tube fittings, which are not separately reported) increased from about 2.1 billion pounds in 1958 to 5.2 billion pounds in 1966, representing an increase of 148 percent. These shipments consisted of the following classes of products in 1958, 1965, and 1966 (in millions of pounds):

| | 1958 | 1965 | 1966 |
|---|---|---|---|
| Sheet (including strip) and plate | 1,153 | 2,619 | 2,942 |
| Angles, shapes, and sections | 1/ 605 | 1,281 | 1,433 |
| Rods and bars | 1/ 120 | 243 | 255 |
| Wire, bare | 44 | 83 | 103 |
| Pipes and tubes | 1/ 172 | 355 | 388 |
| Atomized powder | 7 | 33 | 85 |
| Flaked powder | 4 | 7 | 8 |
| Total | 2,105 | 4,621 | 5,214 |

1/ Partly estimated.

Although data on shipments of fittings for pipe and tube are not available, such shipments probably increased at a rate comparable to that shown above for pipe and tube.

U.S. producers' shipments as reported in tables 1 and 2 and in the above tabulation do not include certain interplant transfers because their inclusion would result in duplication. In 1963, the most recent year for which data are available, interplant shipments were equal to approximately 17 percent of U.S. producers' total shipments of aluminum sheet and plate, 55 percent of their total shipments of rod and bar, and 19 percent of their total shipments of bare wire. The excluded interplant shipments consisted principally of sheet to be rolled into foil, rod to be drawn into wire, and bare wire to be insulated. Interplant transfers did not account for a substantial part of total shipments of the other products covered in this summary.

Based on data in the 1963 Census of Manufactures, U.S. producers' shipments of the aluminum mill products dealt with in this summary are estimated to have had an average value of 40.5 cents a pound in 1963 or 18.1 cents a pound more than the average value of unwrought aluminum shipments (ingots, etc.) during the same year.

Data for 1966 on producers' shipments, exports, imports, and apparent consumption, by classes of product, are shown in table 2.

U.S. exports

U.S. exports of the aluminum mill products included in this summary increased annually from an estimated 21 million pounds, valued at $11 million, in 1958 to 190 million pounds, valued at $83 million in 1966 (table 1); the quantity of annual exports thus increased eightfold. The quantity exported in 1966 was equal to 3.6 percent of total U.S. producers' shipments.

In 1966, sheet, strip, plate, rod, and bar products accounted for 88 percent of the total quantity of exports of the aluminum products considered here. Exports in 1966, by product classes, were as follows:

| | Quantity (1,000 pounds) | Value (1,000 dollars) |
|---|---|---|
| Sheet (including strip) and plate | 148,107 | 56,273 |
| Angles, shapes and sections | 6,295 | 8,194 |
| Rods and bars | 18,392 | 6,805 |
| Wire, bare | 7,045 | 3,676 |
| Tubes, pipes, and tube blooms | 3,422 | 2,464 |
| Electrical conduit | 2,406 | 992 |
| Pipe and tube fittings | 2,051 | 2,897 |
| Powder and flakes | 1,815 | 1,235 |

U.S. aluminum mill products were exported to more than 70 countries in 1966. Canada became the leading export market in 1963 (table 3), after a large Canadian producer of primary aluminum built a rolling mill in upper New York State and exported to Canada a significant part of the mill's production of sheet and plate, which was fabricated from imported ingot. U.S. drawback privileges permit a 99-percent refund on the duty paid on ingot that is imported for conversion into mill products for export. U.S. exports of sheet and plate products to Canada increased from 7 million pounds in 1962 to 45 million pounds in 1963 (the first year in which this new mill was in operation), and further increased to 148 million pounds in 1966. The Canadian company mentioned above acquired four more aluminum-rolling plants in the United States in early 1965, but it is unlikely that these acquisitions will have the same dramatic effect on U.S. exports to Canada as the first acquisition. The New York plant supplies reroll stock to certain Canadian mills as well as to domestic mills, whereas the plants acquired in 1965 are expected to supply sheet and strip principally to domestic consumers.

India was the second largest market for U.S. exports of aluminum mill products in the 1962-66 period. Exports to India during those years consisted principally of rod that was to be further fabricated into wire for use in electrification programs. U.S. exports of rod

to India totaled 70 million pounds during 1962-66, accounting for 62 percent of total U.S. exports of rod and bar in that period. Rod exports to India have been financed largely through funds provided by the Agency for International Development.

Exports to the United Kingdom, Japan, and the European Economic Community (EEC) countries have been significant in recent years, although with respect to these countries the United States is a substantial net importer of aluminum mill products. It is believed that the marketing services and the broad range of products offered by U.S. producers (wide sheets, large shapes, and wide selection of alloys) have enabled them to compete in markets that already have advanced domestic industries for producing aluminum mill products.

U.S. imports

U.S. imports of the products considered here fluctuated during the 1958-66 period from 57 million pounds valued at $21 million, in 1958 to 250 million pounds, valued at $78 million, in 1966. Imports in 1966 by product classes, were as follows (see more detailed data in table 4):

| | Quantity (1,000 pounds) | Value (1,000 dollars) |
|---|---|---|
| Sheet, plate and strip (including nonrectangular blanks) | 213,468 | 63,800 |
| Angles, shapes, and sections | 2,049 | 1,005 |
| Rods and bars | 29,414 | 10,844 |
| Wire, bare | 2,441 | 858 |
| Pipes and tubes and pipe and tube fittings | 1,179 | 710 |
| Powder | 515 | 177 |
| Flakes | 468 | 243 |

During 1958-66 imports of rods, bars, sheets, plates, and strip, including nonrectangular blanks, accounted for 98 percent of the total quantity of imports of the products covered by this summary. These products are particularly well suited to import trade. They are frequently purchased in standard sizes, alloys, and tempers and therefore may be imported and held for resale or direct consumption without the importer's running an undue risk of having material in inventory for which there may be little demand; also, the import duties on these articles are somewhat lower than on most of the other mill products. The quantity of annual imports of the aforementioned products fluctuated during 1958-66 at levels ranging from 4 to 6 percent of domestic consumption.

Although domestic consumption of angles, shapes, and sections is very large (approximately 1.4 billion pounds in 1966), imports of thi class of products have been insignificant (about 2 million pounds in 1966). The relative unimportance of imports of angles, shapes, and sections (item 618.17) is attributable to (1) the intense competition among the 140 domestic producers which has resulted in low prices for these articles in the U.S. market, (2) the relatively high rate of duty (19 percent ad valorem prior to Jan. 1, 1968), and (3) the long lead times required by foreign firms to fill U.S. orders, compared with the delivery schedules offered by domestic producers. Furthermore, these products are generally produced to exacting customer specifications, and often close liaison between the customer and the producer must be maintained in order to effect changes in specifications desired by the customer. Similar liaison between a U.S. customer and a foreign supplier is difficult and expensive to maintain.

The principal sources of U.S. imports of wrought aluminum rods, bars, plates, sheet and strip (including circles and discs) have been the countries in the EEC, also Japan, Canada, the United Kingdom, Yugoslavia, Spain and Austria. The EEC supplied approximately 59 percent of the total quantity of U.S. imports during 1958-66. Imports from EEC countries increased from approximately 36 million pounds, valued at $13 million, in 1958 to 151 million pounds, valued at $46 million in 1966 (table 5).

In addition to the imports mentioned above, a significant quantity of imports in some years are known to have consisted of aluminum mill products that were processed in foreign countries from ingot produced in the United States; however, official statistics on such transactions (reported under item 806.30) are not segregated by products of individual metals.

The reported value of annual U.S. imports of rods, bars, sheets, plates, and strip, including nonrectangular blanks, declined from an average of 36.1 cents a pound in 1958 to 30.7 cents a pound in 1966. The decline in the average unit value of these imports may have been due, in part, to differences in the product mix, but it followed the general decline in domestic prices for wrought aluminum products that occurred in 1958-64 and early 1965, when domestic capacity to produce these products far exceeded demand. As domestic prices for aluminum rods, bars, sheets, and plates declined, the price advantage of imports diminished. As a result, the share of apparent domestic consumption of these products accounted for by imports declined from 6.0 percent in 1962 to 3.8 percent in 1963, and 4.0 percent in 1964. However, domestic prices began to firm after the early part of 1965 owing to a significant increase in defense requirements and continued growth in commercial demand. With improved domestic demand and higher prices in 1965 and 1966, the share of domestic consumption supplied by import increased from 4.6 percent in 1965 to 7.4 percent in 1966.

In view of the ample domestic capacity to supply a complete range of wrought aluminum products, it is likely that the volume of future imports will be governed largely by the relative prices of domestic and foreign aluminum mill products.

Table 1.--Aluminum mill products: U.S. producers' shipments, imports for consumption, exports of domestic merchandise, and apparent consumption, 1958-66

(Quantity in thousands of pounds; value in thousands of dollars)

| Year | Producers' shipments 1/ | Imports 2/ | Exports 2/ | Apparent consumption | Ratio (percent) of imports to consumption |
|---|---|---|---|---|---|
| | Quantity | | | | |
| 1958 | 2,105,000 | 56,709 | 20,777 | 2,140,932 | 2.6 |
| 1959 | 2,805,000 | 102,416 | 20,984 | 2,886,432 | 3.5 |
| 1960 | 2,490,000 | 75,903 | 37,929 | 2,527,974 | 3.0 |
| 1961 | 2,700,000 | 100,693 | 53,319 | 2,747,374 | 3.7 |
| 1962 | 3,090,000 | 120,614 | 85,514 | 3,125,100 | 3.9 |
| 1963 | 3,480,000 | 84,880 | 112,598 | 3,452,282 | 2.5 |
| 1964 | 3,960,000 | 102,302 | 144,083 | 3,918,219 | 2.6 |
| 1965 | 4,621,000 | 134,196 | 146,284 | 4,607,912 | 2.9 |
| 1966 | 5,214,000 | 249,534 | 189,533 | 5,274,001 | 4.7 |
| | Value | | | | |
| 1958 | 3/ | 20,624 | 11,184 | 3/ | 3/ |
| 1959 | 3/ | 35,483 | 11,018 | 3/ | 3/ |
| 1960 | 3/ | 27,382 | 17,069 | 3/ | 3/ |
| 1961 | 3/ | 34,327 | 25,061 | 3/ | 3/ |
| 1962 | 3/ | 38,434 | 34,751 | 3/ | 3/ |
| 1963 | 3/ | 26,675 | 41,283 | 3/ | 3/ |
| 1964 | 3/ | 31,249 | 52,747 | 3/ | 3/ |
| 1965 | 3/ | 39,692 | 61,170 | 3/ | 3/ |
| 1966 | 3/ | 77,636 | 82,536 | 3/ | 3/ |

1/ U.S. producers' shipments represent total shipments to customers and to their own fabricating departments which manufacture products beyond the level of mill shapes. Thus interplant transfers of sheet for conversion into siding are included, but interplant transfers of sheet for conversion into foil and rod for conversion into wire are not included.

2/ Data on imports and exports are partly estimated and are not entirely comparable with data on producers' shipments.

3/ Not available.

Source: Derived from official statistics of the U.S. Department of Commerce.

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Table 2.--Aluminum mill products: U.S. producers' shipments, imports for consumption, exports of domestic merchandise, and apparent consumption by classes of product, 1966

| Class of product | Producers' shipments 1/ | Imports | Exports | Apparent consumption | Ratio of imports to consumption |
|---|---|---|---|---|---|
| | 1,000 pounds | 1,000 pounds | 1,000 pounds | 1,000 pounds | Percent |
| Sheet (including strip) and plate | 2,942,275 | 213,468 | 148,107 | 3,007,636 | 7.1 |
| Angles, shapes, and sections | 1,432,996 | 2,049 | 6,295 | 1,428,750 | 2/ |
| Rods and bars | 254,725 | 29,414 | 18,392 | 265,747 | 11.1 |
| Wire, bare | 103,206 | 2,441 | 7,045 | 98,602 | 2.5 |
| Pipes and tubes | 388,388 | 3/ 1,179 | 3/ 7,879 | 381,688 | 4/ |
| Powder | 5/ 84,921 | 515 | 1,815 | 91,534 | 1.1 |
| Flakes | 6/ 7,445 | 468 | | | |
| Total | 5,213,956 | 249,534 | 189,533 | 5,273,957 | 4.7 |

1/ Total shipments to customers plus shipments to own fabricating departments for manufacture into products more advanced than mill shapes. Thus interplant transfers of sheet for conversion into siding are included, but interplant transfers of sheet for conversion into foil, or of rod for conversion into wire, are not included.
2/ Less than 0.05 percent.
3/ Includes pipe and tube fittings.
4/ Not computed because data are not strictly comparable.
5/ Atomized powder.
6/ Flaked powder.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 3.--Aluminum rods, bars, sheets, plates, and strip (including nonrectangular blanks, and rods): U.S. exports of domestic merchandise, by principal markets, 1958 and 1962-66

| Country | 1958 | 1962 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|---|
| | Quantity (1,000 pounds) | | | | | |
| Canada | 4,980 | 8,545 | 46,245 | 68,355 | 75,730 | 106,987 |
| India | 2,094 | 22,145 | 15,914 | 12,440 | 10,594 | 10,826 |
| United Kingdom | 68 | 14,387 | 8,482 | 4,462 | 2,393 | 1,480 |
| Netherlands | 365 | 2,547 | 5,526 | 5,974 | 2,257 | 3,584 |
| Mexico | 106 | 3,713 | 3,258 | 5,875 | 4,275 | 988 |
| Venezuela | 728 | 1,160 | 2,318 | 1,643 | 1,073 | 2,389 |
| West Germany | 9 | 1,459 | 1,901 | 2,313 | 2,653 | 3,974 |
| Japan | 28 | 377 | 1,356 | 1,124 | 1,876 | 3,093 |
| Others | 3,333 | 19,396 | 14,747 | 28,313 | 25,484 | 33,178 |
| Total | 11,711 | 73,729 | 99,747 | 130,499 | 126,335 | 166,499 |
| | Value (1,000 dollars) | | | | | |
| Canada | 3,247 | 4,842 | 15,710 | 23,072 | 28,094 | 37,788 |
| India | 607 | 5,337 | 3,728 | 3,276 | 2,805 | 2,790 |
| United Kingdom | 44 | 4,861 | 3,272 | 1,883 | 1,608 | 1,138 |
| Netherlands | 219 | 1,279 | 2,220 | 2,282 | 1,182 | 2,082 |
| Mexico | 76 | 1,162 | 869 | 1,579 | 1,220 | 460 |
| Venezuela | 355 | 423 | 823 | 563 | 548 | 814 |
| West Germany | 7 | 608 | 771 | 1,138 | 1,123 | 1,547 |
| Japan | 16 | 232 | 758 | 659 | 1,246 | 1,682 |
| Others | 1,697 | 8,452 | 5,970 | 10,234 | 10,477 | 14,777 |
| Total | 6,268 | 27,196 | 34,121 | 44,686 | 48,273 | 63,078 |

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 4.--Aluminum mill products: Imports for consumption, by types of products, 1966

| TSUSA item no. | Article description | Quantity | Value | Unit value |
|---|---|---|---|---|
| | | 1,000 pounds | 1,000 dollars | Per pound |
| | Wrought rods: | | | |
| 618.1520 | Under 0.375 inch in diameter | 1,622 | 647 | $0.40 |
| 618.1540 | 0.375 inch or more in diameter | 22,968 | 8,285 | .36 |
| 618.1700 | Wrought angles, shapes, and sections | 2,049 | 1,005 | .49 |
| | Wire: | | | |
| 618.2000 | Not coated or plated with metal | 2,441 | 858 | .35 |
| 618.2200 | Coated or plated with metal | 1/ | 1/ | 1/ |
| | Wrought bars, plates, sheets, and strip, whether or not cut, pressed or stamped to nonrectangular shapes: | | | |
| | Not clad: | | | |
| 618.2520 | Circles and discs | 25,194 | 7,994 | .32 |
| 618.2540 | Bars | 4,824 | 1,912 | .40 |
| 618.2560 | Plates, sheets, and strip | 179,869 | 52,731 | .29 |
| 618.2580 | Other | 5,275 | 1,887 | .36 |
| | Clad: | | | |
| | Wholly of aluminum: | | | |
| 618.2720 | Circles and discs | 254 | 74 | .29 |
| 618.2740 | Plates, sheets, and strip | 1,812 | 653 | .36 |
| 618.2760 | Other | 1,064 | 461 | .43 |
| 618.2900 | Other | 1/ | 1/ | 1/ |
| | Powder and flakes: | | | |
| 618.4000 | Flakes | 468 | 243 | .52 |
| 618.4200 | Powder | 515 | 177 | .34 |
| | Pipes and tubes and blanks therefor, pipe and tube fittings: | | | |
| 618.4700 | Other than hollow cast extrusion ingots | 1,179 | 710 | .60 |
| | Total | 249,534 | 77,637 | .31 |

1/ There were no imports in 1966.

Source: Compiled from official statistics of the U.S. Department of Commerce.

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Table 5.--Aluminum bars, sheets, plates and strip (including nonrectangular blanks), and rods: U.S. imports for consumption by sources, 1958 and 1962-66

| Source | 1958 | 1962 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|---|
| | Quantity (1,000 pounds) | | | | | |
| Belgium | 18,213 | 26,979 | 29,126 | 38,526 | 60,266 | 93,394 |
| France | 5,589 | 13,427 | 10,088 | 10,528 | 13,351 | 21,891 |
| Japan | 3,944 | 11,460 | 10,383 | 10,766 | 16,094 | 39,726 |
| Italy | 7,784 | 8,759 | 7,245 | 14,283 | 16,256 | 25,297 |
| West Germany | 4,135 | 7,489 | 5,069 | 5,988 | 3,098 | 10,280 |
| Canada | 6,237 | 22,791 | 5,022 | 6,316 | 7,989 | 12,481 |
| United Kingdom | 3,558 | 14,021 | 5,183 | 1,015 | 1,928 | 9,344 |
| Yugoslavia | 1,309 | 4,872 | 2,836 | 4,097 | 4,924 | 10,513 |
| Spain | - | 2,939 | 2,832 | 3,135 | 2,498 | 2,021 |
| Austria | 2,217 | 2,661 | 2,054 | 2,521 | 2,729 | 4,412 |
| Others | 2,906 | 2,978 | 2,587 | 2,248 | 1,734 | 13,523 |
| Total | 55,892 | 118,376 | 82,425 | 99,423 | 130,867 | 242,882 |
| | Value (1,000 dollars) | | | | | |
| Belgium | 6,015 | 8,230 | 8,017 | 10,309 | 15,655 | 26,281 |
| France | 2,161 | 5,172 | 3,781 | 3,987 | 4,882 | 8,353 |
| Japan | 1,331 | 3,682 | 3,084 | 3,271 | 4,651 | 11,253 |
| Italy | 2,668 | 2,806 | 2,221 | 4,230 | 4,709 | 7,309 |
| West Germany | 1,755 | 2,569 | 1,903 | 1,868 | 1,230 | 3,901 |
| Canada | 2,675 | 6,347 | 1,617 | 1,993 | 2,722 | 4,584 |
| United Kingdom | 1,245 | 3,817 | 1,528 | 323 | 558 | 2,969 |
| Yugoslavia | 418 | 1,667 | 981 | 1,348 | 1,696 | 3,515 |
| Spain | - | 939 | 830 | 877 | 666 | 584 |
| Austria | 752 | 880 | 656 | 819 | 936 | 1,586 |
| Others | 1,164 | 1,037 | 806 | 719 | 571 | 4,311 |
| Total | 20,184 | 37,146 | 25,424 | 29,744 | 38,276 | 74,644 |

Source: Compiled from official statistics of the U.S. Department of Commerce.

| Commodity | TSUS item |
|---|---|
| Beryllium ore | 601.09 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

The United States, by far the world's largest consumer of beryllium ore, imports most of the world's production. Domestic production is insignificant. Consumption of beryllium ore depends largely on requirements for beryllium metal, alloys, and ceramics in atomic energy and aerospace activities. Exports have been nil or negligible.

## Description and uses

Beryllium ore is used primarily in the production of beryllium metal, alloys and compounds; small quantities are also ground and used in making ceramics. Although beryllium products have a wide range of industrial applications, they derive a major part of their importance from applications in the U.S. atomic energy and aerospace programs.

Virtually all beryllium ore currently mined is composed of the mineral beryl, essentially a beryllium-aluminum silicate. Domestic beryl is usually found in crystal form and is most frequently separated from associated minerals by hand; ore separated in this way is called hand-cobbed beryl. All imports consist of hand-cobbed beryl. Imported and domestic beryl ores are basically of the same quality, containing an average of 11 percent beryllium oxide, or about 4 percent of the element beryllium. Mining economy usually requires that associated minerals be mined along with beryl. Because of the high cost of mining beryl domestically, virtually all ore consumed in the United States is imported.

Bertrandite and phenakite are the only other beryllium minerals known to be used--and they have been used in very minor quantities--as ores of beryllium. Considerable exploration and research in recent years, however, have delineated large U.S. reserves of these two minerals, particularly bertrandite, and evolved methods of utilizing those reserves. Hence, these minerals may prove to be the ores of the future.

Associated summaries are those on beryllium metal, alloys, waste and scrap (items 628.05 and 628.10) discussed elsewhere in volume 6:1, and beryllium compounds (items 417.90 and 417.92) in volume 4:2.

In this summary all quantities are expressed in terms of short tons (2,000 pounds).

## U.S. tariff treatment

Beryllium ore enters the United States duty-free. The duty-free status was bound under the General Agreement on Tariffs and Trade (GATT), effective January 1, 1948; the binding was reaffirmed in the sixth round of trade negotiations under the GATT, effective January 1, 1968.

## U.S. consumption

Notwithstanding that beryllium ore has a number of miscellaneous industrial uses, U.S. requirements for such ore have been determined primarily by the direct and indirect purchases of beryllium products by the U.S. Government. Beryllium ore has been the raw material for filling the needs of the Atomic Energy Commission for beryllium metal and for supplying the Commodity Credit Corporation (CCC) with beryllium metal and alloys for stockpiling under barter contracts. CCC barter contracts have involved the exchange of surplus U.S. agricultural products for imported beryl, which was converted domestically into beryllium metal and beryllium copper master alloy. Consumption of beryllium ore was likewise stimulated by other Government needs, particularly in defense and aerospace programs, for finished products utilizing beryllium metal, alloys and beryllium oxide ceramics.

Consumption of beryllium ore in the United States, by far the world's largest consumer, totaled almost 9,400 short tons in 1961, but declined irregularly thereafter (see table 1). Consumption of ore in 1964 dropped sharply, to less than half that in 1961, partly as a result of the termination of large Government barter contracts for beryllium metal. Consumption in 1965, however, with none consumed for stockpiled products, was almost a third above that in 1964, and in 1966 it was even higher. The signing of substantial CCC barter contracts for beryllium metal in September 1966 will further increase ore consumption.

U.S. producers

Between 1952 and 1962, U.S. producers sold beryl ore to the General Services Administration under a domestic purchase program at prices from 4 to 56 percent higher than the prices of U.S. imports. Most U.S. mines, situated principally in the Western States, were small, many of them worked by one man, and individual mine output was irregular. With the expiration of the domestic purchase program in 1962, the number of ore producers--100 to 200--declined to probably fewer than half a dozen.

Commercial ores other than beryl were produced by one company from mines in Colorado during 1960-63. Another company purchased these low-grade ores (with an average beryllium oxide content of 3 to 5 percent), containing a mixture of bertrandite, beryl, and phenakite, and concentrated them for the production of beryllium compounds.

U.S. production

Domestic mine shipments of beryllium ore consisted almost exclusively of cobbed beryl until 1958, when shipment of the low-grade ores referred to above was initiated. Shipments in 1958-63, by type, are indicated in the following table (in short tons, gross weight):

| Year | Cobbed beryl | Low-grade beryllium ore | Total |
|---|---|---|---|
| 1958 | 463 | 42 | 505 |
| 1959 | 328 | 97 | 425 |
| 1960 | 244 | 265 | 509 |
| 1961 | 317 | 805 | 1,122 |
| 1962 | 218 | 760 | 978 |
| 1963 | 1 | 750 | 751 |

Data on shipments of beryl in 1964-65 were not published because publication would have disclosed the operations of individual concerns, but they are known to have been insignificant; shipments of low-grade ores were nil. Virtually all cobbed beryl shipped after the termination of the Government's domestic purchase program in 1962--at least until 1966--was ground and used for special ceramic purposes. In 1966, South Dakota produced 124 tons of beryl, and Colorado produced a small additional quantity.

During 1961, the last full year of Government purchases under the purchase program, domestic mine shipments of cobbed beryl ore were equivalent to only about 3 percent of domestic consumption.

## U.S. exports

Exports in 1961-64 were insignificant, ranging between 28 pounds, valued at $600, in 1964 and 1,000 pounds, valued at $3,000, in 1962; apparently all exports have consisted of processed beryl concentrates. In 1965-66, exports were not separately reported and are estimated to have been nil or negligible.

## U.S. imports

U.S. annual imports of beryllium ore (all beryl) in 1961-62 averaged more than 8,500 tons, valued at about $2.8 million. Imports of ore declined in 1963 and 1964, rose in 1965, then declined sharply in 1966 to 2,100 tons, valued at $0.6 million (table 2). During the 1958-66 period, most imports came from Brazil, Argentina, Mozambique, Uganda, India, the Congo, the Republic of South Africa, and Australia. Brazil, India, and Argentina were the largest single sources in 1966. Imports from India have been infrequent because of the nature of Indian Government controls over exports of beryl. Argentina and Brazil also control their exports of beryl.

U.S. Government stocks of beryl ore as of December 31, 1966, amounted to 28,213 tons--12,998 tons in excess of the conventional war objective of 15,215 tons. The largest part of this stockpile was imported. The Government has announced its intention of releasing excess stockpiled materials. An additional substantial quantity of beryl is stockpiled in the form of beryllium copper master alloy and beryllium metal; 2,637 tons of the stockpiled alloy are in excess of the objective of 4,750 tons, and 3 tons of the unalloyed metal are in excess of the objective of 150 tons.

## Foreign production and trade

Most foreign production of beryl ore--with the exception of the output by the U.S.S.R., estimated at 1,200 tons in 1966--has been mined to implement agreements with U.S. purchasers. World production of beryl in 1966 was estimated at 3,500 tons, representing a decline of 73 percent below the 1961 peak of 12,900 tons. In addition to the U.S.S.R., the principal producing countries in 1966 were Brazil (with about 877 tons), India (with about 500 tons), Uganda (249 tons), Argentina (218 tons), Rwanda (147 tons), Rhodesia (72 tons), and Mozambique (71 tons).

Several foreign countries also import beryl ore. France, the largest importer among them, Japan, the United Kingdom, West Germany, and Italy have all produced beryllium products from imported beryl.

Table 1.--Beryllium ore: U.S. mine shipments, imports for consumption, and consumption, 1961-66

(In short tons)

| Item | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|---|
| Mine shipments: | | | | | | |
| Cobbed beryl 1/ | 317 | 218 | 1 | 2/ | 2/ | 2/ |
| Low-grade beryllium ore 3/ | 805 | 760 | 750 | - | - | - |
| Total shipments | 1,122 | 978 | 751 | 2/ | 2/ | 2/ |
| Imports | 8,516 | 8,552 | 6,243 | 5,425 | 7,791 | 2,147 |
| Consumption-- | | | | | | |
| For products for the national stockpile 4/ | 1,000 | 2,400 | 2,700 | 140 | - | - |
| For other products 5/ | 8,392 | 5,358 | 5,234 | 4,295 | 5,845 | 6,026 |
| Total consumption | 9,392 | 7,758 | 7,934 | 4,435 | 5,845 | 6,026 |

1/ Containing an average of 11 percent beryllium oxide (BeO) or about 4 percent beryllium (Be). Virtually all of this material in 1961 and 1962 was shipped to the national stockpile.

2/ Data not published because publication would disclose operations of individual concerns; mine shipments in 1964 and 1965 are known to be minor, but in 1966, 124 tons of beryl was shipped from South Dakota alone, plus a small additional amount from Colorado.

3/ Containing an average of 3 to 5 percent beryllium oxide, or about 1 to 2 percent beryllium.

4/ Estimated; the ore was converted into beryllium and beryllium-copper master alloy.

5/ Estimated.

Source: Mine shipments and total consumption (including ore converted into products for stockpiling) compiled from official statistics of the U.S. Bureau of Mines, except as noted; imports compiled from official statistics of the U.S. Department of Commerce.

Note.--Data on value of domestic mine shipments and consumption are not available and data on value of imports are shown in table 2. Exports were nil or negligible.

Table 2.--Beryllium ore: U.S. imports for consumption, by principal sources, 1961-66

| Source | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|---|
| | Quantity (short tons) | | | | | |
| Argentina | 1,117 | 997 | 718 | 429 | 257 | 218 |
| Australia | 313 | 239 | 123 | 242 | 1,498 | 41 |
| Brazil | 2,661 | 3,715 | 2,280 | 1,895 | 1,171 | 877 |
| Congo (Kinshasa) 1/ | 220 | 485 | 510 | 224 | 1,368 | - |
| India | 885 | 150 | - | - | 1,507 | 500 |
| Malagasy Republic | 564 | 293 | 323 | 297 | 77 | 10 |
| Mozambique | 1,094 | 678 | 850 | 716 | 295 | 70 |
| Republic of South Africa | 445 | 519 | 394 | 659 | 514 | 74 |
| Rhodesia 2/ | 188 | 322 | 347 | 384 | 101 | 72 |
| Uganda 3/ | 1,029 | 1,043 | 664 | 411 | 413 | 129 |
| All other | - | 111 | 34 | 4/ 168 | 5/ 590 | 6/ 156 |
| Total | 8,516 | 8,552 | 6,243 | 5,425 | 7,791 | 2,147 |
| | Value (1,000 dollars) | | | | | |
| Argentina | 417 | 328 | 206 | 106 | 54 | 53 |
| Australia | 91 | 82 | 33 | 61 | 384 | 10 |
| Brazil | 888 | 1,316 | 635 | 490 | 309 | 232 |
| Congo (Kinshasa) 1/ | 64 | 146 | 135 | 53 | 347 | - |
| India | 247 | 46 | - | - | 543 | 178 |
| Malagasy Republic | 189 | 90 | 89 | 72 | 17 | 2 |
| Mozambique | 337 | 225 | 203 | 179 | 63 | 14 |
| Republic of South Africa | 135 | 152 | 107 | 179 | 114 | 16 |
| Rhodesia 2/ | 55 | 99 | 91 | 98 | 19 | 17 |
| Uganda 3/ | 363 | 378 | 169 | 99 | 96 | 26 |
| All other | - | 35 | 4 | 4/ 35 | 5/ 110 | 6/ 33 |
| Total | 2,786 | 2,897 | 1,672 | 1,372 | 2,056 | 581 |

1/ Belgian Congo until June 30, 1960; the capital, Leopoldville, was renamed Kinshasa on July 1, 1966. Prior to Jan. 1, 1964, included Burundi and Rwanda, also sources of ore.

2/ Prior to 1966, statistics include imports from Zambia and Malawi.

3/ Prior to Jan. 1, 1964, Uganda was part of British East Africa, which also included Kenya (a source of ore in 1965).

4/ Includes 101 tons, valued at 20 thousand dollars, from Burundi and Rwanda.

5/ Includes 254 tons, valued at 44 thousand dollars, from Kenya and 167 tons, valued at 30 thousand dollars, from Burundi and Rwanda.

6/ Includes 88 tons, valued at 19 thousand dollars, from Burundi and Rwanda.

Source: Compiled from official statistics of the U.S. Department of Commerce.

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| Commodity | TSUS item |
|---|---|
| Beryllium metal and alloys: | |
| Unwrought, and waste and scrap | 628.05 |
| Wrought | 628.10 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

The United States is the world's largest producer and consumer of beryllium metal. Imports of beryllium metal, unwrought and wrought, have always been relatively small. Importation began in 1960 on a small scale and imports gradually grew to a foreign value of over half a million dollars in 1966; new domestic capacity will probably replace imports within the next decade. Exports of beryllium metal have declined in recent years and since 1963 their value has been considerably smaller than that of imports.

## Description and uses

Beryllium metal and beryllium alloys.--For tariff purposes, metal having a beryllium content of less than 99 percent by weight but in which the beryllium is not less than any other element is classified as an alloy. Beryllium metal has a unique combination of properties which are very important in the aerospace program and in the production of nuclear energy. A gray metal almost as light in weight as magnesium, beryllium has great strength and a high degree of stiffness, a high melting point, a large capacity to absorb heat, high heat of combustion, excellent thermal and electrical conductivity, resistance to oxidation and distortion under stress, and high permeability to X-rays. Beryllium is an excellent moderator of neutrons (it slows them to the thermal state required for nuclear fission), and it also has the lowest thermal neutron absorption rate of all metals (and therefore may be used to confine thermal neutrons). Some of these qualities of the elemental metal are retained in its alloys and compounds.

In the United States, most beryllium metal is made by chemically treating beryllium ore to derive beryllium hydroxide, converting the hydroxide to beryllium fluoride, and reacting the fluoride with magnesium metal in a vacuum furnace. The resulting impure beryllium metal, which is in the form of beads or pebbles, is vacuum-melted to remove impurities such as slag and magnesium, and then cast into ingots of about 99-percent purity. Because the coarse crystallinity of most

cast ingots gives them very poor machine-working qualities, they are machined to chips which are ground to fine powder, and the powder is hot-pressed in a vacuum into dense, fine-grained shapes known as hot-pressed blocks or billets. This change from coarse to fine in the microstructure of the metal permits it to be worked into various shapes and forms. 1/ By relatively new methods, some beryllium sheet is rolled directly from refined, fine-grained cast ingot; this sheet is more easily formed than conventional sheet made from hot-pressed block, but it is not as strong. Beryllium metal is also rolled to thin foil, drawn to fine wire, and extruded to rod, bar, tube, and other forms.

Among the steadily widening uses of beryllium metal, aerospace uses have become the most dominant, whereas atomic energy uses, formerly the most significant, have declined in importance. Aerospace uses of beryllium metal include instrumentation and guidance components, heat shields, and structural members, such as the skin of the Agena D space vehicle. Beryllium powder is being used experimentally as a rocket fuel, but problems of toxicity have retarded progress in that sphere. In atomic energy applications, beryllium is best known for its uses in reactor cores and in reflectors enveloping reactor cores; at times, beryllium oxide ceramics have been used for these purposes in lieu of the metal. Some other uses are in windows in X-ray machines optical mirrors, airplane and auto brake discs, and gas turbine engine parts. At present there is only one commercial series of alloys in which beryllium predominates by weight--Lockalloy, which contains from 24 to 43 percent aluminum with the rest beryllium. These beryllium-aluminum alloys are reported to be more machinable than beryllium metal and less costly, yet they retain many of the properties of beryllium. Lockalloy is relatively new, and its potential is still being tested by prospective users.

Beryllium metal waste and scrap are minor items of trade; they are processed and converted to beryllium powder.

Other alloys containing beryllium.--Most alloys of which beryllium is a significant constituent contain only small quantities of beryllium and for the purposes of the Tariff Schedules of the United States are classified as alloys of the metals of chief weight. These alloys (not covered by this summary) are produced by the manufacturers of beryllium metal, which are specially prepared to handle this toxic material, and the beryllium component of these alloys accounts for a large part of their value. They include: beryllium aluminum master alloy (item 618.06 covered elsewhere in volume 6:1) which contains 5 percent beryllium and is mainly used to add beryllium to aluminum alloys in small

1/ Beryllium dust and powder are toxic when inhaled or in prolonged external contact with the body; therefore, producers must have special ventilating equipment and require workers to follow accepted safety practices at a considerable increase in manufacturing costs.

quantities (0.01 to 0.1 percent) to improve their castability; beryllium nickel alloys (item 620.03, covered in volume 6:2) which have been used for diamond drill bits, clarinet keys, surgical instruments, and special dies; and beryllium magnesium aluminum (item 618.06).

The most widely used beryllium-containing alloys are the beryllium copper alloys, which contain from 0.25 to 4.4 percent beryllium with the balance mainly copper; they exhibit excellent properties of hardness, stiffness, thermal and electrical conductivity, and wear resistance, and are nonsparking and nonmagnetic. Beryllium copper master alloy ingot (item 612.20 covered in volume 6:2), usually containing 4 to 4.25 percent beryllium, is made by melting a mixture of beryllium oxide, carbon, and copper. This master alloy is then diluted to various alloy compositions averaging about 1.9 percent beryllium content. These alloys are less expensive than most other beryllium-containing alloys because they need not be made from the metal.

Beryllium copper alloys are worked by conventional metalworking methods from ingots into various wrought forms, such as sheet, strip, rod, wire, forgings, extrusions, and tubing. Some uses of these alloys are in electrical contacts, springs, nonsparking tools, marine propellers, gears, space vehicle antennae, and aircraft engine parts.

Beryllium ore (item 601.09) is discussed in a separate summary elsewhere in volume 6:1; and beryllium compounds are covered in a summary for items 417.90 and 417.92 in volume 4:2.

In this summary all quantities are expressed in pounds.

## U.S. tariff treatment

The column 1 (or trade-agreement) rates of duty applicable to imports (see general headnote 3 in the TSUSA-1968) are as follows (in percent ad valorem):

| TSUS item | Commodity | Prior rate | U.S. concessions granted in 1964-67 trade conference (Kennedy Round) | |
|---|---|---|---|---|
| | | | First stage, effective Jan. 1, 1968 | Final stage, effective Jan. 1, 1972 |
| | Beryllium metal and alloys: | | | |
| 628.05 | Unwrought, and waste and scrap. | 17% | 15% | 8.5% |
| 628.10 | Wrought | 18% | 16% | 9% |

The tabulation above shows the column 1 rates of duty in effect prior to January 1, 1968, and modifications therein as a result of concessions amounting to a reduction of 50 percent in duties granted by the United States in the sixth round of trade negotiations under the General Agreement on Tariffs and Trade (GATT). Only the first and final stages of the five annual rate modifications are shown above (see the TSUSA-1968 for the intermediate staged rates).

The rate of 15 percent ad valorem, effective January 1, 1968, for unwrought beryllium metal and beryllium waste and scrap is a reduction from 17 percent ad valorem, the final stage of a concession rate granted by the United States under the GATT effective July 1, 1963 (and which remained unchanged when the TSUS became effective on August 31, 1963); prior to July 1, 1963, the rate had been 21 percent ad valorem, effective June 30, 1958, as a result of negotiations under the GATT. The rate of 16 percent ad valorem for wrought beryllium metal, derived from paragraph 397 of the previous tariff schedules, is a reduction from 18 percent ad valorem, the final stage of a concession rate granted by the United States under the GATT effective July 1, 1963 (which also remained unchanged by the TSUS); prior to that date, the rate had been 22.5 percent ad valorem, effective January 1, 1948, also as a result of negotiations under the GATT. (Beryllium ore is imported free of duty).

The duty on waste and scrap has been suspended until June 30, 1969, by Public Law 90-45, the latest in a series of public laws which initially suspended the duty on certain metal scrap on March 14, 1942, and, except for the period from July 1, 1949, to September 30, 1950, have continued the suspension to the present.

U.S. consumption

The United States is the free world's largest consumer and producer (from imported raw materials) of beryllium metal and alloys, which are used principally in its atomic energy and aerospace industries. By purchasing large quantities of metal and alloys for use by the Atomic Energy Commission and for stockpiling, and by purchasing articles and equipment utilizing beryllium metal and alloys, the U.S. Government has been the main stimulus to the beryllium industry. Although principal consumption of these products heretofore has resulted from U.S. Government projects, commercial consumption will become increasingly important as peacetime uses of nuclear energy expand and commercial aviation enters the supersonic era.

Beryllium is a high-cost metal with values ranging from $54 to $71 a pound of unwrought metal, depending on its physical state. Although consumption of beryllium metal has increased considerably since 1958, the high price and beryllium's toxicity have undoubtedly

tended to limit the consumption of the metal. Statistical data on consumption and production of beryllium metal and alloys are not published because they would reveal the operations of individual producers.

## U.S. producers

Most of the world's production of beryllium metal and alloys is the output of two integrated producers in the United States. Most activities of these two producers, one operating at two plants in Pennsylvania and the other at two plants in Ohio, concern the production and sale of beryllium metal, alloys, compounds, and ceramics in unwrought and wrought form.

There are two smaller domestic producers of beryllium metal with plants in Yonkers, N.Y., and Bessemer City, N.C. The New York plant produces beryllium hot-pressed block and semifabricated and fabricated forms from imported electrolytic flake and powder. The North Carolina plant produces electrorefined metal and semifabricated and fabricated forms from beryllium scrap.

A number of domestic concerns fabricate beryllium in addition to other metals, but for most, beryllium fabrication represents only a small part of their activities.

## U.S. production

Domestic producers' sales consist largely of beryllium metal and beryllium copper alloys (for which separate statistics are not available). For this reason, the trend of domestic production of beryllium metal and alloys may be gaged adequately by the value of total net sales of the two major producers as shown below (in millions of dollars):

| | | | |
|---|---|---|---|
| 1958 | 27.4 | 1963 | 52.5 |
| 1959 | 39.3 | 1964 | 47.2 |
| 1960 | 53.0 | 1965 | 52.2 |
| 1961 | 49.7 | 1966 | 71.2 |
| 1962 | 49.7 | | |

Producers' net sales were lower in 1964 than in 1963 mainly because stockpile deliveries of beryllium metal to the Government were almost completed in 1963. During the latter part of 1966, new barter contracts calling for delivery to the U.S. Government for stockpiling of a total of 150,000 pounds of beryllium metal by the two integrated producers were granted by the Commodity Credit Corporation; the beryl used as a raw material is to come from India in exchange for cotton. Stockpile inventories of beryllium metal totaled 153 tons as of December 31, 1966; this is 3 tons in excess of the stockpile objective for conventional warfare. Beryllium metal comprised the major portion of the total value of net sales of all beryllium products of these companies. Wrought articles of beryllium (including metal, alloy, and ceramics) accounted for about three-quarters of the value of net sales of all beryllium products of these companies in the years 1960-61 (more recent information is not available).

U.S. annual capacity for producing beryllium metal from ore was estimated early in 1962 at 660,000 pounds; production in 1962, a depressed period, was estimated at 50 percent of the annual capacity. Current production capacity has not been reported but is believed to be about the same.

U.S. exports

Most exports of beryllium products consist of unwrought low-beryllium-content alloys of copper and aluminum, and beryllium compounds. Published statistics through 1964 combine exports of unwrought beryllium metal and waste and scrap with those of unwrought beryllium alloys; analysis of these data indicates that most, if not all, of the exports consisted of alloys with low beryllium content not within the purview of this summary.

Exports of wrought beryllium metal, unlike imports, have declined in recent years (see table 1). Exports of wrought beryllium metal were largest in 1959 and 1960, when Belgium and the United Kingdom were the principal markets. In the 1958-64 period, the United Kingdom was the largest single recipient, and Canada and West Germany were also regular export markets. Beryllium exports to France began in 1963. In 1964, however, the value of U.S. exports of wrought beryllium metal was only $48,000, or 61 percent less than in the preceding year.

Beginning in 1965, published statistics combine exports of unwrought and wrought beryllium metal and alloys, and waste and scrap. Such statistics for 1965 and 1966 indicate increased exports of unwrought metal, notably to Japan.

U.S. imports

Imports of unwrought beryllium metal, consisting mainly of powder, apparently first entered the United States in 1960; they rose rapidly, from an estimated value of $24,000 in 1960 to $510,000 in 1966, as shown in table 1. Imports of beryllium metal were not separately reported until September 1963. Up to that time the statistics of imports of unwrought beryllium were combined with those on imports of cesium, potassium, and sodium; it is estimated by the staff of the Tariff Commission that all imports of beryllium metal during the time that the statistics were combined came from France and that no other metal within the group came from France. Subsequent imports of beryllium metal were all from France except in 1965 when a small quantity came from the United Kingdom. (See table 2; most imports recorded therein from the United Kingdom, Spain, and Japan consisted of scrap, as indicated by the relatively low values.) All beryllium metal imported from France was made electrolytically. Beryllium metal scrap has been imported from foreign customers of U.S. producers of beryllium metal products, but the value of such imports has been small.

Imports of wrought beryllium metal, consisting of discs, bars, and other forms, totaled 36 pounds valued at $22,290 in 1964, the first full year for which such data were separately reported; France was the only source. In 1965, although France supplied almost all imports, totaling 54 pounds valued at $6,885, negligible quantities were also received from Canada, Italy, and the United Kingdom. Imports of wrought beryllium metal in 1966 totaled 550 pounds valued at $35,723, all from France.

Foreign production and trade

The United States and France are probably the only regular commercial producers of beryllium metal in the free world. French production totaled 31,500 pounds in 1964, about a third less than the 47,000 pounds produced in 1960. Exports from France in 1964 totaled 11,000 pounds, of which about 80 percent went to the United States, and most of the remainder to the United Kingdom. French exports in 1965 likewise went principally to the United States, and to a lesser extent to the United Kingdom and West Germany.

The United Kingdom has produced beryllium metal within recent years, curtailing or suspending production with changes in nuclear requirements. Japan produces very small quantities of beryllium for its own use; it also imported some from the United States in 1964-66.

Table 1.--Beryllium metal, unwrought and wrought: Exports of domestic merchandise and imports for consumption, 1958-66

| Year | Exports of beryllium metal, wrought | Imports of beryllium metal | |
|---|---|---|---|
| | | Unwrought 1/ | Wrought |
| | Quantity (pounds) | | |
| 1958 | 200 | - | 2/ |
| 1959 | 5,313 | - | 2/ |
| 1960 | 6,062 | 735 | 2/ |
| 1961 | 692 | 1,319 | 2/ |
| 1962 | 1,217 | 1,804 | 2/ |
| 1963 | 774 | 3,119 | 2/ |
| 1964 | 222 | 7,503 | 36 |
| 1965 | 2/ | 8,347 | 3/ 54 |
| 1966 | 2/ | 9,323 | 550 |
| | Value | | |
| 1958 | $28,280 | - | 2/ |
| 1959 | 389,614 | - | 2/ |
| 1960 | 506,002 | $23,722 | 2/ |
| 1961 | 149,005 | 74,501 | 2/ |
| 1962 | 100,044 | 110,310 | 2/ |
| 1963 | 123,229 | 161,202 | 2/ |
| 1964 | 47,929 | 405,428 | $22,290 |
| 1965 | 2/ | 468,086 | 6,885 |
| 1966 | 2/ | 509,629 | 35,723 |

1/ Imports of unwrought metal were not separately reported until September 1963; up to that time, data on imports of unwrought beryllium were combined with data for imports of cesium, potassium, and sodium. It is estimated by the staff of the Tariff Commission that all imports of beryllium metal during the time that the statistics were combined came from France and that no other metal within the group came from France. Statistics shown here for later periods reflect exclusions by the staff of the Tariff Commission to correct data.

2/ Not available.

3/ Represents data from the U.S. Department of Commerce corrected by the staff of the Tariff Commission.

Source: Official statistics of the U.S. Department of Commerce, except as noted.

Note.--Data on production and consumption are not published because publication would disclose data for individual producers. Published statistics for 1958-64 do not segregate data on exports of unwrought beryllium metal from data on exports of waste and scrap and of beryllium containing alloys. Analysis of these data indicates that exports of the unwrought products consisted largely of alloys with a low beryllium content. Official statistics for 1965-66 combine data for exports of unwrought products with those for wrought products.

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Table 2.--Beryllium metal, unwrought, and waste and scrap: U.S. imports for consumption, by sources, 1964-66

| Source | 1964 | 1965 | 1966 |
|---|---|---|---|
| | Quantity (pounds) | | |
| United Kingdom | 7,210 | 99 | 6,770 |
| France | 7,503 | 8,248 | 9,323 |
| Spain | 6,315 | - | - |
| Japan | - | 693 | - |
| Total | 21,028 | 9,040 | 16,093 |
| | Value | | |
| United Kingdom | $2,975 | $9,753 | $6,801 |
| France | 405,428 | 458,333 | 509,629 |
| Spain | 3,425 | - | - |
| Japan | - | 10,273 | - |
| Total | 411,828 | 478,359 | 516,430 |

Source: Compiled from official statistics of the U.S. Department of Commerce; statistics reflect exclusions by the staff of the Tariff Commission to correct data.

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| Commodity | TSUS item |
|---|---|
| Chrome ore | 601.15 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

Although the United States is the world's largest consumer of chrome ore, it does not produce any commercially; all requirements are filled by imports.

## Description and uses

Various grades of chrome ore are mined, but the principal mineral contained in all grades is chromite. Chromite is a black mineral which usually originates in massive form in peridotite or serpentine rocks. Basically, the mineral is composed, in varying percentages, of oxides of chromium, iron, aluminum, and magnesium within the formula $(Mg,Fe)(Cr,Al,Fe)_2O_4$. The purpose for which it is used depends on the chromic oxide ($Cr_2O_3$) content, the chrome-iron ratio, the combined content of chromic oxide and aluminum oxide, and physical characteristics. Chrome ore is used by the metallurgical, chemical, and refractory industries.

Metallurgical ore.--For metallurgical use, ore is preferred with a minimum chrome-iron ratio of 3:1 and 48 percent minimum chromic oxide content. In practice, all grades of chrome ore are used for metallurgical purposes and specific furnace feed analyses are achieved by blending. Chrome ore is used metallurgically to make chromium ferroalloys, which are used for alloying purposes, chiefly for making stainless steel; some stainless steel is made by the addition of chrome ore directly into steel furnaces. Chromium ferroalloys are also used to make chromium metal electrolytically. Other summaries cover chromium ferroalloys (items 607.30, 607.31, 607.55, and 607.80 in volume 6:3) and chromium metal (item 632.18 elsewhere in volume 6:1).

Although a decade ago lump ore was preferred for most metallurgical purposes, changing technology has created a demand for fines (small particles of ore) as well as ore concentrates in certain processes. Undoubtedly, these processes evolved in response to at least two factors: cost savings inherent in a switch from lump ore to lower priced fines and concentrates, and a dwindling of indicated reserves of high-grade lump ore.

Chemical ore.--For chemicals, the iron content of chrome ore is not important, whereas a high content of alumina and silica is undesirable. Largely for reasons of economy, the chemicals industry uses a South African ore known as Transvaal Grade B Friable with an average chromic oxide content of 45 percent; the friability of this ore facilitates the relatively fine grinding required for effective separation of the chromic oxide from the other constituents. Chrome products made by the chemicals industry include sodium dichromate, chrome oxide, lead chromate, and other chromium chemicals (all covered in schedule 4 of the TSUSA), which are used in chrome electroplating, leather tanning, textile processing, making pigments and aluminothermic chromium metal, and many other applications.

Refractory ore.--For refractories, the ore must have certain physical and chemical properties, including an appropriate content of combined chromic oxide and alumina, and a minimum content of iron and silica. For many years, producers of chrome refractories have used principally Philippine refractory ores containing about 32 percent chromic oxide. Cuban ores containing about 34 percent chromic oxide have also been used, but imports from Cuba ceased in 1961. South African concentrates with properties of chemical-grade ore have been used for a long time for a small output of chrome refractory mortars, and in recent years a South African ore similar in composition to chemical grade ore but with a lower content of silica has been utilized for refractory bricks and shapes by adding high-purity magnesia to the ore. The refractories industry uses chrome ore to make both chrome and chrome-magnesite bricks, shapes, and mortars for lining metallurgical and glassmaking furnaces, and cement kilns.

In this summary, all quantities are given in terms of short tons (2,000 pounds).

## U.S. tariff treatment

Imports of chrome ore are free of duty. The duty-free status, which was provided for in the original schedules of the Tariff Act of 1930, was bound in a concession granted by the United States in the General Agreement on Tariffs and Trade, effective in October 1951.

U.S. consumption

Annual U.S. consumption of chrome ore, which averaged less than 1.2 million short tons (gross weight) during 1961-63, rose to almost 1.6 million tons in 1965 and was almost 1.5 million in 1966 (see tabulation below). The increase in consumption was reflected not only in larger imports but also in a substantial reduction of industrial inventories, from 1.6 million tons at the end of 1963 to 1.1 million tons at the end of 1965 and 1.3 million at the end of 1966. The trend in annual consumption of chrome ore closely follows the trend of activity in the metallurgical industry. Not only is that industry by far the principal consumer of chrome ore in the United States, but it is also the largest market for chrome refractories. In 1966 the metallurgical industry accounted for 57 percent of total chromite consumption; the refractory industry, 30 percent; and the chemical industry, 13 percent. U.S. annual consumption of chrome ore, by industry, in 1961-66, as compiled from industry reports and published by the U.S. Bureau of Mines, is as follows (in gross weight, and average chromic oxide content):

| Year | Metallurgical industry | | Refractory industry | | Chemical industry | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Quantity | Percent $Cr_2O_3$ | Quantity | Percent $Cr_2O_3$ | Quantity | Percent $Cr_2O_3$ | Quantity | Percent $Cr_2O_3$ |
| | 1,000 short tons | | 1,000 short tons | | 1,000 short tons | | 1,000 short tons | |
| 1961 | 662 | 46.5 | 375 | 34.6 | 163 | 45.2 | 1,200 | 42.6 |
| 1962 | 590 | 46.6 | 365 | 35.0 | 176 | 45.3 | 1,131 | 42.7 |
| 1963 | 632 | 48.7 | 368 | 34.6 | 187 | 45.1 | 1,187 | 43.8 |
| 1964 | 832 | 49.0 | 430 | 33.8 | 189 | 45.1 | 1,451 | 44.0 |
| 1965 | 907 | 49.8 | 460 | 34.7 | 217 | 45.0 | 1,584 | 44.8 |
| 1966 | 828 | 49.6 | 439 | 34.6 | 194 | 44.9 | 1,461 | 44.5 |

U.S. producers

Chrome ore has not been mined in the United States on a regular commercial basis since 1880. Most production since that time has been in response to wartime Government purchase programs. Deposits of commercially acceptable chrome ore are small and far from consuming plants; such ore has been mined mainly in California and Oregon during this century. As many as 200 producers have been active in some years, but most of them accounted for very little output. Production of commercially acceptable ore for sale to the U.S.

Government under a purchase program designed to stimulate the development of domestic resources ceased in May 1958. Production of off-grade chrome concentrates from a large deposit in Montana continued until 1961, when the completion of a Government purchase contract terminated mining and milling activities.

## U.S. production

U.S. production of chrome ore (as indicated by shipments) reached a peak of 166,000 tons, valued at $7.8 million, in 1957. All of the 1957 output was purchased by the Government at incentive prices, and almost three-fourths of it consisted of off-grade concentrates from Montana, which were being mined under a 1953 contract calling for 900,000 tons to be supplied in 8 years. After the domestic chrome purchase program terminated, production from Montana continued until 1961, when shipment of 82,000 tons of ore to the Government completed the contract.

## U.S. exports

Exports of chrome ore classified as domestic merchandise have been minor and have consisted of processed concentrates derived from ore that originated abroad. The processing consists largely of grinding and blending the material, for refractory use. Such exports have fluctuated from year to year. In 1966 they totaled 19,000 tons, valued at $740,000 (table 1); 59 percent of the total quantity went to Canada, 35 percent to Mexico, and most of the rest to Brazil. Exports of chrome ore classified as foreign merchandise (material that left the country in the same condition it entered) have been considerably larger than those mentioned above, totaling 173,000 tons in 1966. By far the greatest portion of these exports (also called reexports) went to Canada and most of the remainder to Mexico. Most of the reexports in 1966 were shipped by U.S. refractories companies.

## U.S. imports

In 1961-66 all U.S. consumption of chrome ore was supplied by imports. Imports exceeded consumption during 1961-63 because of barter purchases of chrome ore from foreign sources by the U.S. Government for stockpiling. Government stocks of chrome ore on December 31, 1966, totaled 6.8 million short dry tons, consisting of over 4.3 million tons of metallurgical grade ore, over 1.2 million tons of refractory grade ore, and over 1.2 million tons of chemical grade ore. Possibly 1.5 million tons in Government stocks was of domestic origin, and the rest was imported. The total quantity of chrome ore in the Government stocks was substantially in excess of the total stockpile objective for conventional warfare, 4.5 million tons.

Average annual imports of chrome ore in 1961-66 were at a low level compared with those in the years during and after the Korean War, through 1957, because of (1) diminution of Government stockpiling of chrome ore and domestic ferrochromium and chromium metal, and (2) substantial imports of chromium ferroalloys and metal, which further reduced ore requirements.

Annual imports rose unevenly from 1.3 million tons, valued at $21 million in 1961 to 1.9 million tons, valued at $30 million, in 1966 (table 1).

Prior to August 31, 1963, official U.S. statistics on imports of chrome ore were classified according to traditional U.S. use patterns as refractory grade, chemical grade, and metallurgical grade. Foreign and U.S. usage of ore differ, however, and what the foreign exporter may regard as chemical ore may be used as high-grade metallurgical ore in the United States. Beginning with the effective date of the TSUS, August 31, 1963, therefore, the statistical division of chrome ore imports into different grades has been based solely on the chromic oxide content of the ore. The lowest category--ore "having a chromium content equivalent to not more than 40 percent chromic oxide ($Cr_2O_3$)"--consists principally of refractory ore from the Philippines (table 2). The middle category--ore "having a chromium content equivalent to more than 40 percent but less than 46 percent chromic oxide ($Cr_2O_3$)"--consists in major part of chemical ore from the Republic of South Africa, although substantial quantities have been imported from other African countries, principally Rhodesia (Southern Rhodesia prior to 1966). Ore in the highest category--that "having a chromium content equivalent to 46 percent or more chromic oxide ($Cr_2O_3$)"--has come chiefly from the U.S.S.R., Rhodesia and the Republic of South Africa.

In the 1961-66 period, the largest foreign suppliers of chrome ore were the Republic of South Africa, Rhodesia, the Philippines, the U.S.S.R., and Turkey. Imports from the U.S.S.R. increased tremendously in 1963 and have continued at a high level to the present. Annual imports from the U.S.S.R. in 1964-66 averaged 273,000 short tons, with a value of $5.4 million, compared with an annual average of 570,000 tons, valued at $6.8 million, from South Africa during the same period (table 2). Much of the ore imported from the U.S.S.R. has been among the highest grade known; it has also been attractive to the metallurgical industry because of its relatively low price. (Current nominal price quotations for various chrome ores are as low as $19 for South African 44-percent $Cr_2O_3$ ores and as high as $35 for Rhodesian ores containing 48 to 50 percent $Cr_2O_3$ with a 3.5:1 chrome-iron ratio. Turkish ores containing 48 percent $Cr_2O_3$ with a 3:1 chrome-iron ratio are quoted at $34.50 to $35.50. Russian ores containing 54 to 56 percent $Cr_2O_3$ with a 4:1 chrome-iron ratio are quoted at $36.50 to $40.00, up from $30.50 to $33.00 quoted prior to August 21, 1967). Importation of chromite from the U.S.S.R. has been

deemed necessary by U.S. producers of ferroalloys to enable them to compete with imported ferrochromium made from low-priced Russian ores. Because of the substantial income derived from large sales of chrome ore to the United States, the participation of the U.S.S.R. as a major supplier of chrome ore in the U.S. market in recent years has been of great concern to other supplying countries, especially to Rhodesia and Turkey.

In recognition of a British ban on exports of chrome ore from Rhodesia, the U.S. Government in early 1966 requested U.S. importers to stop buying chrome ore from that country. The United Nations Security Council brought mandatory economic sanctions against Rhodesia later in the year. Nevertheless, Rhodesian chrome ore has continued to arrive in the United States, presumably from large stockpiles accumulated at ports in Mozambique.

## Foreign production and trade

The world's largest reserves of chrome ore, estimated in billions of tons, are located in the Republic of South Africa. Reserves in Rhodesia are estimated at more than half a billion tons. Not surprisingly, therefore, South Africa was the free world's largest producer of chrome ore in 1961-66, and Rhodesia was among the top three or four producers, along with the Philippines and Turkey. Estimated production in the U.S.S.R. was the world's largest. Altogether, 27 countries produced chrome ore in 1961-66, 19 of them accounting for some production in every year. Very few were sizable producers, however; only seven, including Albania and Iran in addition to those mentioned, each produced more than 100,000 tons in 1966. World production in 1966 was estimated at almost 5.5 million tons.

Aside from exports to the United States, the trade in European chrome ores within Europe is considerable. African ores are exported to some of the European countries, as well as to the United States and Japan. Some Philippine ores also go to Europe, but most go to the United States and Japan, and some to Canada and Australia. Turkish ores go to Europe and the United States. The U.S.S.R. exports to the United States, Japan, and Europe.

Table 1.--Chrome ore: U.S. imports for consumption, exports of domestic and foreign merchandise, and reported consumption, 1961-66

(Quantities shown are gross weight)

| Year | Imports | | Exports | | | | Reported consumption |
|---|---|---|---|---|---|---|---|
| | | | Domestic merchandise | | Foreign merchandise | | |
| | Quantity | Value | Quantity | Value | Quantity | Value | |
| | 1,000 tons | 1,000 dollars | 1,000 tons | 1,000 dollars | 1,000 tons | 1,000 dollars | 1,000 tons |
| 1961 | 1,329 | 21,476 | 5 | 345 | 36 | 1,373 | 1,200 |
| 1962 | 1,446 | 23,700 | 3 | 108 | 51 | 2,033 | 1,131 |
| 1963 | 1,391 | 20,135 | 10 | 352 | 64 | 2,505 | 1,187 |
| 1964 | 1,428 | 22,713 | 6 | 241 | 32 | 1,256 | 1,451 |
| 1965 | 1,518 | 25,239 | 7 | 285 | 95 | 3,719 | 1,584 |
| 1966 | 1,864 | 30,379 | 19 | 740 | 173 | 7,119 | 1,461 |

Source: Compiled from official statistics of the U.S. Bureau of Mines.

Note.--In the 1961-66 period, chrome ore was produced in the United States only in 1961, when 82,000 tons was shipped to the Government for stockpiling.

Table 2.--Chrome Ore: U.S. imports for consumption, by grades and principal sources, 1965 and 1966

| Grade (by $Cr_2O_3$ content) and source | 1965 | | | 1966 | | |
|---|---|---|---|---|---|---|
| | Quantity | | Value | Quantity | | Value |
| | Gross weight | $Cr_2O_3$ content | | Gross Weight | $Cr_2O_3$ content | |
| | 1,000 short tons | 1,000 short tons | 1,000 dollars | 1,000 short tons | 1,000 short tons | 1,000 dollars |
| Not more than 40% $Cr_2O_3$: | | | | | | |
| Republic of the Philippines | 270 | 86 | 4,978 | 332 | 112 | 6,215 |
| Turkey | 7 | 3 | 96 | 40 | 15 | 489 |
| Republic of South Africa | 28 | 9 | 246 | 19 | 7 | 244 |
| All other | - | - | - | 7 | 3 | 25 |
| Total | 304 | 98 | 5,320 | 398 | 139 | 6,973 |
| More than 40%, less than 46% $Cr_2O_3$: | | | | | | |
| Turkey | 115 | 50 | 1,945 | 112 | 54 | 1,577 |
| Republic of South Africa | 339 | 148 | 3,397 | 594 | 263 | 6,853 |
| Rhodesia | 85 | 38 | 1,664 | 32 | 14 | 746 |
| All other | - | - | - | 59 | 25 | 832 |
| Total | 538 | 236 | 7,006 | 797 | 356 | 10,008 |
| 46% or more $Cr_2O_3$: | | | | | | |
| U.S.S.R | 242 | 134 | 4,782 | 281 | 155 | 5,866 |
| Turkey | 42 | 20 | 1,019 | 33 | 16 | 629 |
| Republic of South Africa | 115 | 55 | 1,887 | 184 | 91 | 3,497 |
| Rhodesia | 244 | 124 | 4,473 | 144 | 73 | 2,994 |
| All other | 34 | 19 | 752 | 27 | 13 | 412 |
| Total | 677 | 352 | 12,913 | 669 | 348 | 13,398 |
| All grades: | | | | | | |
| U.S.S.R | 242 | 134 | 4,782 | 302 | 164 | 6,324 |
| Republic of the Philippines | 279 | 91 | 5,146 | 332 | 112 | 6,215 |
| Turkey | 164 | 73 | 3,061 | 186 | 35 | 2,695 |
| Republic of South Africa | 481 | 213 | 5,529 | 797 | 361 | 10,594 |
| Rhodesia | 329 | 162 | 6,137 | 181 | 89 | 3,752 |
| All other | 23 | 12 | 584 | 66 | 30 | 799 |
| Grand total | 1,518 | 685 | 25,239 | 1,864 | 841 | 30,379 |

Source: Compiled from official statistics of the U.S. Bureau of Mines.

Note.--Total of all grades for individual countries may include imports of certain grades listed under "All other." Because of rounding, figures may not add to totals shown.

| Commodity | TSUS item |
|---|---|
| Chromium metal (other than alloys), unwrought, and waste and scrap---------- | 632.18 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

In recent years, imports have supplied an increasing share of the moderately rising domestic consumption of chromium metal. By 1963, the latest year for which consumption data are available, imports accounted for about 40 percent of the estimated quantity consumed. Exports of chromium metal have been minor.

## Description and uses

Chromium is a hard, brittle, corrosion-resistant metal with a high melting point. It is made commercially by two principal methods, the electrolytic and the aluminothermic. The electrolytic method employed in the United States uses high carbon ferrochromium as the source of chromium. The ferrochromium is dissolved in a solution of sulfuric acid and chromium alum, and the chromium metal is deposited on stainless steel cathode plates. The cathodes are removed from the solution and subjected to hammer blows that cause the brittle chromium metal to fall off the cathodes in pieces. The aluminothermic method used in the United States involves placing a mixture of chromic oxide and aluminum powder in an open crucible and igniting the mixture with a peroxide bomb; once ignited, the mixture provides its own heat to effect the reduction of the chromium. The large button of chromium metal formed at the bottom of each crucible is dumped onto the floor and broken up into little pieces by dropping a weight on it.

In general, electrolytic chromium, which contains a minimum of 99.5 percent chromium, is more pure than aluminothermic chromium, which has a minimum of 98.5 percent chromium; aluminothermic chromium, however, has a lower gas content and a higher density than electrolytic chromium. Either type of chromium metal may be used satisfactorily for many purposes, but aluminothermic metal is preferred for use in vacuum melting furnaces. By modifications of both processes, chromium metals are produced with various analyses suitable for special purposes. Electrolytic chromium is sold in the form of thin plates about one-eighth inch thick; aluminothermic chromium is sold in lumps up to 1 or 2 inches in length.

The bulk of the chromium metal is consumed in alloys, mostly steel alloys, to impart strength, hardness, and resistance to corrosion, oxidation, wear, and heat. More than half of the total consumption of chromium metal (55 percent of the total in 1962) is used in the production of high-temperature alloys. Chromium metal is used advantageously as an additive to steel, in lieu of lower-priced ferrochromium, to achieve maximum control of the amount of chromium added with no addition of iron. Ferrochromium, rather than chromium metal, is the principal source of chromium in making stainless steel. Chromium metal is also used as an additive in nonferrous alloys. It is used, for example, in making heating elements of chromium-nickel alloy with high electrical resistance and a high-melting point.

The uses of unalloyed chromium metal in end products are limited because of its extreme brittleness (except when made and used in a very pure state under laboratory conditions). The typical chromium finish on automobile parts and appliances is an electroplated coating obtained by using chromic acid rather than chromium metal as the source of chromium.

Chromic acid and other chromium chemical compounds are included in appropriate summaries for schedule 4 of the TSUSA. Other chromium commodities are discussed in summary volumes as follows: chromium ore (item 601.15) in volume 6:1; ferrochromium and ferrosilicon chromium (items 607.30, 607.31, and 607.55), exothermic chromium ferroalloys (item 607.80), other chromium alloys (item 632.84), and wrought chromium metal (item 633.00), are all discussed in volume 6:3. Chromium waste and scrap are not known to be articles of commerce.

In this summary all quantities are expressed in terms of pounds.

## U.S. tariff treatment

The column 1 (trade-agreement) rates of duty (see general headnote 3 in the TSUSA-1968) applicable to imports of chromium metal, unwrought, and waste and scrap (item 632.18) are shown below:

| | Rate of duty |
|---|---|
| Prior rate (before the concessions noted below)--- | 10.5% ad val. |
| Concessions granted by the United States in the 1964-67 trade conference (Kennedy Round): | |
| First stage, effective Jan. 1, 1968---------- | 9% ad val. |
| Fifth and final stage, effective Jan. 1, 1972- | 5% ad val. |

The prior rate of 10.5 percent ad valorem became effective on June 30, 1958, as a result of a concession granted by the United States in the General Agreement on Tariffs and Trade (GATT); it

remained unchanged when the TSUS became effective on August 31, 1963. As a result, however, of a further concession granted by the United States in the sixth round of trade negotiations under the GATT, the rate is being reduced to 5 percent ad valorem in five annual stages; the first stage, effective January 1, 1968, is a reduction to 9 percent (see the TSUSA-1968 for the intermediate staged rates).

The duty on waste and scrap of various metals, including chromium, is suspended to June 30, 1969 under item 911.12 of the TSUSA-1968 (Public Law 90-45); chromium waste and scrap, however, are not known to be articles of commerce.

## U.S. consumption

Statistics on U.S. consumption of chromium metal are not published because they would reveal the operations of the two producers. According to industry estimates made available for the period 1959-63, annual consumption of chromium metal increased from 3.5 million pounds in 1959 to 4.3 million pounds in 1963 (table 1). There was probably no significant change in the trend of consumption until 1966 when it apparently rose sharply, judging by the large increase in imports.

## U.S. producers

Chromium metal is produced in the United States by two domestic companies, one producing electrolytic chromium metal at Marietta, Ohio, and the other producing aluminothermic chromium metal at Newfield, N.J. A third company ceased production of aluminothermic chromium in 1960. Negligible quantities of special purpose, ultra-high purity metal are produced by two or three other companies. The production and sale of chromium metal is not the sole source of income for any domestic producer, not is such metal the sole product of any one plant.

## U.S. production

From available statistics on consumption and imports of chromium metal, it is estimated that annual production of chromium metal during 1959-63 was 2 million to 3 million pounds valued at roughly $2 million to $3 million. Production is believed to have been at about the same level in 1964-65 but is known to have increased substantially in 1966. The quoted minimum price of standard domestic chromium metal (both aluminothermic and electrolytic) was $1.15 a pound, delivered, throughout the 1959-65 period. U.S. producers reportedly competed with lower-priced imports by offering greater services rather than by reducing prices. In February 1966, however, the quoted price of standard

electrolytic metal was reduced to 96 cents a pound, f.o.b. shipping point, and aluminothermic metal was quoted at 98 cents a pound, delivered; these prices were in effect in December 1967.

U.S. exports

Published statistics on exports in 1959-64 combine figures for chromium metal with those for unwrought chromium alloys (except ferroalloys) and scrap thereof; statistics for 1965-66 include wrought metal and alloys also. The value of such combined exports in 1966 was $173,000, the highest annual total in the period 1959-66; the annual value of exports of chromium metal probably has been equal to less than 5 percent of that of imports.

U.S. imports

Imports of sizable quantities of chromium metal began in 1957, principally under U.S. Government barter contracts for stockpiling, and reached a peak of 5.7 million pounds in 1959. Of that total, only 0.8 million pounds was for industrial consumption (table 1). U.S. Government imports declined sharply after 1959 and ceased after 1961. 1/ Imports by industry grew annually except in 1964, when increased foreign demand reduced the quantity of chromium available for export to the United States. By 1966, imports totaled almost 5 million pounds. U.S. imports for industrial consumption increased from 22 percent of estimated consumption in 1959 to 40 percent in 1963, the latest year for which data on consumption are available without disclosing data for individual concerns.

Foreign productive capacity--increased to supply U.S. Government barter contracts--was in excess of foreign demand when such barter contracts were terminated in 1961. In an effort to utilize their productive capacity more fully, foreign producers offered chromium metal in the U.S. market at prices low enough to stimulate purchases by U.S. industry.

The average foreign value of commercial imports of chromium metal declined from 83.0 cents a pound in 1958 to 75.2 cents a pound in 1966. The landed cost (duty-paid) of commercial imports of chromium metal at New York City in 1966 was about 86 cents a pound.

1/ U.S. Government inventories of chromium metal, of both electrolytic and aluminothermic grades, on Dec. 31, 1966, totaled 16 million pounds; this quantity was 4.5 million pounds in excess of the stockpile objective (for conventional warfare) of 11.5 million pounds for both grades combined.

During 1959-66, virtually all imports of chromium metal were supplied by the United Kingdom, Japan, France, and West Germany (table 2). Europe supplied the aluminothermic chromium, and Japan supplied the electrolytic chromium.

## Foreign production and trade

In recent years, virtually all foreign production of chromium metal outside the Soviet sphere was accounted for by Japan, the United Kingdom, France, and West Germany, although Australia has produced small quantities of high-purity chromium metal. Japan produced an estimated 2.4 million pounds of chromium metal in 1965 and 1.3 million pounds in 1966, mostly for export. The United Kingdom exported 1.3 million pounds in 1965 and 3.4 million pounds in 1966. French production in 1964 amounted to 1 million pounds and rose to 1.4 million pounds in 1965; French exports rose from 410,000 pounds in 1964 to 981,000 pounds in 1966. West German production in 1965 was estimated at 882,000 pounds, and in 1966, at 1.1 million pounds. German exports totaled 88,000 pounds in 1965 and 173,000 pounds in 1966; imports amounted to 156,000 pounds in 1965 and 86,000 pounds in 1966.

Foreign trade in chromium metal is largely confined to the industrial countries of western Europe, Japan, and the United States.

Table 1.--Chromium metal: U.S. imports for consumption, and estimated consumption, 1959-66

| Year | Imports | | | Estimated consumption |
|---|---|---|---|---|
| | Total | Commercial (dutiable) | Government (duty-free) | |
| | Quantity (1,000 pounds) | | | |
| 1959 | 5,730 | 779 | 4,951 | 3,500 |
| 1960 | 1,816 | 471 | 1,345 | 3,200 |
| 1961 | 1,384 | 1,117 | 267 | 3,550 |
| 1962 | 1,295 | 1,295 | - | 3,700 |
| 1963 | 1,719 | 1,719 | - | 4,300 |
| 1964 | 1,465 | 1,465 | - | 1/ |
| 1965 | 2,020 | 2,020 | - | 1/ |
| 1966 | 4,974 | 4,974 | - | 1/ |
| | Value (1,000 dollars) | | | |
| 1959 | 5,179 | 616 | 4,563 | 4,100 |
| 1960 | 1,645 | 372 | 1,273 | 3,750 |
| 1961 | 1,150 | 888 | 262 | 4,150 |
| 1962 | 993 | 993 | - | 4,350 |
| 1963 | 1,308 | 1,308 | - | 5,050 |
| 1964 | 1,109 | 1,109 | - | 1/ |
| 1965 | 1,522 | 1,522 | - | 1/ |
| 1966 | 3,739 | 3,739 | - | 1/ |

1/ Not available.

Source: Imports compiled from official statistics of the U.S. Department of Commerce; consumption estimates made by the Manufacturing Chemists Association, except that for 1963, which is an extrapolation of its estimate for 8 months.

Note.--Imports by the U.S. Government were for stockpiling. Production statistics are not published because they would reveal data considered by the producers to be confidential. Although consumption statistics are not available for 1964-66, consumption is known to have increased sharply in 1966. Exports are not included in this summary because published statistics for 1959-64 combined chromium metal with unwrought chromium alloys (except ferroalloys) and scrap thereof, and those for 1965-66 also included wrought metal and alloys; exports of chromium metal as such are believed to be very small.

Table 2.--Chromium metal: U.S. imports for consumption, by principal sources, 1959-66

| Year | Total | United Kingdom | France | West Germany | Japan | All other |
|---|---|---|---|---|---|---|
| | Quantity (1,000 pounds) | | | | | |
| 1959 | 5,730 | 1,761 | 1,374 | 595 | 2,000 | - |
| 1960 | 1,816 | 1,028 | 415 | 128 | 245 | - |
| 1961 | 1,384 | 374 | 510 | 138 | 362 | - |
| 1962 | 1,295 | 337 | 325 | 29 | 604 | 1/ |
| 1963 | 1,719 | 495 | 460 | 1/ | 764 | - |
| 1964 | 1,465 | 420 | 195 | 20 | 830 | - |
| 1965 | 2,020 | 897 | 396 | 54 | 673 | - |
| 1966 | 4,974 | 2,993 | 380 | 144 | 1,457 | 1/ |
| | Value (1,000 dollars) | | | | | |
| 1959 | 5,179 | 1,643 | 1,299 | 547 | 1,690 | - |
| 1960 | 1,645 | 961 | 388 | 114 | 183 | - |
| 1961 | 1,150 | 322 | 432 | 128 | 268 | - |
| 1962 | 993 | 257 | 264 | 22 | 445 | 5 |
| 1963 | 1,308 | 373 | 361 | 2/ | 574 | - |
| 1964 | 1,109 | 316 | 151 | 17 | 625 | - |
| 1965 | 1,522 | 683 | 305 | 39 | 495 | - |
| 1966 | 3,739 | 2,273 | 302 | 115 | 1,048 | 1 |

1/ Less than 500 pounds.
2/ Less than $500.

Source: Compiled from official statistics of the U.S. Department of Commerce.

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| Commodity | TSUS item |
|---|---|
| Cobalt ore | 601.18 |
| Cobalt metal, unwrought, and waste and scrap | 632.20 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

The United States is almost entirely dependent upon imports for cobalt, a metal which is being consumed in increasing amounts in important industrial applications. The principal U.S. source of cobalt is the Congo (Kinshasa) where it is mined and smelted as a coproduct with copper. Other U.S. sources include countries of Western Europe which refine the metal largely from imported materials.

## Description and uses

Cobalt ore is found in sulphide, oxide, and other types of minerals, which usually contain other metals, such as copper and nickel. Cobalt metal is hard and tough, and generally resembles nickel; the two metals are similar in their maintenance of strength and resistance to corrosion and deterioration at elevated temperatures. Cobalt, however, is harder, more brittle, and more costly than nickel.

This summary covers cobalt ore (item 601.18), including cobalt-bearing concentrates, and crude cobalt metal (item 632.20) in unwrought forms, such as briquets, rondelles, broken cathodes, granules, and metallic waste and scrap. Other summaries cover cobalt alloys and cobalt in wrought forms (items 632.84 and 633.00, respectively, both in volume 6:3); also cobalt chemical compounds, e.g., cobalt oxide (item 418.60) in volume 4:3, cobalt sulfate (item 418.62) in volume 4:3, cobalt compounds, n.e.e. (item 418.68) in volume 4:3, cobalt salts (items 426.24 and 426.26) in volume 4:5, and cobalt linoleate (item 490.40) in volume 4:12.

Cobalt ore is used for the production of cobalt metal, and in the manufacture of salts, pigments and ceramic glazes. Cobalt metal is used in the manufacture of high-temperature, high-strength alloys, alloy steels (including high-speed and tool steels) cemented carbides, and hard-facing materials. Nonferrous cobalt alloys are used under conditions which require strength and resistance to corrosive gases at high temperatures, such as occur within jet engines and gas turbines. Ferrous alloys of cobalt are used for the manufacture of

such industrial equipment as grates for sintering furnaces and industrial tools for metalworking. Cobalt metal is essential to some permanent-magnet alloys used in loudspeakers and other electrical and electronic devices.

In this summary all quantities are expressed in pounds.

## U.S. tariff treatment

Both cobalt ore (item 601.18) and unwrought cobalt metal, including waste and scrap (item 632.20), are free of duty. Their duty-free status, provided in the Tariff Act of 1930 as originally enacted was bound under the General Agreement on Tariffs and Trade (GATT) effective January 1, 1948. The duty-free status has been continued under the TSUS.

## U.S. consumption

Although the United States produces only minor quantities of cobalt, its consumption has in recent years been equivalent to about two-thirds of world production. Annual U.S. consumption of cobalt has increased from about 10 million pounds during 1961-64 to about 14 million pounds annually in 1965-66. About three-fourths of consumption has been in the form of metal, of which the leading applications in 1966 were in high-temperature and high-strength alloys (3.6 million pounds) and in permanent-magnet alloys (2.7 million pounds), with lesser quantities used in various steel alloys, hard-facing materials and cemented carbides. Salts, and paint and varnish driers (1.6 million pounds) were leading nonmetallic applications.

The price of crude cobalt metal through most of 1967 was $1.85 per pound (f.o.b. New York), about double the price of metallic nickel, which can be satisfactorily substituted for cobalt in many metallurgical uses.

## U.S. exports

Official export statistics of the U.S. Department of Commerce combine data for unwrought forms of cobalt--including ore, unwrought metal, alloys and scrap--into a single class. In most recent years the annual value of these combined exports has been about $1 million. Scrap has comprised a substantial part of cobalt exports, which have gone principally to Canada, Japan, and countries of Western Europe.

U.S. producers

Nearly all domestic production of cobalt ore is a byproduct of the mining of certain iron ore deposits (magnetite and pyrite) in Pennsylvania, by a large steel company. A few thousand pounds of cobalt-bearing materials are also derived annually in the course of the mining and smelting of copper and zinc at operations in Idaho. During the 1950's, cobalt was produced for stockpiling, under U.S. Government sponsorship, from cobaltite mineral in Idaho and from cobalt-bearing lead ore (galena) in Missouri.

Cobalt metal is produced in Delaware from domestic concentrates by a chemical company which also makes other cobalt products. Prior to the closing of the Government-sponsored cobalt-mining operations mentioned above, the output of domestic mines was processed into metal at refineries in Missouri and Utah.

U.S. production

Domestic production of cobalt is equivalent to about 5 percent of U.S. consumption. With U.S. cobalt ore produced largely by a single company, exact data on recent output are not available for publication. However, the Cobalt Information Center 1/ has published estimates indicating U.S. mine output at about half a million pounds per annum during 1962-66; in 1958, domestic production, with Government assistance, reached 4.8 million pounds.

U.S. imports

Almost all of the cobalt imported into the United States has been in the form of crude metal. There have also been occasional imports of cobalt ore, but these have usually been small. During 1961-66, the only imports for consumption of cobalt ore (item 601.18) reported in official statistics of the U.S. Department of Commerce were as follows:

| Year | Quantity (1,000 pounds cobalt content) | Value ($1,000) |
|---|---|---|
| 1962 | 37 | 56 |
| 1963 | 28 | 41 |
| 1966 | 289 | 448 |

1/ A trade group with headquarters at 35 rue des Colonies, Brussels 1, Belgium, and a branch office at 505 King Avenue, Columbus, Ohio (c/o Battelle Memorial Institute).

The Congo (Kinshasa) has been by far the largest U.S. source of cobalt metal imports; other sources have been Belgium, West Germany, Norway, France, and Canada. Since 1961, U.S. imports of cobalt metal (item 632.20--see accompanying table) have approximately equaled domestic consumption. In some preceding years, imports included both those for industrial consumption and U. S. Government acquisitions for stockpiling. The Government inventory of cobalt on December 31, 1966, amounted to about 101 million pounds, which was much in excess of the stockpile objective for conventional warfare (42 million pounds). The General Services Administration has been liquidating some of the surplus.

Foreign production and trade

Because cobalt is largely a coproduct or byproduct of more abundant metals, much of the supply is dependent upon mining activity stimulated by the demand for other metals principally copper and nickel. The Congo (Kinshasa) is the world's largest source of cobalt, accounting for about half of free-world output; production there is associated with copper mining, as it is in Zambia. Morocco is another African producer, mining ore which contains cobalt in combination with nickel and other valuable constituents. Some of the cobalt from the foregoing mining operations is smelted in Africa, and some is processed into metal in Belgium and France. Other West European smelter production of cobalt metal is also based on imported minerals, some mined in Canada and some in Finland. Canada produces the metal from ores mined principally for their nickel-copper content. The U.S.S.R. and several countries of Eastern Europe are also producers of cobalt. A large reserve of cobalt exists in nickeliferous laterite deposits of eastern Cuba; U.S. interests built a refinery in Louisiana to extract nickel and cobalt from Cuban material, but the plant was closed shortly after completion in 1959, following political changes in Cuba. A few companies which represent foreign producing interests dominate commercial trade in cobalt. In a study of cobalt published several years ago 1/, the U.S. Tariff Commission found that four importers accounted for about 85 percent of the sales of cobalt and cobalt products in the United States, and that a single supplier of the metal from Africa was a major factor in determining the U.S. market price.

1/ Cobalt: Report to the Congress on Investigation No. 332-42 . . . . TC Publication 64, 1962.

Cobalt: U.S. production, imports for consumption, exports of domestic merchandise, and consumption, 1961-66

| Year | Production 1/ | Imports 2/ | Exports 3/ | Consumption 4/ |
|---|---|---|---|---|
| | Quantity (1,000 pounds cobalt content) | | | |
| 1961 | 1,100 | 10,036 | 5/ | 9,596 |
| 1962 | 500 | 11,777 | 5/ | 11,268 |
| 1963 | 500 | 10,322 | 5/ | 10,529 |
| 1964 | 500 | 11,333 | 5/ | 10,650 |
| 1965 | 600 | 14,846 | 5/ | 13,595 |
| 1966 | 640 | 17,871 | 5/ | 14,205 |
| | Value (1,000 dollars) | | | |
| 1961 | 5/ | 14,867 | 1,881 | 5/ |
| 1962 | 5/ | 17,073 | 997 | 5/ |
| 1963 | 5/ | 14,677 | 1,131 | 5/ |
| 1964 | 5/ | 16,526 | 976 | 5/ |
| 1965 | 5/ | 23,132 | 864 | 5/ |
| 1966 | 5/ | 27,734 | 755 | 5/ |

1/ Cobalt content of ore shipped by U.S. mines as estimated by the Cobalt Information Center, a trade association (see "U.S. production" section of text).

2/ Cobalt metal (item 632.20). The excess of imports over consumption in most of these years may be explained by inventory adjustments, incomplete coverage of consumers, and U.S. Government importations for stockpiling.

3/ Combined data for various cobalt materials such as ore, metal, alloys and scrap.

4/ Actual consumption as reported by consumers to the U.S. Bureau of Mines.

5/ Not available.

Source: Official statistics of the U.S. Department of Commerce and the U.S. Bureau of Mines, except as noted.

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| Commodity | TSUS item |
|---|---|
| Columbium ore | 601.21 |
| Tantalum ore | 601.42 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

Although the United States has been only an occasional producer of columbium and tantalum ores, it is the world's largest processor and consumer of the ores and the metals they yield.

## Description and uses

Columbium and tantalum ores including concentrates (as defined in headnote 2(a) to part 1 of schedule 6 of the TSUS), are the natural sources from which the metallic elements columbium (also known as niobium) and tantalum are derived.

Columbium and tantalum usually constitute only a small percentage of the minerals from which they are extracted, and the ores are often concentrated from materials processed for the recovery of such other products as tin, feldspar, beryl, uranium, zirconium, and rare earths. Columbium and tantalum are usually present together in ores; columbium is commonly the more abundant of the two. Columbite and tantalite ores, in which the two metals occur as combined pentoxides ($Cb_2O_5$ and $Ta_2O_5$) were long the major sources of the metals, the designation of the ore as either columbite or tantalite depending upon which of the two metals is present in larger quantities. However, technical advances have made possible the exploitation of more complex ores such as pyrochlore and euxenite, which contain numerous other elements.

Commercial ores valued principally for their columbium content are usually concentrated in grades having a ratio of either 10:1 or 8.5:1 of columbium pentoxide to tantalum pentoxide. In ore processed primarily for tantalum content, a ratio of at least 3:1 of tantalum pentoxide to columbium pentoxide is preferred by consumers. Some slags which are the residues of tin smelting may also be processed for their content of columbium and tantalum; these are covered by the summary on item 603.70 in volume 6:2.

Columbium and tantalum are used as pure metals or in alloys in electronic, nuclear, and chemical process equipment. They also enter into the manufacture of ferroalloys (ferrocolumbium and ferrotantalum columbium used in alloy steels) and chemical products.

In this summary all quantities are expressed in pounds.

## U.S. tariff treatment

Both columbium ore (item 601.21) and tantalum ore (item 601.42) are free of duty. The duty-free status of these ores provided in the Tariff Act of 1930 as originally enacted, was continued under the TSUS, and has been bound since January 1, 1948 under the General Agreement on Tariffs and Trade.

## U.S. consumption

Data on U.S. production of columbium and tantalum products indicate that domestic consumption of columbium and tantalum ores in 1966 was nearly double the 1962-64 annual average of about 6 million pound (table 1). The increase is attributable to the enlarged uses of columbium and tantalum in ferroalloys, electronics, and chemical equipment. Approximately 10 U.S. companies process the ores, using pyrometallurgical and chemical techniques. Some concerns make columbium and tantalum products only intermittently and on a relatively small scale.

## U.S. production and exports

U.S. production of columbium and tantalum ores is very small and sporadic. During 1966, production of these ores was reported at only two mines, both in South Dakota; the volume of their output was not disclosed, and the production was stockpiled at the mines. This was the first domestic production of these ores in 7 years. During 1956-59 a dredging operation at Bear Valley, Idaho, concentrated ore from an euxenite-columbite-monazite deposit to recover columbium, tantalum and other valuable elements. This operation was supported by a U.S. Government purchase contract, and was terminated after about a million pounds of columbium-tantalum oxides had been delivered to the Government for stockpiling. Previously, there had been intermittent and highly variable production of these ores in a number of States including South Dakota, Colorado, New Mexico, Maine, New Hampshire, and North Carolina.

On December 31, 1966, U.S. Government stockpiles included about 13 million pounds of columbium and 4 million pounds of tantalum, contained in ores. The columbium content of this inventory was classified largely as surplus to mobilization needs for conventional warfare, and disposal of a part of these stocks was planned by the General Services Administration. About 1 million pounds of the tantalum in the inventory was also listed as being in excess of emergency needs.

Exports of columbium and tantalum ores have been minor. In 1964 (the most recent year for which data for both ores are available) they amounted to 543,000 pounds, valued at $590,000, and consisted of imported material that had been processed in the United States. Tantalum ore has been the principal export item; the most important markets have been countries of Western Europe and Japan.

U.S. imports, foreign production and marketing

Annual world production and U.S. imports of columbium and tantalum ores have greatly increased. Annual world output expanded from about 10 million pounds during 1962-63 to 14 million pounds in 1965 and to 27 million pounds in 1966. U.S. imports increased from an annual average of about 6 million pounds in 1962-65 to 11 million pounds in 1966 (table 2); these imports were largely for current domestic consumption.

During the 1950's, the U.S. Government was an important importer of these ores for stockpiling. Imports have been received both from countries which mine the ores and from some which process imported minerals. Nigeria and the Congo (Kinshasa) were among the original suppliers of columbium and tantalum ores obtained as a byproduct of tin mining. More recently, Canada and Brazil became major suppliers of columbium ore as a result of the development of pyrochlore deposits. Tantalum ore has been received from Mozambique, where it is obtained in connection with the recovery of beryl, and from Brazil, where it has been recovered in the mining of beryl and tin.

Most U.S. imports of columbium and tantalum ores are entered by dealers contracting with producing sources and selling to processors. Some U.S. processors, however, buy abroad and import for their own accounts, and a few domestic concerns even have financial interests in foreign ore sources. Prices for ore are usually quoted on the basis of contained pentoxides of both metals, except for ore relatively high in tantalum content, for which prices are based on the tantalum content only.

Table 1.--Columbium and tantalum ores: U.S. imports for consumption, exports of domestic merchandise, and apparent consumption, 1961-66

(Quantity in thousands of pounds, gross weight; value in thousands of dollars)

| Year | Imports | Exports | Apparent consumption | Ratio (percent) of imports to consumption |
|---|---|---|---|---|
| | Quantity | | | |
| 1961 | 3,782 | 273 | 3,509 | 108 |
| 1962 | 6,263 | 159 | 6,104 | 103 |
| 1963 | 6,854 | 103 | 6,751 | 102 |
| 1964 | 5,582 | 543 | 5,039 | 111 |
| 1965 | 6,088 | 1/ 284 | 2/ 6,000 | 2/ 101 |
| 1966 | 11,421 | 1/ 163 | 2/11,000 | 2/ 104 |
| | Value | | | |
| 1961 | 4,308 | 339 | 3,969 | 109 |
| 1962 | 6,932 | 263 | 6,669 | 104 |
| 1963 | 5,555 | 214 | 5,341 | 104 |
| 1964 | 3,883 | 590 | 3,293 | 118 |
| 1965 | 4,861 | 1/ 698 | 2/ 4,500 | 2/ 108 |
| 1966 | 10,460 | 1/ 453 | 2/10,500 | 2/ 100 |

1/ Tantalum ore only; export data for columbium ore was not separately reported.

2/ Estimated by U.S. Tariff Commission staff.

Source: Compiled from official statistics of the U.S. Bureau of Mines and the U.S. Department of Commerce, except as noted.

Note.--Domestic production was reported in 1966 for the first time since 1959. The quantity produced was not disclosed but was probably small in relation to U.S. consumption.

Table 2.--Columbium ore and tantalum ore: U.S. imports for consumption, by sources, 1966

| Source | Columbium ore | | Tantalum ore | | Total | |
|---|---|---|---|---|---|---|
| | Quantity | Value | Quantity | Value | Quantity | Value |
| | 1,000 pounds | 1,000 dollars | 1,000 pounds | 1,000 dollars | 1,000 pounds | 1,000 dollars |
| Canada | 1,524 | 870 | - | - | 1,524 | 870 |
| Brazil | 4,995 | 2,622 | 287 | 984 | 5,282 | 3,606 |
| Nigeria | 2,420 | 1,673 | 40 | 123 | 2,460 | 1,796 |
| Congo (Kinshasa) 1/ | 127 | 226 | 993 | 1,768 | 1,120 | 1,994 |
| Mozambique | - | - | 175 | 508 | 175 | 508 |
| Kenya | 7 | 4 | 27 | 29 | 34 | 33 |
| Malaysia | 74 | 78 | 36 | 41 | 110 | 119 |
| Netherlands | - | - | 166 | 101 | 166 | 101 |
| Portugal | 27 | 64 | 67 | 258 | 94 | 322 |
| Thailand | - | - | 89 | 282 | 89 | 282 |
| Australia | - | - | 29 | 93 | 29 | 93 |
| Other | 104 | 141 | 234 | 595 | 338 | 736 |
| Total | 9,278 | 5,678 | 2,143 | 4,782 | 11,421 | 10,460 |

1/ Belgian Congo until June 30, 1960; the capital, Leopoldsville, was renamed Kinshasa on July 1, 1966.

Source: Compiled from official statistics of the U.S. Department of Commerce.

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| Commodity | TSUS item |
|---|---|
| Columbium metal, unwrought, and waste and scrap | 628.15 |
| Columbium alloys, unwrought | 628.17 |
| Columbium metal, wrought | 628.20 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

The United States is a leading producer of columbium metal but its output is dependent on imported ores. Foreign trade in the metal is minor because its high cost limits consumption.

## Description and uses

Columbium metal (also known as niobium) has a high melting point and unusual resistance to corrosion, characteristics which it shares with tantalum, a similar metal with which it is frequently found in ore and from which complete separation is accomplished with difficulty. Commercial grades of columbium are used in electronic tubes and cryogenic equipment, in the manufacture of carbides for forging dies and cutting tools, in abrasion-resistant coatings, and in jet engine components. High-purity columbium, which has the ability to confine radioactive elements, is used in nuclear reactors as a structural material, for cladding, and for fuel alloying.

Unwrought columbium metal comprises columbium in such crude forms as sponge, powder, pellets, and rondelles. Wrought columbium includes mill products (rod, wire, sheet, and tubes), which are often made to specifications required for individual applications, as in nuclear and electronic installations. Columbium alloys include the metal in combination with molybdenum, titanium, tungsten, and other metals, usually for use in high-temperature or corrosion-resistant equipment. The largest application of columbium is in ferrocolumbium and ferrotantalum columbium, which are ferroalloys produced directly from ore; these ferroalloys are covered in another summary under item 607.80 in volume 6:3.

In this summary all quantities are expressed in pounds.

U.S. tariff treatment

The column 1 (or trade-agreement) rates of duty applicable to imports (see general headnote 3 in TSUSA-1968) are as follows:

| TSUS item | Commodity | Prior rate | U.S. concessions granted in 1964-67 trade conference (Kennedy Round) | |
|---|---|---|---|---|
| | | | First stage, effective Jan. 1, 1968 | Final stage, effective Jan. 1, 1972 |
| | Columbium metal: | | | |
| 628.15 | Unwrought, other than alloys; and waste and scrap. | 10% ad val. | 9% ad val. | 5 % ad val. |
| 628.17 | Unwrought alloys | 15% ad val. | 13% ad val. | 7.5% ad val. |
| 628.20 | Wrought | 18% ad val. | 16% ad val. | 9% ad val. |

The tabulation above shows the column 1 rates of duty in effect prior to January 1, 1968, and modifications therein as a result of concessions granted by the United States in the sixth round of trade negotiations under the General Agreement on Tariffs and Trade (GATT). Only the first and final stages of the annual rate modifications are shown above (see the TSUSA-1968 for the intermediate staged rates). Concessions amounting to a reduction of 50 percent in duties were granted by the United States on the items above; the concessions are being put into effect in five annual stages.

The previous duty of 10 percent ad valorem on unwrought columbium metal (item 628.15) is derived from the rate which became effective July 1, 1963, as a result of a concession granted by the United States in the GATT; this rate continued in effect under the TSUS from August 31, 1963 through the end of 1967. The prior rates of 15 percent ad valorem on unwrought columbium alloys (item 628.17) and 18 percent ad valorem on wrought columbium (item 628.20) both became effective with the adoption of the TSUS and represent and estimated weighted average of assessments on imports for a representative period prior to 1963. Prior to August 31, 1963, the articles covered by these items had been dutiable at different rates under various provisions of the previous tariff schedules.

The duty on columbium waste and scrap (part of item 628.15) has been suspended almost continuously since March 1942 by various public laws; the latest (Public Law 90-45) extends the suspension to June 30, 1969 (see item 911.12 of appendix to the TSUSA-1968).

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## U.S. consumption

The high cost of columbium metal has inhibited its use in all but the most essential applications. The demand for the metal for Government programs in nuclear and space projects and for research and development programs has probably been greater than the demand for this metal for metallurgy, electronics, and other commercial purposes. Annual consumption of unwrought columbium metal (in products other than ferroalloys) in recent years is calculated at approximately 100,000 to 250,000 pounds. The unalloyed metal and columbium alloys are wrought to form mill products. More complex shapes may be made by pressing and sintering the metal powder. The unit value of wrought columbium products (up to $50 a pound for some mill shapes) substantially exceeds the already high unit value of unwrought metal (powder has been quoted at $11 to $23 a pound, depending upon purity).

## U.S. producers and production

Approximately half a dozen companies have produced unalloyed columbium metal in the United States, and output among them has varied greatly from year to year. Columbium metal is derived from the ore by complex chemical extraction methods. The producing companies include several large chemical manufacturers with extensive interests outside metallurgy, as well as smaller concerns engaged principally in the production of metals, alloys, and carbides. U.S. output of columbium metal (unalloyed and in nonferrous alloys) has been approximately equal to consumption (table 1) and has been scheduled principally to meet the needs of specific projects. Owing to the small and fluctuating demand, several companies have suspended production from time to time. Wrought columbium products are also made on special order by some companies which purchase the crude metal.

## U.S. exports

U.S. exports of columbium in various metallic forms have gone mostly to the United Kingdom and countries of Western Europe and have constituted only a small part of annual U.S. production of the crude metal. Such exports, valued at $494,000 in 1963, decreased thereafter in both quantity and value (table 2).

U.S. imports, foreign production, and marketing

U.S. imports for consumption of columbium articles covered here are small. Statistics on columbium imports for the TSUS items included in this summary have been available only since August 31, 1963. For the years 1964-66, such imports (practically all originating in the United Kingdom and countries of Western Europe) were reported in official statistics of the U.S. Department of Commerce as follows:

| Item | 1964 | 1965 | 1966 |
|---|---|---|---|
| | Quantity (pounds) | | |
| Columbium: | | | |
| Unwrought metal (item 628.15) | 654 | 9,749 | 453 |
| Unwrought alloys (item 628.17) | 3,155 | 65 | 3,978 |
| Wrought metal (item 628.20) | 3 | 3 | - |
| Total | 3,812 | 9,817 | 4,431 |
| | Value (1,000 dollars) | | |
| Columbium: | | | |
| Unwrought metal (item 628.15) | 10 | 82 | 11 |
| Unwrought alloys (item 628.17) | 5 | 2 | 7 |
| Wrought metal (item 628.20) | 1 | 1 | - |
| Total | 16 | 85 | 18 |

Production of columbium metal abroad, as in the United States, is on a small scale; foreign producing operations are limited to a relatively few companies having advanced technical facilities. Some of the production is for the commercial market, but much is to fulfill contracts for high-specification material.

Table 1.--Columbium metal, unwrought: U.S. production, imports for consumption, exports of domestic merchandise, and estimated consumption, 1961-66

| Year | Production | Imports | Exports 1/ | Apparent consumption | Ratio of imports to consumption |
|---|---|---|---|---|---|
| | 1,000 pounds | 1,000 pounds | 1,000 pounds | 1,000 pounds | Percent |
| 1961 | 252 | 2 | 13 | 241 | 0.8 |
| 1962 | 128 | 3 | 12 | 119 | 2.5 |
| 1963 | 104 | 2 | 10 | 96 | 2.1 |
| 1964 | 95 | 1 | 1 | 95 | 1.1 |
| 1965 | 2/ | 10 | 1 | 2/ | 2/ |
| 1966 | 2/ | 3/ | 4 | 2/ | 2/ |

1/ Includes undetermined quantities of columbium alloys.
2/ Not available.
3/ Less than 500 pounds.

Source: Compiled from official statistics of the U.S. Bureau of Mines and the U.S. Department of Commerce.

Note.--Data on production in 1965 and 1966 are not published because publication would disclose individual company operations.

Table 2.--Columbium metal: 1/ U.S. exports of domestic merchandise, by type, unwrought and wrought, 1961-66

| Year | Unwrought metal | Wrought metal | Total |
|---|---|---|---|
| | Quantity (pounds) | | |
| 1961 | 12,903 | 473 | 13,376 |
| 1962 | 11,996 | 4,831 | 16,827 |
| 1963 | 10,038 | 4,238 | 14,276 |
| 1964 | 603 | 4,071 | 4,674 |
| 1965 | 1,244 | 2,973 | 4,217 |
| 1966 | 4,101 | 2,821 | 6,922 |
| | Value (1,000 dollars) | | |
| 1961 | 49 | 50 | 99 |
| 1962 | 60 | 204 | 264 |
| 1963 | 129 | 365 | 494 |
| 1964 | 5 | 417 | 422 |
| 1965 | 20 | 157 | 177 |
| 1966 | 93 | 156 | 249 |
| | Average unit value (per pound) | | |
| 1961 | $4 | $106 | $74 |
| 1962 | 5 | 42 | 16 |
| 1963 | 13 | 86 | 35 |
| 1964 | 8 | 102 | 90 |
| 1965 | 16 | 53 | 42 |
| 1966 | 23 | 55 | 36 |

1/ Includes undetermined quantities of columbium alloys.

Source: Compiled from official statistics of the U.S. Department of Commerce.

| Commodity | TSUS item |
|---|---|
| Tantalum metal, unwrought, and waste and scrap | 629.05 |
| Tantalum alloys, unwrought | 629.07 |
| Tantalum metal, wrought | 629.10 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

The United States is a major producer, fabricator, and consumer of tantalum, a metal valued chiefly for its electronic and heat- and corrosion-resistant properties. Virtually all of the tantalum consumed in the United States is produced domestically from imported duty-free ores. U.S. imports of the metal are small, and though exports in unwrought and wrought forms are somewhat larger, both are of minor importance compared with production or consumption.

## Description and uses

Tantalum metal has one of the highest melting points of all metals, unique electrical properties, and unusual resistance to corrosion by most chemicals and molten metals. It is generally similar to columbium, which is somewhat more abundant and with which tantalum is usually associated in ore. In some extreme environments, however, the qualities of chemical inertness and heat resistance possessed by tantalum make it more serviceable than columbium.

Unwrought tantalum is produced as powder, sponge, rondelles, and pellets. Common wrought forms of the metal include such mill products as rod, wire, sheet, and foil. Tantalum metal is used in the form of powder in the manufacture of electronic capacitors which have high electric storage capacity per unit of volume; applications of the metal as wire and foil include components for low-voltage rectifiers, vacuum tubes, and electronic valves useful in cryogenics. Tantalum sheets and tubes are used in the manufacture of equipment for the chemical and petroleum-refining industries, such as heat exchangers, vapor condensers, and pumps handling chlorine, acids, and other corrosive substances. Tantalum metal products are used in high-temperature metallurgy, in carbides for forging dies and cutting tools, and

in surgical repairs. Tantalum is a component of some nonferrous alloys with tungsten, cobalt, and other metals for use at high temperatures. (Ferrotantalum columbium, a ferroalloy used in making special types of steel, is discussed in a summary under item 607.80 in volume 6:3.)

In this summary all quantities are expressed in pounds.

## U.S. tariff treatment

The column 1 (or trade-agreement) rates of duty applicable to imports (see general headnote 3 in TSUSA-1968) are as follows:

| TSUS item | Commodity | Prior rate | U.S. concessions granted in 1964-67 trade conference (Kennedy Round) | |
|---|---|---|---|---|
| | | | First stage, effective Jan. 1, 1968 | Final stage, effective Jan. 1, 1972 |
| | Tantalum metal: | | | |
| 629.05 | Unwrought, other than alloys; and waste and scrap. | 10% ad val. | 9% ad val. | 5% ad val. |
| 629.07 | Unwrought alloys | 15% ad val. | 13% ad val. | 7.5% ad val. |
| 629.10 | Wrought | 18% ad val. | 16% ad val. | 9% ad val. |

The tabulation above shows the column 1 rates of duty in effect prior to January 1, 1968, and modifications therein as a result of concessions granted by the United States in the sixth round of trade negotiations under the General Agreement on Tariffs and Trade (GATT). Only the first and final stages of the annual rate modifications are shown above (see TSUSA-1968 for the intermediate staged rates). Concessions amounting to a reduction of 50 percent in duties were granted by the United States on the items above; the concessions are being put into effect in five annual stages.

The duty of 10 percent ad valorem on unwrought tantalum metal (item 629.05) is derived from the rate which became effective on July 1, 1963, as a result of a concession granted by the United States in the GATT; this rate continued in effect under the TSUS from August 31, 1963 through the end of 1967. The prior rates of 15 percent ad

valorem on unwrought tantalum alloys (item 629.07) and 18 percent ad valorem on wrought tantalum (item 629.10) both became effective with the adoption of the TSUS and represent an estimated weighted average of assessments on imports for a representative period prior to 1963. Prior to August 31, 1963, the articles covered by these items had been dutiable at different rates under various provisions of the previous tariff schedules.

The duty on tantalum waste and scrap (part of item 629.05) has been suspended almost continuously since March 1942 by various public laws; the latest (Public Law 90-45) extends the suspension to June 30, 1969 (see item 911.12 of appendix to the TSUSA-1968).

## U.S. consumption

During 1966, apparent U.S. consumption of tantalum metal was calculated at 1,061,000 pounds, up from 400,000 to 500,000 pounds per annum in 1961-64 (table 1). The high cost of the metal has been an important factor in limiting its use to the most essential applications. Tantalum metal powder suitable for electronic applications has been quoted in the United States at $30 to $50 a pound with powder of the greatest purity selling at the highest prices. Wrought tantalum in sheets and rods has been quoted at $47 to $65 a pound.

## U.S. producers and production

Tantalum has been produced in small quantities for many years. Market demand for the metal has been very limited, and until 1956 there was only one producer in the United States. In recent years, the metal has been made by about eight companies, with the production of unwrought metal associated with the manufacture of tantalum mill products, advanced shapes, carbides, alloys, and electronic components. Generally the producers have also been makers and processors of columbium and a variety of other metallurgical and chemical products. A few companies buy crude metal powder and shape it to fill special orders. Although there is a sustained industrial demand for tantalum, especially in electronics, the level of annual production also depends to a considerable extent on requirements generated by individual construction projects such as chemical plants and nuclear facilities.

United States production of unwrought tantalum metal increased to 1,064,000 pounds in 1966, after averaging about 515,000 pounds per annum in 1961-65. Data on production of wrought tantalum and alloys of tantalum are not available. The average unit value of wrought tantalum considerably exceeds that of the unwrought metal because working it is difficult and costly.

## U.S. exports

Only a small part of domestic production of tantalum metal has been exported. In 1966, total exports of metallic tantalum amounted to 86,000 pounds, valued at $2.9 million; these exports consisted of tantalum in powder and in other crude forms including waste and scrap, as well as wrought forms of the metal. Of the total 1966 exports, tantalum powder accounted for 51,000 pounds, valued at $1.6 million. Exports by types are shown in table 2, together with average unit values, which generally indicate the much higher worth of wrought tantalum than of the unwrought metal. Principal export markets have been Japan, the United Kingdom, West Germany, and other countries in Western Europe.

## U.S. imports and foreign production and trade

U.S. imports of tantalum, principally unwrought metal, including scrap, have increased; in 1966 they amounted to about 48,000 pounds (valued at $472,000), equivalent to about 4.5 percent of the U.S. production in that year. Unwrought tantalum alloys and the metal in wrought forms have been imported in very small quantities. Official statistics on imports by the TSUS items covered in this summary have been available only since August 31, 1963. For the years 1964-66 these imports (all from Western Europe, Japan, and Canada) were reported in official statistics of the U.S. Department of Commerce as follows:

| Item | 1964 | 1965 | 1966 |
|---|---|---|---|
| | Quantity (pounds) | | |
| Tantalum: | | | |
| Unwrought metal (item 629.05) | 3,437 | 26,162 | 47,507 |
| Unwrought alloys (item 629.07) | 52 | 56 | 10 |
| Wrought metal (item 629.10) | 2 | 2 | 231 |
| Total | 3,491 | 26,220 | 47,748 |
| | Value (1,000 dollars) | | |
| Tantalum: | | | |
| Unwrought metal (item 629.05) | 50 | 65 | 468 |
| Unwrought alloys (item 629.07 | 2 | 2 | 1/ |
| Wrought metal (item 629.10) | 1/ | 1 | 4 |
| Total | 52 | 68 | 472 |

1/ Less than $500.

Tantalum metal is produced in several countries of Western Europe, although demand has not always been adequate to support production on a sustained basis. Foreign producers of the metal, like producers in the United States, have been dependent upon ores imported largely from African sources. The foreign metal producers have usually been companies with broad interests in the metallurgical and chemical industries; some of them have been affiliates of U.S. producers, fabricating products from unwrought tantalum metal imported from the United States. Supplying the demand for small quantities of tantalum products made to exact specifications frequently involves special production facilities and processes.

Table 1.--Tantalum metal, unwrought (item 629.05): U.S. production, imports for consumption, exports of domestic merchandise, and consumption, 1961-66

| Year | Production | Imports | Exports 1/ | Consumption 2/ | Ratio of imports to consumption |
|---|---|---|---|---|---|
| | 1,000 pounds | 1,000 pounds | 1,000 pounds | 1,000 pounds | Percent |
| 1961 | 484 | 3 | 12 | 475 | 0.6 |
| 1962 | 514 | 2 | 14 | 502 | .4 |
| 1963 | 418 | 2 | 14 | 406 | .5 |
| 1964 | 448 | 3 | 32 | 419 | .7 |
| 1965 | 712 | 26 | 25 | 713 | 3.6 |
| 1966 | 1,064 | 48 | 51 | 1,061 | 4.5 |

1/ Metal powder only, including undetermined quantities of tantalum alloy powder.

2/ Estimated by U.S. Tariff Commission staff.

Source: Compiled from official statistics of the U.S. Bureau of Mines and the U.S. Department of Commerce, except as noted.

Table 2.--Tantalum metal 1/ : U.S. exports of domestic merchandise by specified type, 1961-66

| Year | Metal powder | Other unwrought metal 2/ | Wrought metal | Total |
|---|---|---|---|---|
| | Quantity (1,000 pounds) | | | |
| 1961 | 12 | 6 | 10 | 28 |
| 1962 | 14 | 12 | 6 | 32 |
| 1963 | 14 | 37 | 7 | 58 |
| 1964 | 32 | 20 | 12 | 64 |
| 1965 | 25 | 11 | 10 | 46 |
| 1966 | 51 | 22 | 13 | 86 |
| | Value (1,000 dollars) | | | |
| 1961 | 196 | 91 | 663 | 950 |
| 1962 | 403 | 177 | 400 | 980 |
| 1963 | 425 | 187 | 498 | 1,110 |
| 1964 | 574 | 226 | 583 | 1,383 |
| 1965 | 757 | 115 | 843 | 1,715 |
| 1966 | 1,564 | 249 | 1,095 | 2,908 |
| | Average unit value (per pound) | | | |
| 1961 | $16 | $15 | $66 | $34 |
| 1962 | 29 | 15 | 67 | 31 |
| 1963 | 30 | 5 | 71 | 19 |
| 1964 | 18 | 11 | 49 | 22 |
| 1965 | 30 | 10 | 84 | 37 |
| 1966 | 31 | 11 | 84 | 34 |

1/ Includes undetermined quantities of tantalum alloys.
2/ Includes waste and scrap.

Source: Compiled from official statistics of the U.S. Department of Commerce.

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| Commodity | TSUS item |
|---|---|
| Mercury ore | 601.30 |
| Mercury metal, including waste and scrap | 632.34 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

The United States, the world's largest consumer of mercury, depends upon imports for one-fifth to more than one-half of its annual requirements of mercury. Spain, Italy, and Mexico are the principal sources of U.S. imports. Exports, consisting principally of redistilled or triple-distilled mercury, are very small compared with domestic production or consumption.

## Description and uses

Mercury, a silver-white metal that is liquid at ordinary room temperatures, is recovered by processing its principal ore mineral, cinnabar. Owing to the relatively low content of mercury in the ore and the high cost of transporting the ore, the metal is extracted from the ore at the mines and the ore is not an article of commerce. The metal is generally referred to as mercury by consumers, and as quicksilver by its producers.

Mercury as recovered from ore is known as prime virgin mercury. About four-fifths of the mercury traded is of this grade--99.9 percent pure--and it is sold in cylindrical steel or iron flasks each containing 76 pounds of mercury. 1/ The remaining one-fifth is further purified to remove undissolved or dissolved impurities. The specially purified mercury is sold under various names for special purposes and commands substantial price premiums over the prime virgin grade. The premium grades are usually packaged in small bottles or jugs (of earthenware, glass, or plastic) holding from 10 pounds to as little as 4 ounces of mercury.

1/ This is the type of flask referred to wherever the term "flask" is used in this summary. These flasks are about 5 inches in diameter, about 12 inches high, and weigh, when empty, about 8 pounds. The flasks are used repeatedly and last many years.

In addition to primary mercury produced from ores, secondary mercury is recovered by processing mercury-bearing substances such as battery scrap, dental amalgams, and sludges from electrolytic processes. Secondary mercury is also reclaimed from old, obsolete, or worn-out electrical apparatus and control instruments and from mercury boilers and caustic soda and chlorine plants when they are withdrawn from service.

Mercury has many uses because of the unusual properties of the metal, its vapor, and its compounds. The metal is especially useful because of its liquidity at ordinary room temperatures (it solidifies at -38° F. and boils at 675° F.), high specific gravity, electrical conductivity, expansibility, and ability to amalgamate with other metals. Mercury vapor has useful thermal and other properties. Many of the mercury compounds are valued for their toxic effect or their catalytic properties.

Mercury metal is used principally in the manufacture of electrical apparatus, in industrial and control instruments, and in the electrolytic preparation of both chlorine (used for bleaching textiles and paper and pulp and in the manufacture of basic chemicals and plastics), and in caustic soda (used in the rayon industry and in the manufacture of soap). Some other uses are in sensitizing photographic film and as a heat-transfer agent in boilers for electrical power generation. Mercury also amalgamates with other metals to form many alloys used for dental applications, bearings, solders, and type.

Mercury compounds have a large variety of uses--in mercuric oxide cells and batteries, pharmaceuticals, dental preparations, antiseptics, insecticides, fungicides, wood preservatives, paints and pigments, catalysts, and mercury fulminate for blasting caps (see summary in volume 4:3 covering items 419.50 to 54 and 423.86).

In some applications, such as those for agricultural, industrial, and pharmaceutical purposes, substitutes for mercury can be used. In other applications such as the use of mercury as a cathode in the electrolytic preparation of chlorine and caustic soda and in boilers for generating electric power, other processes are available that do not require mercury. Satisfactory substitutes are not available,

however, for many of its applications in electrical apparatus and industrial and control instruments that depend upon mercury's high specific gravity, fluidity at normal temperatures, or electrical conductivity. 1/

In this summary all quantities are expressed in flasks containing 76 pounds of mercury.

U.S. tariff treatment

The column 1 (trade-agreement) rates of duty (see general headnote 3 in the TSUSA-1968) applicable to imports of mercury ore (item 601.30) and mercury metal, including waste and scrap (item 632.34) are shown below:

| | Item 601.30 | Item 632.34 |
|---|---|---|
| Prior rate (before the concessions noted below). | Free | 25¢ per lb. |
| Concessions granted by the United States in the 1964-67 trade conference (Kennedy Round): | | |
| First stage, effective Jan. 1, 1968-------- | 1/ | 22¢ per lb. |
| Final stage, effective Jan. 1, 1972-------- | 1/ | 12¢ per lb. |

1/ Duty-free status bound.

The duty-free status of mercury ore has remained unchanged, except for the binding referred to above, since it was established in the Tariff Act of 1930 as originally enacted. The duty on mercury metal of 25 cents per pound was also provided for in the original Tariff Act of 1930 and remained unchanged under the TSUS from August 31, 1963 through the end of 1967. As a result of a concession granted by the United States in the sixth round of trade negotiations under the General Agreement on Tariffs and Trade (GATT), however, the duty on mercury metal is being reduced in five annual stages--the final reduction becoming effective Jan. 1, 1972 (see the TSUSA-1968 for the intermediate staged rates).

1/ For a comprehensive report on developments in the trade in mercury, see U.S. Tariff Commission, Mercury (Quicksilver): Report on Investigation No. 32 Under Section 332 of the Tariff Act of 1930 Made Pursuant to a Resolution of the Committee on Finance, United States Senate, 1958 (processed), and U.S. Tariff Commission, Mercury (Quicksilver): Report To The Congress on Investigation No. 332-32 (Supplemental) Under Section 332 of the Tariff Act of 1930 Made Pursuant to Senate Resolution 206, 87th Congress, Adopted September 23, 1961, 1962 (processed).

The duty on mercury waste and scrap (part of item 632.34) has been suspended almost continuously since March 1942 under various acts of Congress; the latest act (Public Law 90-45) extended the suspension through June 30, 1969 (see item 911.12 of the TSUSA-1968).

The TSUS also provides for U.S. Governmental importations to be entered free of duty (see items 833.00, 834.00 and 836.00 of the TSUSA-1968).

The ad valorem equivalent of the specific rate of duty on mercury metal has varied greatly in recent years owing to the marked increase in the average unit value of mercury imported; in 1963-66 the average ad valorem equivalents of the duty, based on dutiable imports in those years, were as follows:

| Year | Ad valorem equivalent (percent) |
|---|---|
| 1963 | 12.0 |
| 1964 | 8.9 |
| 1965 | 4.0 |
| 1966 | 4.8 |

In addition to the duty imposed on mercury metal, the iron or steel flask containing the mercury is also subject to duty. The duty on such flasks (item 640.30), effective January 1, 1968, is 9 percent ad valorem, reflecting the first stage reduction in a five-stage concession that was granted by the United States in the Kennedy Round; the final staged rate on this item will be 5 percent ad valorem (see summary in volume 6:5).

## U.S. consumption

Annual U.S. industrial consumption of mercury (as reported by consumers to the U.S. Bureau of Mines) has increased substantially since 1954, as indicated by the average annual consumption for the following periods:

| Annual average: | Number of flasks containing 76 pounds each |
|---|---|
| 1954-57 | 51,500 |
| 1958-61 | 53,600 |
| 1962-66 | 74,300 |

Average annual industrial consumption (exclusive of quantities of mercury released by the Atomic Energy Commission in 1963 and 1964 to other Government agencies for use in Government laboratories or donated to schools and so forth) was 30.7 percent larger in 1962-66 than in the preceding 4 years. In 1966, U.S. industrial consumption amounted to 72,000 flasks, compared with the record high of 83,000 flasks in 1964 (table 1). About 300 companies consume prime virgin mercury and about 400 use redistilled mercury; most of the concerns are situated in the eastern part of the United States.

The growth in consumption of mercury has been retarded only slightly by the substantial price advances in recent years; the annual average of the New York quoted price rose from $189.45 per flask in 1963 to $314.79 in 1964, and to $570.75 in 1965. Between January and the end of May 1965, the quoted price rose from $475 per flask to $740 and higher in some sales. After that time the price declined to about $330 per flask in June 1966, rose again to a range of $540 to $555 by mid-October, and averaged $441.72 per flask in 1966.

The principal factors contributing to the increase in U.S. consumption of mercury for industrial purposes between 1962 and 1966 were (1) the construction of new plants and the expansion of others producing chlorine and caustic soda using the mercury-cell process (such construction or enlargement required from 300 to more than 1,000 flasks of mercury per plant), 1/ (2) the increased use of mercury in the production of electrical apparatus, and (3) increases in the amount of mercury needed to replace cathode loses in the manufacture of chlorine and caustic soda (table 2). During this period, the quantity of mercury consumed for other uses, such as in catalysts, anti-fouling paint, and amalgamation also increased. The decline in consumption for paper and pulp manufacture, as well as that decline in consumption for pharmaceuticals and for agricultural uses, between 1964 and 1966 can probably be attributed to the high price of mercury.

In the 5 years 1962-66, mercury used in electrical apparatus accounted for about 19 percent of total industrial consumption; that used in industrial and control instruments, 12 percent; that needed to replace losses in the electrolytic preparation of chlorine and caustic soda, 12 percent; that used for paint, 9 percent; that for dental preparations, pharmaceuticals and agricultural uses, about 5 percent each; and that consumed for paper and pulp manufacture, catalysts, general laboratory use, and amalgamation, 12 percent. The

1/ Mercury used for this purpose, as well as mercury used in boilers, is not consumed and may be regarded as stocks if more urgent demands for mercury develop. At the end of 1965 (the latest period for which data are available), the quantity of mercury at such installations probably amounted to about 150,000 flasks.

great bulk of the remaining 21 percent was used as cathodes in the mercury cells at the new plants or in plant expansions for the electrolytic preparation of chlorine and caustic soda.

Of the total quantity of mercury consumed by the United States in the 9 years 1958-66 (585,907 flasks), 40 percent was supplied by the output of domestic mines; the rest was supplied by imports and domestic production of secondary mercury. In 1965 and 1966, however, part of industrial consumption requirements were supplied by the release of surplus stocks held by the Atomic Energy Commission. Mercury sold for U.S. industrial use by the General Services Administration aggregated 29,753 flasks in 1965 and 8,422 flasks in 1966, leaving approximately 36,825 flasks of surplus stocks available for disposal as of December 30, 1966. In addition to this surplus, there were about 200,000 flasks of mercury in the U.S. Government stockpiles at the end of 1966 all of which is needed for the conventional warfare objective.

U.S. producers

Mercury is produced in the United States by a relatively small number of large mines and by some 25 concerns that process mercury-bearing scrap (such as dental amalgams, and oxide and acetate sludges) and battery scrap. The supply is also augmented by reclaiming mercury from mercury boilers and caustic soda and chlorine plants that are withdrawn from service.

The mercury-mining industry, situated principally in California, Nevada, Oregon, and Idaho, is small compared with most other U.S. mining industries. During 1958-66 the estimated mine value of mercury produced ranged from $3.6 million in 1963 to $11.2 million in 1965.

Most of the U.S. production of virgin mercury has always been recovered at a few of the larger mines. In the period 1958-66 the number of mines in operation ranged from 48 in 1963 to 149 in 1965; some 8 to 22 mines, each producing 100 flasks or more per year, accounted for 95 to 98 percent of total mine production. Three mines, each producing 1,000 flasks or more during 1962-66, have accounted for 75 to 89 percent of total mine production in that period.

It is estimated that the average number of persons (including working proprietors) engaged in mining and processing mercury ores declined from 780 in 1958 to 580 in 1961. In 1963, the latest period for which official data are available, the total number of employees (excluding working proprietors) at mines was 316.

U.S. production

Mercury metal is recovered from its principal ore mineral, cinnabar, by heating the ore in a furnace or retort to a temperature of about 1,080° F., at which point mercury is released from the ore in the form of a mercuric sulfide vapor. The sulfur is separated from the vapor by converting it to sulfur dioxide with the use of air, oxygen, or lime and iron; the mercury vapor is then condensed into liquid mercury and the sulfur dioxide is released as a gas. The mercury content of the ore mined is small. In consequence, the metal is recovered from the ore more economically at the mines than at points distant from the mines.

Mine production of mercury declined from 38,067 flasks in 1958, the largest peace-time production in any year since 1883, to 19,117 flasks in 1963 and to 14,142 flasks in 1964, then rose to 22,008 flasks in 1966 (table 1). During 1951-58 the share of domestic industrial consumption supplied by domestic mines increased from 13 percent in 1951 to 72 percent in 1958; during the years 1954-58 domestic producers were guaranteed a floor-price of $225 a flask by the U.S. Government. With the drop in the price of mercury during the period 1959 to mid-1963, the share of domestic requirements supplied by domestic mines gradually declined; and during 1964-66, despite greatly increased mercury prices, domestic mine out-put accounted for only 24 percent of domestic industrial consumption.

When the price of mercury is high, substantial quantities are produced by many small mines or workings and the average grade of ore mined is lower, as indicated by the following tabulation:

| Year | Mines in operation | Mine output | Average New York quoted price | Average grade of ore |
|---|---|---|---|---|
| | Number | Flasks containing 76 pounds | Per flask | Pounds per ton of ore |
| 1958 | 101 | 38,067 | $229.06 | 8.6 |
| 1959 | 71 | 31,256 | 227.48 | 8.6 |
| 1960 | 75 | 33,223 | 210.76 | 9.7 |
| 1961 | 69 | 31,662 | 197.61 | 9.2 |
| 1962 | 56 | 26,277 | 191.21 | 13.6 |
| 1963 | 48 | 19,117 | 189.45 | 12.8 |
| 1964 | 72 | 14,142 | 314.79 | 7.2 |
| 1965 | 149 | 19,582 | 570.75 | 4.3 |
| 1966 | 130 | 22,008 | 441.82 | 5.2 |

There is a considerable time lag between changes in mine output and those of price. Owing to the general instability of mercury prices domestic operators are reluctant to reopen closed mines or to expand operations when prices begin to rise after a prolonged period of low prices. Such reopenings or expansions require much time and considerable expenditures of funds to recruit technical and other help, block out ore reserves, and acquire the necessary equipment and supplies. On the other hand, when the market prices decline to low levels many mine operators are forced out of business and those that remain in operation (as in 1962-63) resort to mining only the highest grade ore in the deposit and reduce operating costs by curtailing or halting exploration and associated development work.

During 1958-62, three States accounted for 93 percent of the total production of virgin mercury; these States, listed in order of magnitude of mercury output were California, Nevada, and Alaska. Since 1962, however, output in the latter State has been small (table 3) because of the closing and subsequent flooding of the Red Devil mine--one of the largest producers during 1956-62.

The recovery of mercury from secondary sources, excluding the mercury released by the Atomic Energy Commission, ranged from 4,950 flasks in 1959 to almost 17,000 flasks in 1965; the high level output in 1965 is attributable in part, to the withdrawal from service of a mercury boiler.

U.S. exports

U.S. exports of domestic mercury are small. Exports are discouraged by the fact that the price abroad has usually been lower than that prevailing in the United States, and exports, except those to Canada, have been subjected to various restrictions such as licensing requirements by foreign governments.

It is estimated that annual exports, if any, of mercury metal produced in the United States were less than 100 flasks during 1958-64. 1/ In 1965, however, when the prices in foreign countries were higher than those in the United States, exports of domestic mercury aggregated 7,569 flasks valued at $5 million (table 4). Mercury

1/ Export statistics for years prior to 1965 as compiled by the U.S. Department of Commerce are not comparable with statistics on production, imports, or consumption, since such export data represent not only shipments of mercury metal (primary, redistilled, or triple-distilled) but also compounds and preparations of mercury and mercury-bearing raw materials, such as furnace soot, scrap, spent catalysts, and residues.

was exported in that year principally to the United Kingdom, Japan, Canada and Taiwan. During 1966, exports aggregated 357 flasks valued at $197,000; about 26 percent of the total quantity was exported to Canada, 25 percent to France, 33 percent to 20 countries in Central and South America, and the remainder to 19 countries in Europe, Asia, and Africa.

U.S. imports

Annual U.S. imports of mercury metal declined from 30,200 flasks in 1958 to 12,300 in 1961 and then rose to an annual average of 42,000 flasks in 1963-64. Imports of mercury metal declined to 16,200 flasks in 1965 but rose to 31,400 flasks in 1966 (table 1). Mercury ore has not been imported in recent years.

Dutiable imports have consisted almost entirely of mercury imported by private industry. During 1958-61 when domestic mines were operating at fairly high levels, dutiable imports fluctuated from 12,300 flasks in 1961 to 24,100 flasks in 1959. During 1963-64, with demand at high levels and domestic production declining, dutiable imports increased substantially, averaging about 42,000 flasks a year. In 1965, despite increased consumption requirements combined with a low level of mine production in the United States, dutiable imports declined to 16,200 flasks. This low level of importation is probably attributable to the high foreign demand, foreign producers' prior commitments in their own and other countries, and the release of surplus mercury by the Atomic Energy Commission to U.S. consumers. In 1966, however, dutiable imports increased to 30,900 flasks.

Although duty-free imports amounted to 11,157 flasks in 1958 and 6,005 in 1959 (mostly acquired by the U.S. Government under the barter program), duty-free imports were relatively small thereafter and consisted almost entirely of waste and scrap entered under various laws which suspended duties on such imports.

Spain, Italy, Mexico, and Yugoslavia have been the principal sources of both dutiable and duty-free imports of mercury. In 1963 and 1964, however, substantial quantities were also supplied by Peru and other countries (table 5).

The share of U.S. consumption (excluding that released by the Atomic Energy Commission supplied by dutiable imports has varied widely from year to year during 1958-66, ranging from as much as 63 percent in 1964 to as little as 22 percent in 1961; the ratio was 49 percent in 1966.

Foreign production and trade

Mercury is produced in approximately 18 countries. In some countries mercury is recovered at many small mines whereas in others, such as Spain and Italy, the total output is obtained at very few large mines. Little information is available on operations in Communist countries. The average grade of ore mined in foreign countries, especially in Spain and Italy, is higher than that of ore mined in the United States. Spanish ore is believed to average about 50 pounds of mercury per ton and Italian ore about 15 pounds per ton, compared with an average of less than 8 pounds per ton for ore mined in the United States. The principal foreign mines are partly or wholly State-controlled.

Annual world production of primary mercury (excluding that produced in the U.S.S.R. and mainland China) averaged 191,700 flasks during 1958-66, ranging from 175,000 flasks in 1959 to 206,000 flasks in 1965 (table 6). Spain, Italy, the United States, and Mexico were the principal producers, accounting for 84 percent of the total output during 1958-66. Yugoslavia and Japan have also been important, but smaller, producers. There are no reliable data available on the output of mercury in the Soviet Union or mainland China, but some observers have estimated that annual production in these countries in recent years probably ranges from 50,000 to 65,000 flasks.

The U.S. share of world production rose almost steadily after 1950 (a year when almost all of the domestic mines were shut down owing to the low price of mercury) until it reached 18.7 percent in 1958; thereafter its share declined. Mercury production in the United States represented only 9.5 percent of world output in 1965 and 10.9 percent in 1966.

Mercury is consumed in practically every country in the world. In three of the large producing countries--Spain, Yugoslavia, and Mexico--consumption is negligible and most of the output is exported. Italy probably consumes about one-tenth of its own production and exports the remainder. The U.S.S.R. and some of the Eastern European countries have in the past exported some of their mercury to the free world but since 1964 these countries not only have consumed their output within their borders or within the Communist bloc but also have purchased mercury from the free world.

Table 1.--Mercury: U.S. production, imports for consumption, exports of domestic merchandise, and reported consumption, 1958-66

| Year | Production | | | Imports | Exports | Reported consumption |
|---|---|---|---|---|---|---|
| | Mine output | Secondary output 1/ | Total 1/ | | | |
| | Quantity (flasks containing 76 pounds) | | | | | |
| 1958 | 38,067 | 5,400 | 43,467 | 30,196 | 2/ | 52,617 |
| 1959 | 31,256 | 4,950 | 36,206 | 30,141 | 2/ | 54,895 |
| 1960 | 33,223 | 5,350 | 38,573 | 19,488 | 2/ | 51,167 |
| 1961 | 31,662 | 8,360 | 40,022 | 12,313 | 2/ | 55,763 |
| 1962 | 26,277 | 5,800 | 32,077 | 31,652 | 2/ | 65,301 |
| 1963 | 19,117 | 10,520 | 29,637 | 42,872 | 2/ | 3/ 77,963 |
| 1964 | 14,142 | 24,519 | 38,661 | 41,153 | 2/ | 3/ 82,608 |
| 1965 | 19,582 | 46,670 | 66,252 | 16,238 | 7,569 | 3/ 73,560 |
| 1966 | 22,008 | 16,100 | 38,108 | 31,365 | 357 | 3/ 72,033 |
| | Value 4/ (1,000 dollars) | | | | | |
| 1958 | 8,720 | 1,237 | 9,957 | 5,922 | 2/ | 5/ |
| 1959 | 7,110 | 1,126 | 8,236 | 5,992 | 2/ | 5/ |
| 1960 | 7,002 | 1,128 | 8,130 | 3,510 | 2/ | 5/ |
| 1961 | 6,257 | 1,653 | 7,910 | 2,048 | 2/ | 5/ |
| 1962 | 5,024 | 1,109 | 6,133 | 5,102 | 2/ | 5/ |
| 1963 | 3,623 | 1,993 | 5,616 | 6,766 | 2/ | 5/ |
| 1964 | 4,452 | 7,718 | 12,170 | 8,775 | 2/ | 5/ |
| 1965 | 11,176 | 26,637 | 37,813 | 7,614 | 5,042 | 5/ |
| 1966 | 9,724 | 7,113 | 16,837 | 12,322 | 197 | 5/ |

1/ Data include Government surplus releases amounting to 4,000 flasks in 1963, 17,000 flasks in 1964, 29,753 flasks in 1965 and 8,422 flasks in 1966. Releases in 1963 and 1964 were for the use of U.S. Government agencies.
2/ Not available (see note to table 4).
3/ Includes the quantities referred to in Note 1 above.
4/ Value of domestic production computed by multiplying the number of flasks produced by the average New York price.
5/ Not available.

Source: Production and consumption data compiled from official statistics of the U.S. Bureau of Mines, except as noted; import and export data compiled from official statistics of the U.S. Department of Commerce.

Table 2.--Mercury: U.S. consumption, by uses, 1958 and 1962-66

(In flasks containing 76 pounds)

| Use | 1958 | 1962 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|---|
| Pharmaceuticals | 1,430 | 3,378 | 4,081 | 5,047 | 3,261 | 3,668 |
| Electrical apparatus 1/ | 12,736 | 14,080 | 13,422 | 13,427 | 16,201 | 14,982 |
| Catalysts | 816 | 874 | 612 | 656 | 924 | 1,932 |
| Industrial and control instruments 1/ | 10,117 | 8,871 | 9,003 | 9,534 | 10,004 | 7,380 |
| Agriculture (for insecticides, fungicides, and bactericides for industrial purposes) | 2/ 6,270 | 4,266 | 2,538 | 3,144 | 3,116 | 2,374 |
| Paint (antifouling and mildew-proofing) | 3/ 749 | 4,678 | 6,655 | 5,445 | 7,789 | 8,395 |
| Paper and pulp manufacture | 4/ | 2,600 | 2,831 | 2,148 | 619 | 612 |
| Dental preparations 1/ | 2,686 | 3,291 | 3,545 | 5,007 | 3,411 | 2,125 |
| Electrolytic preparation of chlorine and caustic soda | 4,547 | 7,314 | 7,999 | 9,572 | 8,753 | 11,541 |
| General laboratory 5/ | 968 | 1,752 | 5,062 | 18,516 | 1,077 | 2,203 |
| Amalgamation | 248 | 299 | 306 | 667 | 495 | 485 |
| Other | 12,050 | 13,898 | 21,909 | 9,445 | 17,910 | 16,336 |
| Total | 52,617 | 65,301 | 77,963 | 82,608 | 73,560 | 72,033 |

1/ Data include the consumption of prime virgin metal as reported to the U.S. Bureau of Mines plus estimates of the quantity of redistilled mercury consumed.

2/ Includes quantity used in paper and pulp manufacture.

3/ Represents the quantity consumed in the manufacture of antifouling paint only.

4/ Included with data for uses in agriculture.

5/ Includes 3,821 flasks in 1963 and 17,000 flasks in 1964 released by the Atomic Energy Commission to other Government agencies.

Source: Compiled from official statistics of the U.S. Bureau of Mines.

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Table 3.--Mercury: U.S. mine production, by principal producing States, 1958 and 1962-66

(In flasks contaiaing 76 pounds)

| State | 1958 | 1962 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|---|
| Alaska | 3,380 | 3,719 | 400 | 303 | 1/ | 1/ |
| Arizona | 53 | 1/ | 1/ | 77 | 158 | 363 |
| California | 22,365 | 15,951 | 13,592 | 10,291 | 13,404 | 16,070 |
| Idaho | 2,625 | - | 1/ | 83 | 1,119 | 1,134 |
| Nevada | 7,336 | 6,573 | 4,944 | 3,262 | 3,333 | 3,355 |
| Oregon | 2,276 | 1/ | 1/ | 126 | 1,364 | 700 |
| Other | 32 | 34 | 181 | - | 204 | 386 |
| Total | 38,067 | 26,277 | 19,117 | 14,142 | 19,582 | 22,008 |

1/ Included in quantity shown for "Other".

Source: Compiled from official statistics of the U.S. Bureau of Mines.

Table 4.--Mercury: U.S. exports of domestic merchandise, by principal markets, 1965

| Market | Quantity | Value | Unit value 1/ |
|---|---|---|---|
| | Flasks containing 76 pounds | 1,000 dollars | Per flask |
| United Kingdom | 1,627 | 1,170 | $719.15 |
| Japan | 1,380 | 892 | 645.92 |
| Canada | 999 | 691 | 691.98 |
| Taiwan | 768 | 515 | 669.91 |
| West Germany | 543 | 345 | 635.55 |
| France | 590 | 432 | 732.13 |
| Netherlands | 500 | 266 | 532.50 |
| All others | 1,162 | 731 | 629.91 |
| Total or average | 7,569 | 5,042 | $666.21 |

1/ Computed on basis of unrounded figures.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Note.--Before 1965, exports of mercury were small compared with imports and domestic production. Moreover, official data on exports included--in addition to mercury metal (primary, redistilled, or triple distilled)--compounds and preparations of mercury as well as mercury-bearing raw materials such as furnace soot and scrap.

In 1966, exports of mercury metal aggregated 357 flasks, valued at $197,400. About 26 percent of the total quantity was exported to Canada, 25 percent to France, 33 percent to 20 countries in Central and South America, and the remainder to 19 other countries in Europe, Asia, and Africa.

Table 5.--Mercury: U.S. imports for consumption, by principal sources, 1/ 1961-66

| Country | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|---|
| | Quantity (flasks containing 76 pounds) | | | | | |
| Spain | 6,544 | 9,826 | 19,950 | 24,344 | 10,995 | 6,115 |
| Peru | - | - | 3,227 | 3,065 | 1,368 | 451 |
| Mexico | 3,010 | 7,718 | 4,292 | 1,230 | 1,290 | 6,030 |
| Italy | 2,073 | 10,501 | 8,474 | 5,236 | 1,203 | 13,942 |
| Yugoslavia | 355 | 3,276 | 4,459 | 3,953 | 1,101 | 3,277 |
| Chile | 82 | 200 | 740 | - | - | - |
| All other | 249 | 131 | 1,730 | 3,325 | 281 | 1,550 |
| Total | 12,313 | 31,652 | 42,872 | 41,153 | 16,238 | 31,365 |
| | Value (1,000 dollars) | | | | | |
| Spain | 1,118 | 1,638 | 3,176 | 5,037 | 5,811 | 2,524 |
| Peru | - | - | 511 | 502 | 318 | 149 |
| Mexico | 444 | 1,076 | 585 | 272 | 544 | 2,212 |
| Italy | 365 | 1,799 | 1,402 | 1,262 | 334 | 5,554 |
| Yugoslavia | 62 | 537 | 696 | 939 | 475 | 1,264 |
| Chile | 15 | 31 | 112 | - | - | - |
| All other | 44 | 21 | 284 | 763 | 132 | 619 |
| Total | 2,048 | 5,102 | 6,766 | 8,775 | 7,614 | 12,322 |

1/ Includes duty-free imports amounting to 24 flasks, valued at 4 thousand dollars in 1961, 61 flasks, valued at 10 thousand dollars in 1962, 151 flasks, valued at 28 thousand dollars in 1963, 59 flasks, valued at 15 thousand dollars in 1964, 28 flasks, valued at 11 thousand dollars in 1965, and 500 flasks, valued at 132 thousand dollars in 1966.

Source: Compiled from official statistics of the U.S. Department of Commerce.

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Table 6.--Mercury: World production, by principal producing countries, 1958 and 1962-66 1/

(In flasks containing 76 pounds)

| Country | 1958 | 1962 | 1963 | 1964 | 1965 | 1966 1/ |
|---|---|---|---|---|---|---|
| United States | 38,067 | 26,277 | 19,117 | 14,142 | 19,582 | 22,008 |
| Italy | 58,712 | 54,506 | 54,448 | 57,001 | 57,320 | 53,549 |
| Spain | 55,382 | 52,798 | 56,954 | 78,322 | 82,760 | 78,002 |
| Mexico | 22,556 | 18,855 | 16,302 | 12,549 | 19,190 | 17,000 |
| Yugoslavia | 12,270 | 16,273 | 15,838 | 17,318 | 16,419 | 15,896 |
| Japan | 5,720 | 4,199 | 4,668 | 4,812 | 4,536 | 4,500 |
| Peru | 1,983 | 3,481 | 3,092 | 3,275 | 3,117 | 3,000 |
| Turkey | 1,486 | 2,667 | 3,042 | 2,615 | 2,755 | 2,800 |
| Philippines | 3,321 | 2,767 | 2,651 | 2,496 | 2,384 | 2,400 |
| All other 2/ | 4,663 | 1,749 | 1,640 | 1,294 | 1,636 | 1,335 |
| Total 3/ | 204,000 | 184,000 | 178,000 | 194,000 | 206,000 | 201,000 |

1/ Preliminary; partly estimated.

2/ Includes Bolivia, Canada, Chile, Colombia, Czechoslovakia, Romania, and Tunisia. Mainland China and the U.S.S.R., not included in this tabulation, are known to produce mercury, but no reliable information on which to base estimates of their production is available; annual output from these countries may range between 50,000 to 65,000 flasks.

3/ Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.

Source: Compiled from official statistics of the U.S. Bureau of Mines Mines.

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| Commodity | TSUS item |
|---|---|
| Cadmium: | |
| Ores | 601.66 (pt.) |
| Flue dust or fume | 603.20 |
| Metal, waste, and scrap | 632.14 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

In recent years the United States--the free world's largest producer and consumer of cadmium metal--has imported at least two-thirds of the cadmium-bearing materials (mostly zinc ores and cadmium flue dust) processed in its plants for the recovery of cadmium metal. In addition, the United States imported about one-tenth of the cadmium metal it consumed. Annual exports of cadmium metal have generally exceeded imports of cadmium metal by a small margin.

## Description and uses

Cadmium is a soft, bluish-silver-white metal derived from processing the mineral greenockite (cadmium sulfide), which is present in small quantities in zinc ores (chiefly sphalerite) and to a lesser extent in lead ores. Since there are no known commercial deposits of greenockite, cadmium ore (included in item 601.66) as such is not an article of commerce. Cadmium flue dust and fume are recovered as a byproduct during roasting, smelting, or other processing of zinc-bearing ores, and the bulk of the unwrought cadmium metal produced is obtained by processing the flue dust or fume.

Since cadmium is recovered primarily as a byproduct of zinc smelting and refining operations, the U.S. supply is dependent upon the level of those operations. Although practically all zinc ores contain some cadmium-bearing minerals, the content is often too small to warrant the cost of recovery. Currently, the cadmium content of zinc concentrates treated for the recovery of cadmium ranges from 0.17 percent to 1.4 percent--equivalent to 3.4 to 28 pounds per ton of concentrates.

Cadmium, one of the higher priced base metals, is marketed primarily as metal in the form of sticks, bars, balls, ingots, anodes, powder, flakes, and special platers' shapes. Some cadmium is shipped in the form of sponge and in chemical compounds and pigments; cadmium

sponge, an intermediate product used in the production of metal, is classified as unwrought metal for tariff purposes. In recent years, commercial grade cadmium metal has been at least 99.95 percent pure; some cadmium metal is also available in the hyperpure form--containing not more than 1 part per million of impurities. To retard oxidation, cadmium sponge is shipped to consumers in bags or drums. Balls and sticks are generally packed in boxes containing 50, 100, or 200 pounds of cadmium; ingots, weighing about 25 pounds each, are packed eight to the box; and the method of packing anodes, powder, and flakes depends on the size of the order.

Almost two-thirds of annual U.S. consumption of cadmium (whether in the form of metal or plating chemicals) is used for anticorrosive coatings applied by electroplating primarily to steel and, to a lesser extent, to copper-base alloys. Although zinc is a good anticorrosive coating material and the initial cost of zinc per pound is much less than that of cadmium, the latter metal is preferred for electroplating because it can be deposited more uniformly (especially in the recesses of intricately shaped parts). Cadmium is also more ductile than zinc and slightly more resistant to atmospheric corrosion; moreover, less electric current is consumed per unit of area covered. Cadmium-plated articles include a wide range of parts and accessories used in military equipment, aircraft, automobiles, and household appliances.

The manufacture of pigments and other compounds accounts for 15 to 20 percent of the total consumption of cadmium in the United States. These articles (e.g., items 423.00, 427.28, and 473.88), which are manufactured either directly from cadmium sponge or from cadmium metal, are discussed in separate summaries in volumes 4:4, 4:5, and 4:10.

Cadmium is a neutron absorber, and thus the intensity of the chain reaction which occurs in an atomic reactor--as by the fission of $U_{235}$--can be moderated by the insertion of cadmium into the reactor, either as a coating on graphite or in the form of solid cadmium rods.

The metal is also used in various proportions as an alloying agent in many special applications. Alloys of which the cadmium content is, by weight, not less than the content of any other metallic element (not presently articles of commerce), is included under item 632.84 (see summary in volume 6:3). Copper containing 1 percent of cadmium has a tensile strength approximately 50 percent greater than that of pure copper; copper alloys of this type are used for telephone cables and trolley wires and for certain electric-welding electrodes. Bismuth alloys (items 632.64 and 632.66) containing 1 to 15 percent of cadmium metal have a very low melting point and are used in automatic sprinkler systems, steam boilers, and fire alarm systems; these are discussed elsewhere in volume 6:1. Cadmium-silver, cadmium-nickel, and cadmium-silver-copper alloys are all used for specific

types of bearings. Cadmium-nickel alkaline storage batteries are employed in buses, diesel locomotives, and other heavy machinery. Hyperpure cadmium is used primarily in electronic applications, such as in semiconductor devices.

In this summary all quantities of the products covered by this summary are expressed in pounds.

## U.S. tariff treatment

The column 1 (or trade-agreement) rates of duty applicable to imports of cadmium (see general headnote 3 in the TSUSA-1968) are as follows:

| TSUS item | Commodity | Prior rate | U.S. concessions granted in 1964-67 trade conference (Kennedy Round) | |
|---|---|---|---|---|
| | | | First stage, effective Jan. 1, 1968 | Final stage, effective Jan. 1, 1971 |
| | Cadmium: | | | |
| 601.66 (pt.) | Ore | Free | 1/ | 1/ |
| 603.20 | Flue dust or fume. 2/ | Free | 1/ | 1/ |
| 632.14 | Metal, including waste and scrap. | 3.75¢ per lb. | 3¢ per lb. | Free |

1/ Duty-free status not affected by trade conference.
2/ Containing, by weight, over 55 percent of cadmium and not over 15 percent of any one or combination of the metals lead, zinc, or copper.

The duty-free status of both cadmium ore and cadmium flue dust or fume was established in the Tariff Act of 1930 as originally enacted, and that of the cadmium flue dust or fume was bound in a concession granted by the United States in the General Agreement on Tariffs and Trade (GATT) in 1965. The prior rate of duty of 3.75 cents per pound on cadmium metal including cadmium waste and scrap, was established on January 1, 1948, as a result of a concession granted by the United States in the GATT; this rate remained unchanged under the TSUS from August 31, 1963 through 1967. Under a concession granted by the United States in the sixth round of trade negotiations under the GATT, however, this rate is being reduced to zero, in four annual stages, with the

free rate effective January 1, 1971. The first stage of the concession reduced the rate to 3 cents per pound, effective January 1, 1968 (see the TSUSA-1968 for the intermediate staged rates).

The duty on cadmium waste and scrap has been suspended almost continuously since March 14, 1942, pursuant to receiving temporary suspensions by public laws. The latest Public Law (90-45) extends the suspension through June 30, 1969 (see item 911.12 of the appendix to the TSUSA-1968).

In addition to the aforementioned, the TSUSA also provides for U.S. Governmental importations to be entered free of duty (see items 833.00, 834.00 and 836.00 of the TSUSA-1968).

The ad valorem equivalent of the duty of 3.75 cents per pound on cadmium metal, based on dutiable imports in 1966, averaged 1.8 percent.

U.S. consumption

Cadmium is consumed by approximately 1,500 firms centered in industrial areas, chiefly in Illinois, Ohio, New York, Michigan, Pennsylvania, California, New Jersey, and Massachusetts. In 1958 the estimated apparent domestic consumption of cadmium metal was slightly in excess of 8 million pounds (table 1). Consumption reached a high of 12.1 million pounds in 1962, declined to 9.4 million pounds in 1964, and then rose to a record high of 14.8 million pounds in 1966.

In 1963, when cadmium metal was in short supply, 2 million pounds of it was released to domestic consumers from U.S. Government stockpiles. Supplies continued to be tight in early 1964, and the General Services Administration (GSA) was authorized to dispose of an additional 5 million pounds from the Government stockpiles. Although GSA made available 600,000 pounds (of the 5 million pounds authorized) during the third quarter of 1964 at prevailing U.S. market prices, total sales in that period amounted to only 33,400 pounds. The lack of bids was attributed to an improvement in the availability of cadmium through commercial channels and to the unsuitability of available shapes in the Government stockpiles. Cadmium metal was not offered for sale by the GSA during the last quarter of 1964, and although it was offered in 1965, no sales were made. In 1966, however, approximately 640,000 pounds was sold as the result of increased demand. At the end of 1966, cadmium metal in the U.S. Government stockpiles aggregated 14.8 million pounds--substantially in excess of the current U.S. stockpile conventional warfare objective of 5.1 million pounds.

## U.S. producers

The principal producers of cadmium metal are the leading producers of primary 1/ slab zinc. In 1966, 9 companies produced primary metallic cadmium at 10 plants; 7 of the plants were operated in conjunction with facilities for producing primary slab zinc, 2 were operated in conjunction with facilities for producing primary lead, and the remaining plant was operated almost exclusively for the recovery of metallic cadmium from flue dust and residues produced elsewhere. Two plants were situated in each of the States of Oklahoma and Pennsylvania, and one plant each in Colorado, Idaho, Illinois, Kansas, Montana, and Texas. In 1965, when 10 concerns were engaged in recovering cadmium metal, the 3 largest accounted for 61 percent of the total; the next 3, for 27 percent; and the remaining 4, for 12 percent. It is estimated that the total average annual employment in the cadmium plants ranged from 600 to 630 persons.

In addition to the aforementioned 10 plants at which metallic cadmium was recovered, there are primary zinc and lead smelters and refineries with facilities for the recovery of cadmium-bearing materials such as fume, dust, and residues. These substances are either (1) transferred to other plants of the same ownership for the production of cadmium metal, (2) sold outright to other cadmium-metal producers, or (3) processed by cadmium-metal producers on a toll basis (i.e., having cadmium-bearing materials processed by others for a fee while retaining ownership of the metal produced). Several other companies generally recover cadmium metal or compounds from scrap, such as old bearings and secondary residues. Production from these sources, however, is small.

## U.S. production, stocks, and prices

Production of cadmium metal (including the metal content of cadmium sponge used directly in the production of compounds) from both foreign and domestic materials during 1958-66 ranged from 8.7 million pounds in 1959 to a record high of 11.1 million pounds in 1962 (table 1). In 1966, production was about 10.5 million pounds. In recent years (1962-66) about 13 percent of the total production has been derived from imported cadmium flue dust (table 2), which came principally from Mexico. Except for a small quantity recovered from scrap, the rest has been obtained in processing domestic and foreign zinc ores, with foreign ores accounting for more than half of the total.

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1/ The term "primary" refers to metal recovered by processing ores, concentrates, residues, flue dust, fume or other cadmium-bearing raw materials, whereas the term "secondary" refers to metal obtained by processing scrap and waste materials.

As previously noted, the production of cadmium metal depends primarily upon the accumulation of cadmium-bearing materials such as fume, dust, and residues at zinc plants. Inasmuch as new supplies of these materials are not constant but are governed by the rate of zinc-refining operations, producers of cadmium metal generally build up their stocks of both the cadmium-bearing materials and the metal even when the demand for the metal is at a low level. Stocks of cadmium metal held by domestic producers declined steadily from a high of 5.5 million pounds at the end of 1958 to 755,000 pounds at the end of 1963 (table 2). Producers' stocks then rose to 1.5 million pounds at the end of 1964 and to slightly more than 3 million pounds at the end of 1965--the highest level since the end of 1959. At the end of 1966 producers' stocks aggregated 1.7 million pounds. Stocks of metal held by distributors and by manufacturers of compounds were smaller than those held by producers--ranging from 228,000 pounds at the end of 1958 to a high of 758,000 pounds at the end of 1966.

Although producers market some cadmium directly to consumers, they sell the bulk of their output through distributors to avoid handling a large number of small orders. Prices quoted by distributors are normally similar to those quoted by the primary producers; at times, however, the distributors' quoted price has exceeded the producers' quoted price by as much as 50 cents a pound. U.S. producers' quoted prices for bars, sticks, and other shapes in lots of 1 to 5 tons, which averaged $1.36 a pound in 1959, advanced to an average of $2.26 a pound in 1963. By reason of the tight supply in 1963, the price rose from $1.70 to $1.80 a pound in January to $3.00 a pound in December; the latter price was maintained throughout 1964. With a buildup of producers' stocks, however, the price declined to $2.65 a pound early in March 1965 and to $2.40 a pound in June 1965, where it remained until November 22, 1966 when it advanced to $2.55 a pound.

## U.S. exports

Annual exports of cadmium during 1958-62, except for the year 1960, were less than a million pounds, consisting almost entirely of metal (table 1). In 1960, owing to an unusual rise in demand in the United Kingdom, exports increased to almost 2.5 million pounds (gross weight). In 1963 and 1964, when the price of cadmium was still considerably higher in foreign countries than in the United States, exports amounted to 1.3 million pounds and 1.4 million pounds, respectively. In 1965 and 1966, prices abroad were lower than those in the United States, and exports declined to 73,000 pounds in 1965 and amounted to 379,000 pounds in 1966.

During 1958-66, annual exports of cadmium averaged 950,000 pounds (valued at $1.67 million) and were equivalent to about 9 percent of the annual average of production or consumption in the United States (table 1). Of the total quantity exported during 1963-66, 55 percent went to the United Kingdom, 19 percent to the Netherlands, 11 percent to France, and 8 percent to West Germany; the remainder was distributed among some 10 to 20 countries (table 3).

U.S. imports

During 1958-66 the aggregate quantity of cadmium entering the United States, based on the gross weight of imports of the metal and on the cadmium content of imported flue dust ranged from 1.3 million pounds in 1961 to 4.5 million pounds in 1966. During 5 out of 9 of the years 1958-66, the cadmium content of imports of flue dust was larger than that of imports of cadmium metal (table 4). In 1966, however, almost 75 percent of the total quantity imported was in the form of metal. In 1961-66, 66 percent of the total imports of cadmium in all forms were supplied by Mexico and Canada (table 5).

Imports of cadmium metal only (dutiable and duty-free) during 1958-66 ranged from 942,000 pounds in 1960 to 3.36 million pounds in 1966. In that period about 7 percent of the total quantity entered duty-free and consisted principally of metal acquired by the U.S. Government under barter transactions. Canada, Peru, and the Republic of the Congo were the principal sources of the dutiable imports, whereas the Republic of the Congo, Japan, Peru, and Angola were the principal suppliers of duty-free imports.

Annual duty-free imports of cadmium flue dust varied widely during 1958-66 and averaged about 1.3 million pounds of contained cadmium, valued at $878,000 (table 4). In 1966, imports of cadmium flue dust contained 1.2 million pounds of cadmium, valued at $989,000. All imports of flue dust during 1958-66 came from Mexico, except for small quantities imported from Canada in 1960 and from Belgium in 1964.

In 1958-66, aggregate imports of cadmium metal (including that acquired by the U.S. Government for stockpiling) were equivalent to about 14 percent of the estimated quantity of U.S. consumption of cadmium in all forms. In addition, it is estimated that about 70 percent of the cadmium contained in flue dust and cadmium-bearing zinc ores used for the production of metallic cadmium in the United States during 1958-66 was of foreign origin--12 percent contained in the imported flue dust and an estimated 58 percent contained in imported cadmium-bearing zinc ores.

Foreign production and trade

World production of cadmium metal increased steadily from 16.1 million pounds in 1954 to 21.6 million pounds in 1958 and to 28.9 million pounds in 1964 (table 6). In 1966, producers in the free world--principally the United States, Canada, Belgium, France, and Australia--accounted for 81 percent of the world total of 26.9 million pounds; the remaining 19 percent was produced by the U.S.S.R., Poland, and the Soviet Zone of East Germany.

The United States, with an average annual output in recent years of about 10 million pounds of cadmium metal, is the largest producer in the world. The rate of growth in the production of cadmium metal in the United States, however, has been considerably less in recent years than that in many of the other countries of the free world, partly because increasing amounts of foreign cadmium-bearing zinc ores have been diverted from the United States to other countries and partly because the zinc ores mined in the United States have recently contained smaller amounts of cadmium. Consequently, the share of total world production accounted for by U.S. producers has steadily diminished--from 59 percent of the total in 1954 to 45 percent in 1958 and to 39 percent in 1966.

Of the large producers of cadmium metal in the free world, Japan has shown the greatest increase in recent years. Japanese production rose from 974,000 pounds in 1958 to 3.3 million pounds in 1966 (i.e., from 4 to 12 percent of world production). Much of Japan's increase is attributable to byproduct production of cadmium that resulted from expansion in the production of slab zinc (from 155,000 short tons in 1958 to 405,400 in 1966); much of the zinc and cadmium produced in Japan, especially in recent years, has been derived from high cadmium-bearing zinc ores from Mexico and South American countries obtained in competition with buyers in the United States and in Europe.

Table 1.--Cadmium flue dust, and unwrought metal (including waste and scrap): U.S. production, imports for consumption, exports of domestic merchandise, and apparent consumption, 1958-66

| Year | Production 1/ | Imports 2/ | Exports 3/ | Apparent consumption 4/ |
|---|---|---|---|---|
| | Quantity (1,000 pounds of contained cadmium) | | | |
| 1958 | 9,673 | 2,220 | 580 | 8,209 |
| 1959 | 8,710 | 3,182 | 900 | 11,589 |
| 1960 | 10,445 | 2,803 | 2,448 | 10,126 |
| 1961 | 10,466 | 1,318 | 702 | 10,184 |
| 1962 | 11,137 | 2,687 | 717 | 12,146 |
| 1963 | 9,990 | 2,095 | 1,313 | 11,482 |
| 1964 | 10,458 | 2,376 | 1,439 | 9,364 |
| 1965 | 9,671 | 3,652 | 73 | 10,431 |
| 1966 | 10,460 | 4,539 | 379 | 14,780 |
| | Value (1,000 dollars) | | | |
| 1958 | 12,294 | 1,973 | 771 | 5/ |
| 1959 | 9,669 | 2,328 | 1,024 | 5/ |
| 1960 | 12,833 | 1,936 | 3,014 | 5/ |
| 1961 | 14,557 | 1,584 | 983 | 5/ |
| 1962 | 17,071 | 2,490 | 1,139 | 5/ |
| 1963 | 21,590 | 2,927 | 3,070 | 5/ |
| 1964 | 29,588 | 4,415 | 4,033 | 5/ |
| 1965 | 22,790 | 6,190 | 195 | 5/ |
| 1966 | 23,747 | 7,802 | 795 | 5/ |

1/ Represents production of primary cadmium metal (from ores, residues, and flue dust) plus secondary cadmium metal (from waste, scrap, and old residues). Value is estimated on the basis of average unit value of shipments, f.o.b. plant, by domestic producers.

2/ Represents imports of cadmium metal, flue dust, and waste and scrap. Imports of cadmium ore, if any, were negligible.

3/ Data for years prior to 1965 include cadmium metal, alloys, dross, flue dust, residues and scrap, whereas beginning in 1965, data represent exports of cadmium metal, alloys--wrought and unwrought, and waste and scrap. However, judging from average unit values of exports to the various countries, practically all of the exports since 1958 have consisted of cadmium metal only.

4/ Production plus imports minus exports, adjusted for yearend changes in known industrial and U.S. Government stocks. 5/ Not available.

Source: Production and apparent consumption compiled from official statistics of the U.S. Bureau of Mines; imports and exports compiled from official statistics of the U.S. Department of Commerce.

Note.--Import data are not strictly comparable with data on production, apparent consumption, or exports. Import data include the cadmium content of cadmium flue dust as well as the content of metal, whereas data for production, apparent consumption, and exports represent the cadmium content of metal only. The ratio of imports to domestic consumption or production cannot be ascertained since it is impossible to determine with any degree of accuracy the cadmium content of zinc ores from which cadmium metal is recovered in the United States.

Table 2.--Unwrought cadmium metal: U.S. Production, shipments, and stocks held by producers and others, 1958-66

(In thousands of pounds of contained cadmium)

| Year | Production | | | Producers' shipments of cadmium metal | Stocks of metal held at end of year | | |
|---|---|---|---|---|---|---|---|
| | From foreign and domestic cadmium-bearing zinc ores 1/ | From imported cadmium flue dust | Total | | By producers | By Others 2/ | Tot |
| 1958-- | 8,455 | 1,218 | 9,673 | 7,921 | 5,367 | 228 | 5,59 |
| 1959-- | 7,166 | 1,544 | 8,710 | 11,012 | 3,105 | 358 | 3,46 |
| 1960-- | 8,584 | 1,861 | 10,445 | 11,982 | 1,579 | 534 | 2,11 |
| 1961-- | 10,227 | 239 | 10,466 | 10,222 | 1,800 | 499 | 2,29 |
| 1962-- | 9,567 | 1,570 | 11,137 | 12,057 | 880 | 377 | 1,25 |
| 1963-- | 8,886 | 1,104 | 9,990 | 10,124 | 755 | 624 | 1,37 |
| 1964-- | 9,186 | 1,272 | 10,458 | 9,689 | 1,523 | 637 | 2,16 |
| 1965-- | 8,140 | 1,531 | 9,671 | 8,128 | 3,066 | 369 | 3,43 |
| 1966-- | 9,279 | 1,181 | 10,460 | 11,792 | 1,735 | 758 | 2,49 |

1/ Estimated by subtracting cadmium content in flue dust from the total production of cadmium metal.

2/ Includes metal held by manufacturers of compounds and by metal distributors.

Source: Compiled from official statistics of the U.S. Bureau of Mines and the U.S. Department of Commerce.

Table 3.--Unwrought cadmium metal, alloys, dross, flue dust, residues, and scrap: 1/ U.S. export of domestic merchandise, by principal markets, specified years, 1958 to 1966

| Market | 1958 | 1960 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|---|
| | Quantity (1,000 pounds) | | | | | |
| United Kingdom | 446 | 1,105 | 568 | 995 | 56 | 129 |
| Netherlands | 47 | 152 | 304 | 271 | 2/ | 25 |
| France | 6 | 423 | 176 | 34 | - | 130 |
| West Germany | 25 | 265 | 142 | 60 | - | 67 |
| Sweden | - | 11 | 36 | - | - | - |
| Italy | - | 58 | 26 | 24 | - | 7 |
| Belgium | - | 11 | 39 | 21 | - | - |
| India | 5 | 28 | 1 | 10 | 6 | - |
| Colombia | - | 2/ | 4 | 5 | 2/ | - |
| All other | 51 | 395 | 17 | 19 | 11 | 16 |
| Total | 580 | 2,448 | 1,313 | 1,439 | 73 | 379 |
| | Value (1,000 dollars) | | | | | |
| United Kingdom | 612 | 1,345 | 1,249 | 2,770 | 144 | 193 |
| Netherlands | 50 | 177 | 740 | 727 | 3/ | 41 |
| France | 7 | 522 | 461 | 103 | - | 330 |
| West Germany | 32 | 321 | 380 | 191 | - | 161 |
| Sweden | - | 13 | 88 | - | - | - |
| Italy | - | 76 | 56 | 79 | - | 16 |
| Belgium | - | 14 | 38 | 47 | - | - |
| India | 6 | 27 | 2 | 33 | 21 | - |
| Colombia | - | 1 | 10 | 21 | 3/ | 15 |
| All other | 64 | 518 | 46 | 62 | 30 | 39 |
| Total | 771 | 3,014 | 3,070 | 4,033 | 195 | 795 |

1/ Beginning in 1965, data represent exports of cadmium metal and alloys (wrought and unwrought) and waste and scrap. Average unit values of exports to individual countries indicate that practically all, if not all, exports represent shipments of cadmium metal only.
2/ Less than 500 pounds.
3/ Less than $500.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 4.--Cadmium flue dust, and unwrought metal (including waste and scrap): U.S. imports for consumption, by kind of material and duty treatment, 1958-66

| Year | Metal 1/ | | | Flue dust 3/ (free) | Total |
|---|---|---|---|---|---|
| | Dutiable | Free 2/ | Total | | |
| | Quantity (1,000 pounds of contained cadmium) | | | | |
| 1958 | 991 | 11 | 1,002 | 1,218 | 2,220 |
| 1959 | 1,392 | 246 | 1,638 | 1,544 | 3,182 |
| 1960 | 942 | 4/ | 942 | 1,861 | 2,803 |
| 1961 | 638 | 441 | 1,079 | 239 | 1,318 |
| 1962 | 937 | 180 | 1,117 | 1,570 | 2,687 |
| 1963 | 989 | 2 | 991 | 1,104 | 2,095 |
| 1964 | 1,092 | 12 | 1,104 | 1,272 | 2,376 |
| 1965 | 2,120 | 1 | 2,121 | 1,531 | 3,652 |
| 1966 | 3,352 | 6 | 3,358 | 1,181 | 4,539 |
| | Value (1,000 dollars) | | | | |
| 1958 | 1,301 | 11 | 1,312 | 661 | 1,973 |
| 1959 | 1,472 | 272 | 1,744 | 584 | 2,328 |
| 1960 | 1,157 | 1 | 1,158 | 778 | 1,936 |
| 1961 | 868 | 604 | 1,472 | 112 | 1,584 |
| 1962 | 1,391 | 249 | 1,640 | 850 | 2,490 |
| 1963 | 2,060 | 4 | 2,064 | 863 | 2,927 |
| 1964 | 2,837 | 33 | 2,870 | 1,545 | 4,415 |
| 1965 | 4,667 | 2 | 4,669 | 1,521 | 6,190 |
| 1966 | 6,802 | 11 | 6,813 | 989 | 7,802 |

1/ Represents the gross weight of cadmium metal including very small quantities of scrap in 1958 and in 1963-64.

2/ In 1959-62 consists of duty-free imports of metal for U.S. Government use; in other years consists of waste and scrap on which the duty was suspended by various public laws.

3/ Quantity represents cadmium content. Imports of cadmium ore were nil or negligible.

4/ Less than 500 pounds.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 5.--Unwrought cadmium metal, waste, scrap, and flue dust: U.S. imports for consumption, by principal sources, 1958, 1961, and 1963-66

| Country | 1958 | 1961 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|---|
| | Quantity (1,000 pounds of contained cadmium) | | | | | |
| Mexico | 1,218 | 239 | 1,121 | 1,365 | 1,542 | 1,197 |
| Canada | 508 | 510 | 624 | 428 | 615 | 907 |
| Congo (Kinshasa) 1/ | 59 | 284 | 2 | 219 | 287 | 154 |
| Peru | 103 | 104 | 119 | 152 | 337 | 352 |
| Japan | 121 | 22 | 53 | 86 | 289 | 1,048 |
| Belgium | 119 | 48 | 31 | 78 | 60 | 6 |
| Australia | 45 | - | 61 | 41 | 204 | 424 |
| Netherlands | 13 | - | 40 | 4 | 56 | 6 |
| Argentina | - | - | 22 | 3 | 3 | - |
| All other | 34 | 111 | 22 | - | 2/ 259 | 3/ 445 |
| Total | 2,220. | 1,318. | 2,095. | 2,376. | 3,652. | 4,539. |
| | Value (1,000 dollars) | | | | | |
| Mexico | 661 | 112 | 902 | 1,829 | 1,557 | 1,025 |
| Canada | 682 | 696 | 1,372 | 1,084 | 1,129 | 1,773 |
| Congo (Kinshasa) 1/ | 69 | 386 | 4 | 575 | 681 | 310 |
| Peru | 155 | 140 | 168 | 342 | 865 | 793 |
| Japan | 142 | 31 | 94 | 247 | 609 | 2,129 |
| Belgium | 139 | 67 | 66 | 206 | 153 | 12 |
| Australia | 63 | - | 145 | 113 | 492 | 860 |
| Netherlands | 18 | - | 82 | 11 | 138 | 12 |
| Argentina | - | - | 56 | 8 | 6 | - |
| All other | 44 | 152 | 38 | - | 2/ 560 | 3/ 888 |
| Total | 1,973. | 1,584. | 2,927. | 4,415. | 6,190. | 7,802. |

1/ Belgian Congo until June 30, 1960; the capital, Leopoldville, was renamed Kinshasa on July 1, 1966.

2/ Includes 53 thousand pounds valued at 104 thousand dollars from the U.S.S.R.; these imports were dutiable at the higher column 2 rate of duty.

3/ Includes 295 thousand pounds valued at 590 thousand dollars from the United Kingdom.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 6.--World smelter production of cadmium by continents and by principal countries, 1958 and 1963-66

(In thousands of pounds)

| Continent and country | 1958 | 1963 | 1964 | 1965 | 1966 1/ |
|---|---|---|---|---|---|
| North America: | | | | | |
| Canada 2/ | 1,756 | 2,475 | 2,773 | 1,756 | 2,006 |
| Mexico 3/ 4/ | 14 | 326 | 260 | 58 | 58 |
| United States 5/ | 9,673 | 9,990 | 10,458 | 9,671 | 10,460 |
| South America: Peru 4/ | 141 | 382 | 435 | 473 | 454 |
| Europe: | | | | | |
| Austria | 25 | 41 | 43 | 46 | 45 |
| Belgium 3/ | 1,488 | 1,943 | 1,857 | 849 | 346 |
| France | 386 | 655 | 1,085 | 937 | 1,048 |
| Germany: | | | | | |
| Soviet Zone | - | 11 | 22 | 22 | 22 |
| Federal Republic | 703 | 492 | 705 | 723 | 785 |
| Italy | 413 | 622 | 597 | 602 | 540 |
| Netherlands 6/ | 88 | 88 | 88 | 88 | 88 |
| Norway | 240 | 243 | 254 | 172 | 161 |
| Poland 6/ | 573 | 930 | 930 | 940 | 950 |
| Spain | 14 | 119 | 133 | 110 | 101 |
| U.S.S.R. 6/ | 2,866 | 3,700 | 3,900 | 4,200 | 4,200 |
| United Kingdom 5/ | 278 | 247 | 435 | 486 | 403 |
| Yugoslavia 6/ | 55 | 88 | 90 | 90 | 90 |
| Africa: | | | | | |
| Congo (Kinshasa) 7/ | 1,080 | 866 | 1,034 | 880 | 896 |
| Zambia 8/ | 38 | 33 | 32 | 40 | 24 |
| Asia: Japan | 964 | 2,231 | 2,678 | 3,262 | 3,307 |
| Oceania: Australia | 791 | 1,089 | 1,107 | 1,182 | 924 |
| World total 5/9/ | 21,600 | 26,600 | 28,900 | 26,600 | 26,900 |

1/ Preliminary; data for some countries are estimated.

2/ Refined metal from domestic ores plus the cadmium content of some exported ores and concentrates. 3/ Represents exports of metal.

4/ Excludes cadmium contained in ores, concentrates and flue dusts exported to other countries for the recovery of cadmium.

5/ Data include cadmium metal recivered from secondary sources.

6/ Estimated.

7/ Belgian Congo until June 30, 1960; the capital, Leopoldville, was renamed Kinshasa on July 1, 1966.

8/ Former protectorate of Northern Rhodesia; acquired independence Oct. 24, 1964.

9/ Data do not add to totals shown because of rounding and use of estimates. No estimate is included for Bulgaria, but it is reported to be producing cadmium metal.

Source: U.S. Bureau of Mines. Data derived in part from World Non-Ferrous Metal Statistics, bulletins of The World Bureau of Metal Statistics and annual issues of Metal Statistics (Metallgesellschaft).

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| Commodity | TSUS item |
|---|---|
| Germanium metal: | |
| Unwrought, and waste and scrap-------- | 628.25 |
| Wrought---------- | 628.30 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

Annual U.S. consumption of unwrought germanium metal increased from about 60,000 pounds in 1958 to 120,000 pounds in 1960 and then declined to 80,000 to 90,000 pounds during 1963-66. Imports of germanium metal supplied less than 5 percent of annual consumption in 1958-66. Exports were probably negligible or nil.

## Description and uses

In the United States, the most common primary source of germanium is the mineral sphalerite, which is valued principally for its zinc content; germanium, 1/ occurring as a trace element, is recovered as a byproduct from the dust and residues of zinc production. Germanium is also found in other minerals valued chiefly for other metals. After 1958, secondary germanium (i.e., that produced from scrap) has been a more important component of new supply in the United States than primary metal.

Germanium-bearing material is passed through several stages of reduction and refining before the unwrought metal reaches the market in the form of an ingot or a crystal bar. The imports under item 628.25 consist of unalloyed germanium ingots and germanium crystal of various qualities, and waste and scrap. Imports of wrought germanium under item 628.30 have been nil. Germanium alloys have been prepared in small quantities for use in research but have not been produced commercially either in the United States or elsewhere.

The highly refined germanium metal into which minute quantities of other, also highly refined, metals (e.g., antimony or boron) have been introduced is used predominantly in making electronic devices,

1/ Although classified as a metal for U.S. tariff purposes, the element germanium exhibits typical properties of a metal only under certain conditions.

including diodes, triodes, and rectifiers. Such devices are used in a large variety of end items, ranging from hearing aids to missiles. Germanium-bearing compounds are discussed in the summary on item 423.00 in volume 4:4.

U.S. tariff treatment

The column 1 (trade-agreement) rates of duty applicable to imports (see general headnote 3 in the TSUSA-1968) are as follows:

| TSUS item | Commodity | Prior rate | U.S. concessions granted in 1964-67 trade conference (Kennedy Round) | |
|---|---|---|---|---|
| | | | First stage, effective Jan. 1, 1968 | Final stage, effective Jan. 1, 1972 |
| | Germanium metal: | | | |
| 628.25 | Unwrought, and waste and scrap. | 10.5% ad val. | 9% ad val. | 5% ad val. |
| 628.30 | Wrought | 18% ad val. | 16% ad val. | 9% ad val. |

The tabulation above shows the column 1 rates of duty in effect prior to January 1, 1968, and modifications therein as a result of concessions granted by the United States in the sixth round of trade negotiations under the General Agreement on Tariffs and Trade (GATT). Only the first and final stages of the annual rate modifications are shown above (see the TSUSA-1968 for the intermediate staged rates).

The prior rate of 10.5 percent ad valorem on item 628.25 became effective on June 30, 1958, and that of 18 percent ad valorem on item 628.30, on July 1, 1963--both as a result of U.S. concessions granted in the GATT. These rates were continued unchanged under the TSUS from August 31, 1963, through the end of 1967. These articles were provided for under the previous tariff schedules, as follows: Unwrought germanium metal and waste and scrap under paragraph 5, along with germanium dioxide; wrought germanium articles under paragraph 395, among other metal manufactures, not specially provided for. In the TSUS, such unwrought and wrought articles of germanium were set up as separate items without a change in the applicable duties.

As a result of further concessions granted by the United States in the trade conference concluded on June 30, 1967, the rates on both items, as indicated in the tabulation above, are being reduced about 50 percent in five annual stages; and, for each item the first stage reduction is effective January 1, 1968.

The duty on germanium waste and scrap (part of item 628.25) has been suspended almost continuously since March 1942 by a number of acts of Congress; the latest (Public Law 90-45) extends the suspension to June 30, 1969 (see item 911.12 of the TSUS).

In the TSUS, duty-free entry of germanium articles for U.S. Government use is provided for under such items as 833.00, 834.00, and 836.00.

## U.S. consumption

Estimated annual U.S. consumption of unwrought germanium metal increased from 60,000 pounds in 1958 to 120,000 pounds in 1960, and decreased to 90,000 pounds in 1966 (table 1). The general decline in consumption after 1960 reflects principally a significant reduction (brought on by advances in technology) in unit requirements of the metal for manufacturing electronic components and the substitution of other materials, principally silicon, in the manufacture of such components. Consumption of germanium in electronic devices, as mentioned earlier, has made up by far the greater part of total consumption.

The general decline in total consumption of germanium was accompanied by decreases in prices. For example, the quoted U.S. price of first-reduction germanium metal (with a minimum resistivity of 5 ohms per centimeter), delivered, was reduced from 40 cents a gram (or $181.44 a pound) 1/ in 1958 to 17.2 cents a gram (or $78.02 a pound) in 1966, or by 57 percent.

## U.S. producers and production

In 1966, six domestic firms produced germanium metal at plants in Oklahoma, Illinois, Pennsylvania, and New Jersey. Of these plants, two produced primary germanium as a byproduct from the residues obtained in refining zinc, and secondary germanium, from scrap; two produced primary metal from imported concentrates, and secondary metal, from scrap; and the remaining two plants produced the metal entirely from scrap. The sale of germanium metal has probably not been an important source of income to any of these producers.

1/ 1 pound=453.6 grams. In October 1965 the unit of quantity for the price quotation was changed from a gram to a kilogram.

Estimated total annual U.S. production of primary and secondary germanium metal grew from 60,000 pounds in 1958 to 120,000 pounds in 1960 (table 1), in response to increasing requirements of domestic consumers. After 1960, as requirements decreased, production generally decreased; in 1966, production was about 90,000 pounds--25 percent below that in 1960. Secondary germanium metal increased from about one-third of the total production in 1958 to about two-thirds of the total in 1966.

U.S. imports and exports

Total U.S. imports of unwrought germanium metal and waste and scrap grew from $38,000 in 1963 to $172,000 in 1966; these were much smaller than the imports of $243,000 and $230,000 in 1958 and 1959 (table 1). Unwrought germanium metal made up all of the imports in 1958 and most of the imports in 1966; waste and scrap, on which duty was suspended, accounted for the great bulk of the imports in 1963-65 (table 2). In 1958 almost all imports came from Belgium and Luxembourg; in 1963-66, the bulk of the imports of unwrought germanium metal (measured in terms of quantity) came from Italy and Belgium and Luxembourg, and that of germanium waste and scrap from France and Australia. Imports of unwrought germanium metal and waste and scrap supplied less than 5 percent of the estimated total domestic consumption of germanium in the years considered

U.S. imports of wrought germanium metal have been nil; certain products of germanium are provided for under item 687.60, covered in a summary in volume 6:11.

U.S. exports of unwrought and wrought germanium metal and germanium waste and scrap are not reported separately in official statistics; they are believed to have been negligible or nil during 1958-66.

Table 1.--Germanium metal, unwrought, and waste and scrap: U.S. production, imports for consumption, and apparent consumption, 1958-66

| Year | Production 1/ | | | Imports 2/ | | Apparent consumption 1/ |
|---|---|---|---|---|---|---|
| | Primary | Secondary | Total | Quantity | Value | |
| | 1,000 pounds | 1,000 pounds | 1,000 pounds | 1,000 pounds | 1,000 dollars | 1,000 pounds |
| 1958 | 40 | 20 | 60 | 3/ 2 | 3/ 243 | 60 |
| 1959 | 45 | 60 | 110 | 4/ 2 | 4/ 230 | 110 |
| 1960 | 50 | 70 | 120 | 5/ | 5/ | 120 |
| 1961 | 40 | 70 | 110 | 5/ | 5/ | 110 |
| 1962 | 37 | 70 | 110 | 5/ | 5/ | 110 |
| 1963 | 20 | 70 | 90 | 6/ 2 | 6/ 38 | 90 |
| 1964 | 15 | 65 | 80 | 1 | 59 | 80 |
| 1965 | 30 | 60 | 90 | 7/ 4 | 7/ 136 | 90 |
| 1966 | 30 | 60 | 90 | 4 | 172 | 90 |

1/ Estimated.
2/ For the details by type and country of origin, see table 2.
3/ Compiled from entry documents.
4/ Estimated on the basis of entry documents.
5/ Not available.
6/ Estimated on the basis of official data for September-December.
7/ Includes 341 pounds, valued at 19 thousand dollars, entered free of duty for U.S. Government use.

Source: Data on imports were compiled from official statistics of the U.S. Department of Commerce, except for estimates (as noted) prepared by the staff of the U.S. Tariff Commission. Estimates on production and consumption were prepared by either the U.S. Bureau of Mines or the staff of the Commission, or were taken from a trade journal.

Note.--Annual imports of unwrought germanium metal and germanium waste and scrap probably supplied 5 percent or less of the domestic consumption in each year during 1958-66. Annual exports of unwrought germanium metal and germanium waste and scrap, not reported separately in official statistics, are believed to have been nil or negligible during 1958-66. Wrought germanium metal articles (item 628.30) are not covered by this table; these articles are not known to be traded commercially.

Table 2.--Germanium metal, unwrought, and waste and scrap: U.S. imports for consumption, by principal sources, 1958 and 1963-66

| Type and country | 1958 | 1963 1/ | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|
| | Quantity (pounds) | | | | |
| Unwrought metal: | | | | | |
| Italy | - | - | - | - | 1,323 |
| Belgium and Luxembourg | 1,600 | - | 78 | 21 | 213 |
| United Kingdom | 60 | 50 | - | 60 | 23 |
| All other | 26 | - | - | 2 | 2/ 1,013 |
| Total | 1,686 | 50 | 78 | 83 | 2,572 |
| Waste and scrap: | | | | | |
| West Germany | - | - | - | - | 416 |
| United Kingdom | - | - | 93 | 211 | 330 |
| Canada | - | 700 | 8 | - | 149 |
| France | - | - | - | 2,250 | 122 |
| Netherlands | - | - | 538 | 3/ 341 | - |
| Australia | - | 1,050 | 535 | - | - |
| All other | - | - | - | 4/ 1,394 | - |
| Total | - | 1,750 | 1,174 | 4,196 | 1,017 |
| Grand total | 1,686 | 1,800 | 1,252 | 4,279 | 3,589 |
| | Value (1,000 dollars) | | | | |
| Unwrought metal: | | | | | |
| Italy | - | - | - | - | 47 |
| Belgium and Luxembourg | 229 | - | 12 | 5 | 42 |
| United Kingdom | 10 | 3 | - | 3 | 1 |
| All other | 4 | - | - | 5/ | 2/ 45 |
| Total | 243 | 3 | 12 | 8 | 135 |
| Waste and scrap: | | | | | |
| West Germany | - | - | - | - | 14 |
| United Kingdom | - | - | 6 | 12 | 12 |
| Canada | - | 18 | 1 | - | 4 |
| France | - | - | - | 30 | 7 |
| Netherlands | - | - | 33 | 3/ 19 | - |
| Australia | - | 17 | 7 | - | - |
| All other | - | - | - | 4/ 67 | - |
| Total | - | 35 | 47 | 128 | 37 |
| Grand total | 243 | 38 | 59 | 136 | 172 |

1/ Estimated on the basis of data for September-December.

2/ Includes 383 pounds, valued at 20 thousand dollars, from the Republic of South Africa and 291 pounds, valued at 11 thousand dollars, from the Netherlands.

3/ Imported free of duty for U.S. Government use.

4/ Includes 661 pounds, valued at 35 thousand dollars, from Japan and 733 pounds, valued at 32 thousand dollars, from Italy.

5/ Less than $500.

Source: Data for 1958 compiled from entry documents; data for 1963-66 compiled from official statistics of the U.S. Department of Commerce, except as noted.

Note.--Imports of germanium alloys for these years were nil.

| Commodity | TSUS item |
|---|---|
| Unwrought magnesium, other than alloys; and waste and scrap | 628.55 |
| Unwrought magnesium alloys | 628.57 |
| Wrought magnesium | 628.59 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

The United States is the world's largest producer and consumer of magnesium. With the exception of magnesium waste and scrap, which has entered the United States free of duty in recent years, imports of the products considered here have been relatively insignificant. Exports, which consist predominantly of unwrought magnesium metal, are large in relation to domestic production, and in 1966 were equal to 19 percent of U.S. production of primary magnesium.

## Description and uses

Magnesium is the lightest of the structural metals; it weighs about two-thirds as much as aluminum and one-fourth as much as steel per unit of volume. Magnesium is silver-white in color, ductile, easily machinable, and has good shock- and vibration-absorption characteristics. Pure magnesium is low in strength, and consequently it is rarely used for structural applications without being alloyed. Magnesium is also highly reactive and may be used as a reducing agent.

For tariff purposes unwrought magnesium (other than alloys) contains a minimum, by weight, of 99 percent magnesium and is generally marketed in the form of ingots. Under the TSUS, the magnesium content of a magnesium alloy is less than 99 percent but not less than any other metallic element. Most commercial magnesium alloys contain from 1 to about 15 percent, by weight, of one or more of the following: aluminum, manganese, zinc, zirconium, thorium, lithium, and the rare-earth elements. Wrought magnesium comprises magnesium and magnesium alloy products which have been rolled, forged, drawn, or extruded and includes such articles as sheets, plates, rods, bars, wire, angles, shapes, sections and tubes; it also includes castings which have been machined.

The principal sources of magnesium are sea water, underground brines, and magnesium ores (chiefly brucite, dolomite, and magnesite) which are included in TSUS item 601.66. Since there is an abundant

supply of magnesium-rich ores and a virtually limitless supply of magnesium in sea water, producers of magnesium metal are not greatly concerned with the problem of the depletion of reserves as most other metal-producing industries are. In addition to the above-mentioned sources of primary magnesium, substantial quantities of secondary magnesium are recovered from scrap.

Magnesium metal was produced in 1967 in the United States by two processes--the silicothermic and the electrolytic. The silicothermic process involves the thermic reduction of a mixture of dolomite and ferrosilicon. In the electrolytic process, magnesium chloride which has been obtained from sea water is electrolytically reduced to chlorine and magnesium metal. Such salable products as magnesium hydroxide, magnesium chloride, and chlorine are produced as intermediate or byproducts of the electrolytic process; see summaries on magnesium compounds not elsewhere enumerated (item 419.38) in volume 4:3, and magnesium chloride (items 419.24 and 419.28) in volume 4:3.

Magnesium is used in such structural applications as parts for aircraft, missiles, electronic equipment, portable tools, materials handling equipment, lawn mowers, and motor vehicles. It is also used for alloying (particularly with aluminum); as a reducing agent in the production of titanium, zirconium, hafnium, uranium, and beryllium; for cathodic protection of such iron and steel products as ground pipe, ships, and water tanks; and in the production of nodular iron, explosives and pyrotechnics. Magnesium is used in explosives and pyrotechnics because in the presence of oxygen it easily ignites and burns with intense heat and light. This property has resulted in limiting the use of magnesium for certain applications because of its fire-hazard potential.

In this summary, all quantities are given in terms of pounds.

U.S. tariff treatment

The column 1 (trade-agreement) rates of duty applicable to imports (see general headnote 3 in the TSUSA-1968) are as follows (in cents per pound of magnesium content plus percent ad valorem):

| TSUS item | Commodity | Prior rate | U.S. concessions granted in 1964-67 trade conference (Kennedy Round) | |
|---|---|---|---|---|
| | | | First stage, effective Jan. 1, 1968 | Final stage, effective Jan. 1, 1972 |
| 628.55 | Unwrought magnesium, other than alloys; and waste and scrap. | 40% | 36% | 20% |
| 628.57 | Unwrought magnesium alloys. | 16¢ per lb. + 8% | 14.4¢ per lb. + 7% | 8¢ per lb. + 4% |
| 628.59 | Wrought magnesium------ | 13.5¢ per lb. + 7% | 12¢ per lb. + 6% | 6.5¢ per lb. + 3.5% |

The tabulation above shows the column 1 rates of duty in effect prior to January 1, 1968, and modifications therein as a result of concessions amounting to a reduction of about 50 percent in duties granted by the United States in the sixth round of trade negotiations under the General Agreement on Tariffs and Trade (GATT). Only the first and final stages of the five annual rate modifications are shown above (see the TSUSA-1968 for the intermediate staged rates).

The prior rates of duty applicable to these magnesium products had been in effect since July 1, 1963, as a result of a concession granted by the United States under the GATT; the duties remained unchanged when the TSUS became effective on August 31, 1963.

The ad valorem equivalents of the prior rates applicable to unwrought magnesium alloys and wrought magnesium based on dutiable imports in 1966, were 15.4 and 10.6 percent, respectively.

The duty on magnesium waste and scrap (part of item 628.55) has been suspended almost continuously since March 1942 pursuant to recurring temporary suspensions by various public laws; the latest

(Public Law 90-45) extends the suspension to June 30, 1969 (see item 911.12 of the TSUS). 1/

U.S. consumption

Apparent consumption of unwrought magnesium (primary and secondary) increased from 78 million pounds in 1958 to 168 million pounds in 1966, or by 115 percent (table 1). This growth in consumption is due largely to increased use for producing aluminum alloys and to increased military requirements. In 1966, U.S. consumption of primary magnesium only, by principal uses, as reported by the U.S. Bureau of Mines from data obtained from consumers, was as follows:

| | 1,000 pounds |
|---|---|
| Castings | 19,146 |
| Wrought products (sheet, plate, extrusions and forgings) | 26,350 |
| Aluminum alloys | 61,724 |
| Other alloys | 4,150 |
| Cathodic protection | 9,340 |
| Reducing agent for titanium, zirconium, hafnium, uranium, and beryllium | 16,858 |
| Chemicals | 9,208 |
| Other uses | 18,580 |
| Total | 165,356 |

1/ In view of the relatively high duty applicable to unwrought magnesium and magnesium alloys, the question has arisen on several occasions whether imported magnesium ingots produced from scrap are entitled to duty-free entry as metal scrap under the provisions of Public Law 81-869, as amended and extended (most recently by Public Law 90-45). The Bureau of Customs ruled in T.D. 54608(30) that magnesium alloy ingots melted down abroad from magnesium alloy scrap are classifiable as metal scrap provided that (a) the melting was for convenience in handling and transportation, (b) the melted scrap was not "sweetened" (by adding pure magnesium), (c) the ingots were not suitable for distribution in the usual course of trade as specification magnesium alloys, and (d) they were not suitable for use in the direct casting of magnesium alloy products but required sweetening before they could be used for that purpose.

The question has also arisen whether magnesium crowns or muffs (products of the silicothermic process for producing magnesium) are dutiable as unwrought magnesium or are entitled to free entry as metal scrap. The Bureau of Customs ruled in T.D. 56190(126) that such products are dutiable as unwrought magnesium. Crowns or muffs are high-purity magnesium products which can be readily converted into magnesium ingot although their appearance is such that they might easily be mistaken for scrap.

Consumption of wrought magnesium products increased irregularly from 17 million pounds in 1958 to 26 million pounds in 1966, or by 53 percent. The availability of lower cost substitute materials has restricted the growth in consumption of wrought magnesium products; e.g., aluminum can be substituted for magnesium in most structural applications, although where light weight is of paramount importance magnesium is generally preferred. Domestic consumers of magnesium have indicated that their consumption of magnesium would increase significantly if the price of magnesium was reduced to a level equivalent to 1.3 times the price of aluminum or less. As of December 11, 1967, the price of magnesium (35.25 cents a pound, f.o.b. point of production) was 1.41 times that of aluminum (25.0 cents a pound, delivered to customer's plant). Consequently, no significant change in the consumption of wrought magnesium products is considered likely unless the prices of magnesium and aluminum come closer together. On the other hand, many nonstructural uses for magnesium, being based on its chemical properties and reactivity, are relatively insensitive to price considerations. It is likely that consumption in these uses will continue to increase.

U.S. producers

Two U.S. companies operate three plants at which they produce primary magnesium for sale to industry. One large diversified concern operates two plants which produce magnesium from sea water; these plants are situated in Texas and have a combined annual capacity of about 190 million pounds, or more than 90 percent of total domestic commercial capacity. Numerous other products are produced in the same manufacturing complexes where magnesium is produced; certain parts of the complexes, however, such as the electrolytic-reduction facilities are used exclusively for magnesium production. The other domestic producer extracts primary magnesium from dolomite ore in a plant situated in Alabama. A third company produces primary magnesium from recycled magnesium chloride for its own use in producing titanium metal. A fourth company ceased production of primary magnesium from dolomite in 1966.

There are 8 concerns in the United States that recover magnesium from scrap (secondary producers), approximately 30 concerns that produce wrought mill products, and approximately 150 concerns that make magnesium castings. These concerns are situated principally in California, New York and the East North Central States. The great bulk of the plants that process magnesium also work with at least one other metal, principally aluminum, and generally aluminum accounts for the larger share of their output of these two metals.

It is estimated that 10,000 persons were employed in 1964 in domestic establishments producing the magnesium products covered by this summary. Most of these workers were employed in foundries and plants that fabricate wrought magnesium mill products.

During the years 1963-67 several U.S. firms, including two aluminum producers, announced plans to construct magnesium-producing facilities in the Pacific Northwest or the Great Salt Lake, Utah, area; as of November 1, 1967, however, construction had not begun on any of these facilities.

## U.S. production

U.S. production of primary magnesium increased from 60 million pounds in 1958 to 163 million pounds in 1965 and was 160 million pounds in 1966 (table 1). Production during 1958-66 showed a larger increase than consumption, reflecting a substantial increase in exports. Secondary recovery increased irregularly from 17 million pounds in 1958 to 30 million pounds in 1966. The share of total production accounted for by secondary output declined from 22 percent in 1958 to 16 percent in 1966. Secondary production during this period was restricted by the limited availability of scrap, which resulted from the relatively static consumption of wrought products and the fact that magnesium used for many nonstructural purposes is generally nonrecoverable.

The published price for primary magnesium ingot having a minimum magnesium content of 99.8 percent, f.o.b. point of production, in lots of 10,000 pounds or more, was 35.25 cents a pound throughout the 1958-66 period. During this same period the price of the principal die-casting alloy (known as AZ 91B) was reduced from 37.25 to 30.0 cents a pound in an effort to encourage wider use of this material in automobile manufacturing and other large potential markets. This bid for increased use in domestic automobile manufacturing appears to have met with little success.

Domestic producers' shipments of wrought magnesium products (sheet, plate, tubing, extruded shapes, and forgings) in the 1959-66 period increased irregularly from 19 million pounds in 1958 to 27 million pounds in 1966 (table 2).

As of December 31, 1966, U.S. Government stocks of unwrought magnesium totaled 304 million pounds, of which 14 million pounds was in excess of the national stockpile objective for conventional warfare. Sales of magnesium ingot from Government stocks totaled 7.0, 8.7, 5.3, and 41.9 million pounds during 1963, 1964, 1965, and 1966, respectively.

U.S. exports

U.S. exports of unwrought magnesium, including alloys and waste and scrap, increased from 0.4 million pounds, valued at $0.2 million, in 1958 to 30 million pounds, valued at $9 million, in 1966 (table 3). Exports, which consisted almost entirely of primary magnesium ingot, were equal to about 20 percent of primary production during 1963-66. West Germany was by far the largest export market, receiving two-thirds of total U.S. exports in these years, mainly for conversion into cast automotive parts.

The value of U.S. exports of wrought magnesium products fluctuated in the 1958-66 period from a low of $1 million in 1961 to a high of $1.4 million in 1966 (table 4). In 1963-66, the leading export markets for wrought products were Canada, West Germany, Japan, and Mexico.

U.S. imports

U.S. imports of the magnesium products covered by this summary increased from 1.1 million pounds, valued at $0.4 million, in 1958 to 7.9 million pounds, valued at $3.3 million, in 1966 (table 5). During 1958-66 there was a trend towards increased imports of unwrought magnesium (both alloyed and nonalloyed) and waste and scrap, whereas imports of wrought products fluctuated irregularly.

Magnesium waste and scrap accounted for 73 percent of the quantity of all magnesium imports during 1958-66. The duty on imports of waste and scrap was suspended throughout this period as a result of several public laws. Canada has been the principal source of scrap imports, although in certain years Japan, the United Kingdom, and several countries of the European Economic Community also supplied significant quantities.

During 1961-64, approximately 60 percent of total imports of unwrought magnesium (alloyed and nonalloyed) entered the United States free of duty for U.S. Government use. 1/ Such duty-free imports subsequently declined in importance but were still significant, comprising 33 percent of the total in 1965, and 49 percent in 1966. The bulk of these imports were of Canadian origin (see table 6) and were imported for use in the production of defense material. Canada and Norway had been the leading suppliers of unwrought magnesium other than alloys until 1966, when the quantity of imports from

1/ Under the TSUS, U.S. Government imports covered by such provisions as items 833.00, 834.00, and 836.00 are free of duty.

the U.S.S.R. almost equaled those from Canada. Canada and the United Kingdom are the leading suppliers of alloys. The unit values of magnesium alloy imports ($1.20 per pound in 1966) indicate that these alloys probably contain high-priced alloying constituents such as thorium, zirconium, or rare-earth elements.

Imports of wrought magnesium products were insignificant during 1958-66.

## Foreign production and trade

World production of primary magnesium, by country, in 1966 as reported by the U.S. Bureau of Mines was as follows:

| Country | Million pounds |
|---|---|
| United States | 159.6 |
| U.S.S.R. | 1/ 72.0 |
| Norway | 1/ 60.6 |
| Canada | 13.6 |
| Italy | 1/ 13.6 |
| United Kingdom | 1/ 12.0 |
| Japan | 1/ 8.4 |
| France | 7.5 |
| China | 1/ 2.0 |
| West Germany | 1/ 1.1 |
| Total | 350.4 |

1/ Estimated.

West Germany, which produced only a million pounds of primary magnesium in 1966, is the world's leading importer and second largest consumer of magnesium. Consumption in West Germany during 1965 was about 106 million pounds, of which approximately 78 million pounds was imported under a duty-free quota. In recent years Norway and the United States have been the principal suppliers of West Germany's imports.

Table 1.--Magnesium metal and alloys, unwrought, including waste and scrap (items 628.55 and 628.57): U.S. production, imports for consumption, exports of domestic merchandise, and apparent consumption, 1958-66

(In thousands of pounds)

| Year | Production | | | Imports | Exports | Apparent consumption | Ratio (percent) of imports to consumption |
|---|---|---|---|---|---|---|---|
| | Primary | Secondary | Total | | | | |
| 1958--A | 60,192 | 17,414 | 77,606 | 1,092 | 413 | 78,285 | 1.4 |
| 1959---- | 62,066 | 20,180 | 82,246 | 1,236 | 3,201 | 80,281 | 1.5 |
| 1960---- | 80,140 | 20,696 | 100,836 | 858 | 1/ | 2/ | 2/ |
| 1961---- | 81,490 | 16,250 | 97,740 | 2,070 | 1/ | 2/ | 2/ |
| 1962---- | 137,910 | 19,220 | 157,130 | 4,825 | 1/ | 2/ | 2/ |
| 1963---- | 151,690 | 18,450 | 170,140 | 4,693 | 31,684 | 143,149 | 3.3 |
| 1964---- | 158,976 | 23,580 | 182,556 | 5,404 | 31,898 | 156,062 | 3.5 |
| 1965---- | 162,722 | 27,234 | 189,956 | 5,755 | 35,673 | 160,038 | 3.6 |
| 1966---- | 159,588 | 30,258 | 189,846 | 7,906 | 29,699 | 168,053 | 4.7 |

1/ Export data for 1960-62 are not shown because industry representatives have advised that exports during those years were several times greater than the quantities reported in U.S. Government statistics.

2/ Not available.

Source: Production compiled from official statistics of the U.S. Bureau of Mines; imports and exports compiled from official statistics of the U.S. Department of Commerce.

Note.--Data for wrought magnesium (item 628.59) are given separately in table 2.

Table 2.--Magnesium, wrought (item 628.59): U.S. producers' shipments, imports for consumption, exports of domestic merchandise, and apparent consumption, 1958-66 1/

(In thousands of pounds)

| Year | Producers' shipments | Imports | Exports | Apparent consumption |
|---|---|---|---|---|
| 1958 | 18,702 | 31 | 1,690 | 17,043 |
| 1959 | 22,169 | 52 | 1,575 | 20,646 |
| 1960 | 20,656 | 9 | 1,331 | 19,334 |
| 1961 | 21,280 | 10 | 1,041 | 20,249 |
| 1962 | 26,122 | 71 | 1,229 | 24,964 |
| 1963 | 24,805 | 27 | 1,446 | 23,386 |
| 1964 | 22,987 | 13 | 1,741 | 21,259 |
| 1965 | 24,137 | 52 | 968 | 23,221 |
| 1966 | 27,302 | 4 | 1,159 | 26,147 |

1/ Data on U.S. producers' shipments, imports, and exports are not fully comparable.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 3.--Magnesium metal and alloys, unwrought, including waste and scrap: U.S. exports of domestic merchandise, by principal markets, 1958-59 and 1963-66 1/

| Market | 1958 | 1959 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|---|
| | Quantity (1,000 pounds) | | | | | |
| West Germany | 39 | 1,960 | 21,927 | 21,325 | 24,019 | 16,199 |
| Canada | 52 | 199 | 1,195 | 3,453 | 3,492 | 3,860 |
| Brazil | 2 | - | 2,542 | 1,792 | 1,622 | 2,745 |
| Yugoslavia | - | - | 332 | 603 | 1,194 | 109 |
| Mexico | 3 | 424 | 687 | 538 | 955 | 1,375 |
| United Kingdom | 1 | 301 | 762 | 800 | 848 | 2,128 |
| Japan | - | - | 1,145 | 1,103 | 667 | 545 |
| All other | 316 | 317 | 3,094 | 2,284 | 2,876 | 2/ 2,738 |
| Total | 413 | 3,201 | 31,684 | 31,898 | 35,673 | 29,699 |
| | Value (1,000 dollars) | | | | | |
| West Germany | 14 | 506 | 6,125 | 5,908 | 6,640 | 4,499 |
| Canada | 71 | 36 | 311 | 967 | 1,198 | 1,406 |
| Brazil | 1 | - | 674 | 474 | 483 | 736 |
| Yugoslavia | - | - | 93 | 165 | 332 | 31 |
| Mexico | 3 | 122 | 190 | 154 | 314 | 418 |
| United Kingdom | 1 | 88 | 215 | 226 | 245 | 686 |
| Japan | - | - | 324 | 313 | 192 | 165 |
| All other | 136 | 130 | 866 | 641 | 861 | 2/ 890 |
| Total | 226 | 882 | 8,798 | 8,848 | 10,265 | 8,831 |

1/ Export data for 1960-62 are not shown because industry representatives have advised that actual exports during those years were several times as great as the quantities reported in U.S. Government statistics.

2/ Includes 866,000 pounds, valued at 252 thousand dollars, exported to Australia.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 4.--Magnesium metal and alloys, wrought: U.S. exports of domestic merchandise, by principal markets, 1961-66 1/

| Market | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|---|
| | Quantity (1,000 pounds) | | | | | |
| Canada | 315 | 327 | 417 | 710 | 375 | 638 |
| West Germany | 40 | 106 | 100 | 186 | 168 | 38 |
| Sweden | 20 | 22 | 7 | 64 | 54 | 23 |
| France | 70 | 23 | 12 | 63 | 43 | 53 |
| United Kingdom | 16 | 34 | 22 | 42 | 38 | 19 |
| Belgium | 20 | 66 | 46 | 31 | 16 | 25 |
| Japan | 64 | 54 | 334 | 203 | 9 | 28 |
| Venezuela | 89 | 98 | 14 | 39 | 30 | 32 |
| Mexico | 106 | 48 | 136 | 134 | 4 | 63 |
| All other | 301 | 451 | 2/ 358 | 269 | 3/ 231 | 4/ 240 |
| Total | 1,041 | 1,229 | 1,446 | 1,741 | 968 | 1,159 |
| | Value (1,000 dollars) | | | | | |
| Canada | 426 | 436 | 608 | 599 | 633 | 796 |
| West Germany | 45 | 119 | 86 | 150 | 135 | 40 |
| Sweden | 19 | 15 | 12 | 94 | 103 | 54 |
| France | 44 | 35 | 35 | 99 | 61 | 71 |
| United Kingdom | 22 | 47 | 36 | 65 | 49 | 31 |
| Belgium | 21 | 79 | 50 | 25 | 15 | 26 |
| Japan | 38 | 36 | 123 | 83 | 14 | 42 |
| Venezuela | 66 | 39 | 34 | 14 | 11 | 18 |
| Mexico | 43 | 24 | 66 | 61 | 3 | 32 |
| All other | 233 | 226 | 2/ 225 | 194 | 3/ 236 | 277 |
| Total | 957 | 1,056 | 1,275 | 1,384 | 1,260 | 1,387 |

1/ Export data cover powder and semimanufactured forms and therefore are not fully comparable with data on imports of wrought magnesium products.

2/ Includes 46 thousand pounds, valued at 50 thousand dollars, exported to India.

3/ Includes 38 thousand pounds, valued at 82 thousand dollars, exported to Australia.

4/ Includes 54 thousand pounds, valued at 96 thousand dollars, exported to the Netherlands.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 5.--Magnesium: U.S. imports for consumption, by type of product, 1959-66

| Type of product | 1959 | 1960 | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|---|---|---|
| | Quantity (1,000 pounds) | | | | | | | |
| Waste and scrap | 1,064 | 765 | 1,401 | 4,586 | 3,582 | 3,670 | 4,392 | 4,411 |
| Unwrought, not alloyed | 121 | 38 | 608 | 91 | 381 | 785 | 709 | 2,118 |
| Unwrought, alloyed | 51 | 55 | 61 | 149 | 730 | 949 | 654 | 1,377 |
| Wrought | 52 | 9 | 10 | 71 | 27 | 13 | 52 | 4 |
| Total | 1,288 | 867 | 2,080 | 4,897 | 4,720 | 5,417 | 5,807 | 7,910 |
| | Value (1,000 dollars) | | | | | | | |
| Waste and scrap | 267 | 189 | 332 | 1,047 | 707 | 648 | 903 | 1,031 |
| Unwrought, not alloyed | 37 | 13 | 151 | 25 | 118 | 242 | 198 | 582 |
| Unwrought, alloyed | 155 | 288 | 170 | 114 | 568 | 710 | 760 | 1,656 |
| Wrought | 121 | 61 | 80 | 83 | 96 | 38 | 42 | 13 |
| Total | 580 | 551 | 733 | 1,269 | 1,489 | 1,638 | 1,903 | 3,282 |
| | Unit value (per pound) | | | | | | | |
| Waste and scrap | $0.25 | $0.25 | $0.24 | $0.23 | $0.20 | $0.18 | $0.21 | $0.23 |
| Unwrought, not alloyed | .31 | .34 | .25 | .27 | .31 | .31 | .28 | .27 |
| Unwrought, alloyed | 3.04 | 5.24 | 2.79 | .77 | .78 | .75 | 1.16 | 1.20 |
| Wrought | 2.33 | 6.78 | 8.00 | 1.17 | 3.56 | 2.92 | .81 | 3.70 |
| Average | .45 | .64 | .35 | .26 | .32 | .30 | .33 | .41 |

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 6.--Magnesium metal and alloys, unwrought, wrought, and waste and scrap: U.S. imports for consumption, by principal sources, 1961-66

| Source | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|---|
| | Quantity (1,000 pounds) | | | | | |
| United Kingdom | 1,242 | 120 | 387 | 264 | 456 | 860 |
| Canada | 514 | 1,788 | 2,580 | 3,964 | 2,892 | 3,215 |
| Norway | 1 | 10 | 138 | 199 | 561 | 134 |
| Belgium | - | 35 | 208 | - | 512 | 800 |
| Netherlands | - | 23 | 286 | 447 | 415 | 348 |
| West Germany | 58 | 334 | 334 | 266 | 231 | 662 |
| Sweden | 35 | 138 | 87 | 57 | 185 | 229 |
| Japan | 110 | 2,019 | 148 | 34 | 92 | - |
| All other | 120 | 430 | 1/ 552 | 186 | 2/ 463 | 3/ 1,662 |
| Total | 2,080 | 4,897 | 4,720 | 5,417 | 5,807 | 7,910 |
| | Value (1,000 dollars) | | | | | |
| United Kingdom | 433 | 101 | 375 | 479 | 691 | 1,487 |
| Canada | 225 | 387 | 707 | 894 | 648 | 900 |
| Norway | 4/ | 2 | 30 | 54 | 152 | 32 |
| Belgium | - | 7 | 44 | - | 112 | 190 |
| Netherlands | - | 5 | 56 | 96 | 92 | 84 |
| West Germany | 13 | 74 | 70 | 54 | 56 | 157 |
| Sweden | 7 | 26 | 18 | 12 | 39 | 52 |
| Japan | 31 | 581 | 94 | 7 | 17 | - |
| All other | 24 | 86 | 1/ 95 | 42 | 2/ 96 | 3/ 380 |
| Total | 733 | 1,269 | 1,489 | 1,638 | 1,903 | 3,282 |

1/ Includes 256 thousand pounds, valued at 38 thousand dollars, imported from Pakistan.

2/ Includes 134 thousand pounds, valued at 31 thousand dollars, imported from Denmark and 95 thousand pounds, valued at 16 thousand dollars, from the Republic of South Africa.

3/ Includes 996 thousand pounds, valued at 241 thousand dollars, imported from the U.S.S.R., 150 thousand pounds, valued at 36 thousand dollars, from Denmark, and 109 thousand pounds, valued at 20 thousand dollars, from Greece.

4/ Less than $500.

Source: Compiled from official statistics of the U.S. Department of Commerce.

| Commodity | TSUS item |
|---|---|
| Arsenic metal, and waste and scrap---------- | 632.04 |

Note.--For the statutory description, see the Tariff Schedules of the United States Annotated (TSUSA-1968).

## U.S. trade position

Imports have been the sole source of the U.S. supply of arsenic metal for more than a decade. In 1963-66 annual imports increased sharply and averaged 342,000 pounds, valued at $163,000.

## Description and uses

Arsenic metal is moderately hard, and brittle. Arsenic is found in several minerals, but almost always in minute quantities; hence, the metal is obtained only as a byproduct of the smelting of ores of other metals, principally lead and copper.

Arsenic metal is used in extremely small quantities, primarily as an alloying agent. It is added to molten lead, to reduce surface tension, thus permitting the formation of spherical lead shot, and to impart strength. Arsenic is also added to lead-base alloys used to make bearings; it hardens the alloys, imparts a fine, uniform structure, and increases their resistance to metal fatigue. When added to copper-base alloys, arsenic increases the resistance of the alloy to corrosion and erosion and raises its annealing temperature.

Ultrapure arsenic metal has been used in making devices of advanced design such as transistors and diode components of masers and lasers. For some of these applications, the metal is combined with other elements to form intermetallic compounds, e.g., gallium arsenide, indium arsenide, and indium-gallium arsenide. Chemical compounds containing arsenic are provided for in schedule 4 of the TSUSA, viz, arsenic acid (item 416.05), covered in volume 4:2, calcium arsenate (item 418.10) and lead arsenate (item 419.00) in volume 4:3, and sodium arsenate (item 420.70), zinc arsenate (item 422.70) and miscellaneous inorganic compounds including those containing indium and gallium (item 423.00), in volume 4:4. Alloys of arsenic are covered in the summary on item 632.84 in volume 6:3.

## U.S. tariff treatment

The column 1 (trade-agreement) rates of duty (see general headnote 3 in the TSUSA-1968) applicable to imports of arsenic metal, unwrought, and waste and scrap (item 632.04) are shown below:

| | Rate of duty |
|---|---|
| Prior rate (before the concession noted below) | 2.5¢ per lb. |
| Concession granted by the United States in the 1964-67 trade conference (Kennedy Round): | |
| First stage, effective Jan. 1, 1968 | 2.2¢ per lb. |
| Fifth and final stage, effective Jan. 1, 1972 | 1.2¢ per lb. |

The prior rate of 2.5 cents per pound became effective June 30, 1958, as a result of a concession granted by the United States under the General Agreement on Tariffs and Trade (GATT). On the basis of the further concession granted by the United States in the sixth round of trade negotiations under the GATT, that rate is to be reduced about 50 percent in five annual stages, with the first stage effective January 1, 1968 (see the TSUSA-1968 for the intermediate staged rates). The duty on waste and scrap of arsenic metal was suspended to June 30, 1969, by Public Law 90-45 (see item 911.12 of the TSUS), but such waste and scrap are not known to be articles of commerce.

The average ad valorem equivalent of the duty of 2.5 cents per pound, based on dutiable imports in 1966, is 4.7 percent. Average ad valorem equivalents of the duty, based on dutiable imports from individual countries, would vary considerably, however, as suggested by the average unit values of imports (see accompanying table).

## U.S. consumption and production

Annual U.S. consumption of arsenic metal has apparently been generally increasing since 1958, which is indicated by the trend in imports, the sole source of supply for more than a decade. The United States has not produced arsenic metal since 1950, except perhaps some small quantities of ultrapure metal produced for experimental purposes.