MERCURY

A MATERIALS SURVEY

BY JAMES W. PENNINGTON

* * * * * * * * * **Information Circular 7941**

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OFFICE OF THE DIRECTOR

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
WASHINGTON 25, D.C.

March 17, 1959

Hon. Leo A. Hoegh, Director
Office of Civil and Defense Mobilization
Executive Office Building
Washington 25, D.C.

Dear Mr. Hoegh:

Copies of the Materials Survey - Mercury, prepared by the Bureau of Mines with the cooperation of the Geological Survey, are being forwarded to your office.

This report is one of the Materials Surveys to be completed under the terms of the April 15, 1955 agreement between the Department of the Interior and the Office of Defense Mobilization which assigned responsibility to Interior for preparation and revision of Surveys covering 45 mineral commodities.

Manuscript revisions proposed by reviewing officials of the Office of Civil and Defense Mobilization have been incorporated in the Survey.

Sincerely yours,

Thos. H. Miller

Acting Director

Foreword

Materials Surveys are designed to bring into a single document all the fundamental data needed by war or defense personnel with major responsibilities with respect to the Survey subjects. The Surveys dealing with metals and minerals summarize the demand-supply position in the United States and include information on production, imports, consumption, exports, substitutes, and pertinent history, usually in some detail back to 1925. The properties of the commodity and its principal compounds and alloys are described. Exploration, mining, and metallurgical methods are discussed. Domestic and foreign resources and reserves are covered. An extended presentation of the structure of the industry, pertinent laws and taxation policies, tariffs, Government controls, and history of wartime control experiences are included. Other special data are presented for particular commodities.

The Mercury Materials Survey was prepared in the Division of Minerals under the direct supervision of Richard H. Mote, chief, Branch of Base Metals. The manuscript was reviewed, in whole or in part, by specialists in the Bureau of Mines, Geological Survey, and industry.

CHARLES W. MERRILL,
Chief, Division of Minerals.

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JAMES W. PENNINGTON [2]

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Introduction and Summary

MERCURY, also widely known as quicksilver, ranks tenth in quantity in world output of nonferrous metals. However, its unusual and desirable combination of properties—liquidity at ordinary temperatures, high density, uniform volume expansion, electrical conductivity, ability to alloy readily, high surface tension, chemical stability, and toxicity of its compounds—gives mercury an industrial and military importance out of proportion to the small physical size of the production industry.

Although mercury has been known and used for over 20 centuries, until the 16th century consumption was small and chiefly in medicine. Since then mercury's applications have paralleled scientific advancements, and current principal uses of mercury are in electrical apparatus, industrial and control instruments, agriculture, pharmaceuticals, and the electrolytic preparation of chlorine and caustic soda. Other materials may be substituted for mercury in some applications; yet, for those uses that require mercury's unusual combination of physical and chemical properties, there is no ideal substitute.

Of 25 minerals known to contain mercury, the chief source is the red sulfide, cinnabar (HgS). Cinnabar deposits are relatively shallow and confined to areas of late Tertiary orogeny and volcanism. Despite widespread occurrences of cinnabar, deposits of commercial importance are found in only a few countries—China, Italy, Mexico, the Philippines, Peru, Spain, the U.S.S.R., the United States, and Yugoslavia.

Measured, indicated, and inferred world reserves of mercury ore are an estimated 4 million flasks, with the United States accounting for about 300,000 flasks. Most of the reserve is in the principal mercury-producing mines of the world.

Depending on the type of deposit, mercury ore is mined by either surface or underground methods. With either method mercury mining is a comparatively small-scale operation because the deposits are characteristically small and irregular in size. With the less costly surface methods, ore averaging 3 pounds of mercury per ton may be mined profitably, whereas the underground methods may require a grade of 10 pounds or more per ton.

Beneficiation of mercury ore, other than crushing to a suitable size, is seldom done. However, mercury ore may be upgraded by hand sorting, screening, jigging, tabling, or flotation. Of the various processes, flotation is the most efficient, and concentrates containing 25–50 percent mercury with a recovery of about 90 percent have been produced commercially.

Roasting is the conventional process used for extracting mercury from its ores and concentrates. It is essentially a distillation process in which

[1] Work on manuscript completed January 1959.
[2] Assistant chief, Branch of Base Metals, assisted by Gertrude N. Greenspoon, statistical assistant, who compiled all statistical data and helped prepare the text.
[3] Geologist, Geological Survey, U.S. Department of the Interior.

mercury ore is heated in a mechanical furnace or retort to vaporize the mercury, followed by cooling and condensation of the vapor to liquid metal. Recovery of mercury is high, averaging about 95 percent for furnace plants and 98 percent for retort installations. In addition, the product—prime or virgin mercury—averages about 99.9 percent pure which is satisfactory for virtually all uses. Dirty or contaminated mercury is cleaned and refined by filtering, oxidization or acid leaching of the impurities, or by distillation methods.

Secondary mercury is reclaimed from waste products, such as dental amalgams, sludges, used batteries, and other mercury-bearing materials, in retorts similar to those used for treating primary materials. The quantity of mercury recovered from secondary material in the United States each year is significant, and the 5,800 flasks reclaimed in 1957 represented 14 percent of the total domestic production.

World mine output of mercury is dominated by Italy and Spain, which furnished 26 percent and 22 percent, respectively, of the 245,000 flasks produced in 1957. Most of the remainder is furnished by the United States, Mexico, Japan, Yugoslavia, the U.S.S.R., China, and the Philippines. About 10 other countries report minor and sporadic mercury production.

In the United States, California is the leading mercury-producing State and furnished 48 percent of the 35,000 flasks produced in the Nation in 1957. Of the total, Nevada supplied 18 percent, Alaska 16 percent, Oregon 12 percent, Idaho 6 percent, and Arizona, Texas, and Washington the remainder.

The major part of the free-world mercury consumption is distributed among the United States, the United Kingdom, Germany, Canada, France, and Japan. In most cases, those countries depend largely on imported metal supplied by Italy, Spain, Mexico, the Philippines, and Yugoslavia.

Market quotations cover virgin metal in flasks containing 76 pounds. Producers sell the mercury through dealers, brokers, or directly to consumers. Grades of mercury other than virgin are produced by concerns that reduce impurities in mercury by redistilling or by other means.

Mercury prices tend to fluctuate widely because of erratic demands and the great adverse effect of slight overproduction. In addition, domestic prices are influenced by imports of mercury from the large, low-cost foreign producers.

The Government has enacted various legislation in an effort to stabilize and assist the domestic mercury industry. During the period of depressed mercury prices in 1922, the current import duty of 25 cents a pound or $19 a flask was imposed on mercury. In emergency periods, such as World War II and the Korean war, price, export, import, and use controls were placed on mercury; purchase contracts were made with mercury producers; and mercury was obtained for the national stockpile. Under the Defense Production Act of 1950, as amended, the Government advanced loans for the exploration of eligible domestic mercury deposits; established expansion goals and granted rapid tax amortization; and provided a guaranteed-price purchase program for domestic and Mexican mercury.

Although the United States relies on foreign sources for a part of the mercury supply during peacetime, domestic production plus mercury in the national stockpile probably would be adequate for domestic demands in an emergency period.

ACKNOWLEDGMENTS

Sincere appreciation is extended to Helena M. Meyer, formerly assistant chief, Branch of Base Metals, who contributed material and data on the mercury industry.

The Gordon I. Gould Co., San Francisco, Calif.; Pacific Foundry, Ltd., San Francisco, Calif.; F. W. Berk & Co., Inc., Wood-Ridge, N.J.; Metalsalts Corporation, Hawthorne, N.J.; Rare Metals Corp. of America, Salt Lake City, Utah; and the Cordero Mining Co., Palo Alto, Calif., graciously contributed information and illustrations for the report.

CHAPTER 1. PROPERTIES, USES, AND SUBSTITUTES (*73, 86*)[4]

PROPERTIES

Mercury, also widely known as quicksilver, is the only metal that is liquid at ordinary temperatures. Liquid mercury is silvery white in color with a faint bluish tinge. Below its melting point of minus 38.85° C., mercury is a white solid, and above its boiling point of 357.25° C., it is a colorless vapor.

Mercury, symbol Hg, is classed in Group II of the periodic table with an atomic number of 80, an atomic weight of 200.61, and a valence of either one or two. Seven stable isotopes of mercury with mass numbers ranging from 196 to 204 have been identified; in addition, artificial isotopes with mass numbers ranging from 195 to 205 have been produced.

The specific gravity of mercury at 0° C. is 13.595, and at minus 38.8° C. in the solid state it is 14.193. It has a latent heat of fusion of 2.8 calories per gram and a latent heat of vaporization of 65 calories per gram.

The volume expansion of mercury, one of its important properties, over its entire liquid range is—

$$V_t = V_o(1 + 0.18182 \times 10^{-3}t + 0.0078 \times 10^{-6}t^2)$$

Another valuable property of mercury is its relatively high-surface tension, 480.3 dynes per centimeter compared with 75.6 for water. Because of its high surface tension, mercury does not wet glass and exhibits a reverse meniscus in a capillary tube.

The electrical conductivity of mercury is an essential characteristic contributing to the use of mercury in instruments and apparatus that are actuated by electricity.

At ordinary temperatures, mercury is stable and does not react with air, ammonia, carbon dioxide, nitrous oxide, nor oxygen. It combines readily with the halogens and sulfur, but it is little affected by hydrochloric acid and is attacked only by concentrated sulfuric acid. Either dilute or concentrated nitric acid dissolves mercury-forming mercurous salts, when the mercury is in excess or no heat is used, and mercuric salts, when excess acid or heat is used.

Alloys of mercury with other metals are known as amalgams. Although mercury alloys readily with other metals, the principal exception being iron, amalgams are rarely used in an alloy form, but only serve as intermediate products in technical processes. The principal amalgams are those formed in recovering gold and silver by the amalgamation process; the sodium amalgams of the electrolytic process that use mercury cells in preparing chlorine and caustic soda; and the sodium amalgams used in the production of tetraethyl lead.

Mercury compounds and preparations possess various properties that make them valuable as intermediate or end-use products in medicine, agriculture, and diverse other applications. Except for mercurous chloride and the mercury sulfides, most mercury compounds are extremely toxic.

The principal mercury compounds and their chief applications are as follows:

Mercuric acetate—starting material in the manufacture of organic mercurials.

Mercuric cyanide—antiseptic in medicine.

Mercurous chloride—fungicides and insecticides.

Mercuric bichloride—production of other mercury compounds—yellow oxide, ammoniated mercury, and mercuric iodide; seed treatment in agriculture; catalyst in organic reactions; antiseptic in medicine; and to intensify negatives in photography.

Mercuric iodide—skin treatment in medicine; analytical reagent.

Mercuric nitrate—preparation of other mercury compounds.

Mercuric oxides—yellow and red—oxides are chemically identical; yellow color due to fine particle size (less than 2 microns); red form, 10–20 microns; red oxide can be ground to yellow form; germicide in medicine; fungicide and pesticide in agriculture; preparation of other mercury compounds; and antifouling paint. Red oxide used in dry cell battery.

Mercurous sulfate—constituent of standard cells—both Clark and Weston type.

Mercuric sulfate—catalyst.

Mercuric sulfide—pigments.

Complex mercury halide—analytical reagents, antiseptics, thermosensitive paints.

USES

When mercury was first in demand in substantial quantities in the United States a century ago, its predominant use was for the recovery of gold; later, pigment requirements became important. These uses subsequently were replaced almost entirely by others. In recent years, high-purity mercury has been

[4] Italicized figures in parentheses refer to items in the bibliography.

widely used in scientific and industrial control apparatus, which depend more on the physical than on the chemical characteristics of mercury.

Mercury is consumed in many pharmaceutical preparations, and in times of war, this usage increases substantially. It is an important ingredient in mercuric ointment for wounds; in antiseptics—bichloride of mercury, and mercurochrome to guard against infections; and in calomel and diuretics to cleanse the body. As dental amalgams, mercury aids in rebuilding teeth.

Mercury is used as a base material in making phenyl mercurial compounds, which are used as fungicides and bactericides to preserve textiles and for slime control in paper and pulp manufacture. Agricultural uses include germicides in treating and storing seed, in weed control, and in fungicidal fruit-tree sprays.

In industrial and control instruments, mercury is used in barometers, thermometers, manometers, and in gas-pressure and tank gages. In recent years, considerable mercury has been used in flowmeters to indicate, register, and record the flow of water, sewage, steam, compressed air, and high-pressure gases. Mercury diffusion pumps were used originally to attain the high vacuum required for radio and television tubes and neon signs. In some electronic computers, a tube of mercury serves as the "memory unit."

In electrical apparatus, many kinds of lamps use mercury, including mercury-vapor, arc, and sun lamps. Modern mercury lamps combine the compactness and high-wattage properties of incandescent lamps and are adaptable to higher voltage supply lines than those used with incandescent lamps. This combination of characteristics makes mercury lamps of unique value in high-bay industrial, street lighting, and floodlighting applications where high mounting requires high-wattage units, and replacement costs can be minimized by a few units. Because of greater efficiency and more lumens per watt output, mercury-vapor lamps are replacing other type of indoor and outdoor lighting. In addition, mercury lamps are used in motion picture projection, photography, examination of teeth, heat therapy in medicine, and in sterilizing water. Other electrical applications of mercury include arc rectifiers and oscillators for use in electric furnaces; rectifier bulbs and power-control switches for motors; and various kinds of mercury switches, including wall-type switches for use in the home.

In 1944 production of a mercury dry-cell battery, whose principal characteristic is its ability to stand up under high temperatures and high humidity, was begun. Other features of the battery are its long shelf life, its ability within its rated current range to deliver the same ampere-hours service whether operated intermittently or continuously, and its much greater power for the size of unit used. The battery was developed primarily for war purposes, but it has since been perfected for peacetime use. Mercury cells are used in Geiger counters, portable radios, portable two-way communications' equipment, electronic measuring devices, digital computers, guided missiles, and hearing aids.

Electrolytic mercury cells were first employed in producing chlorine and caustic soda in the mid-1890's. This process was used on a large scale in Europe for many years, but it was not until World War II that production of chlorine and caustic soda by the mercury-cell process became widespread in the United States. Mercury combines with metallic sodium as sodium amalgam, which, in the presence of water, immediately reacts and forms metallic mercury and sodium hydrate. Rayon-grade caustic can be produced in mercury-cell plants without purification and with a caustic content up to 73 percent without supplementary concentration.

In the manufacture of glacial acetic acid, mercury is converted to a salt that acts as a catalyst. A recent use of mercury as a catalyst is in the production of methyl styrene.

Mercury has been used in the generation of power since 1923. It is heated in one boiler, and the vapor is used to drive a turbine; the vapor is then exhausted into a second boiler to produce steam that drives a second turbine. The mercury is used in a closed circuit.

A recent new use for mercury is in precision or investment castings. Liquid mercury is poured into a steel die that is then immersed in a freezing bath. The die is opened, and the solid mercury form is removed. If exceptionally complex parts are to be produced, they may be formed as separate frozen-mercury patterns, then joined under only the slightest pressure. The finished unit, formed into a seamless, one-piece pattern, utilizes as many individual sections as necessary to form the desired part. The finished pattern is then dipped into baths of ceramic slurry that use a nonaqueous solvent. When the resultant hardened shell has attained a thickness of approximately one-eighth inch, the mercury is melted out at room temperature. The ceramic-shell mold is strengthened by firing at 1,850°F. for 2 hours. Molten metal is poured into the ceramic molds, and after sufficient cooling, the shell is broken away, leaving the finished part. Sand blasting or other standard means are utilized to clean the part. Steel castings with a diameter of 42 inches and weighing 300 pounds have been produced. A slight loss of mercury occurs from spilling or retention of small quantities in the ceramic molds.

Another new use for mercury is in selenium-free pigments called mercadium reds. The new pigments are comparable to the selenium-containing cadmium sulfoselenides that had been the only satisfactory heat- and light-fast red pigments available. Mercadiums are a solid solution of cadmium and mercury sulfide.

Other uses of mercury include amalgamation of gold and silver, in antifouling paint to protect ship bottoms, in the oil industry to maintain uniform temperatures in the distillation of oil, as a boiler compound to eradicate scale and prevent corrosion in locomotive boilers, and in the purification of metals.

Reports to the United States Atomic Energy Commission on Nuclear Power Reactor Technology in May 1953 noted that mercury was to be used in one of four experiments conducted to appraise the prospect of private industrial participation in joint production of electric energy and fissionable material from reactors.

Results of investigations on the electrolysis of carbonate-leach solutions with a mercury-cathode cell indicated that good recoveries of both uranium and vanadium were obtainable. Despite a high initial investment, the operating costs appeared favorable compared with other methods of recovery.

SUBSTITUTES

In the pharmaceutical field, substitutes for mercury include sulfa drugs, iodine, and other antiseptics and disinfectants. Lead azide and organic initiators, such as diazo-dinitro-phenol, are substitutes for mercury fulminate. Plastic paint and copper-oxide paint are employed to protect ship bottoms. Metal powders and porcelain replace mercury in some dental uses. For agricultural uses, copper compounds, formaldehyde, and other products may be substituted for mercury. Other processes are available to replace those using mercury in production of chemical compounds and metals.

HEALTH HAZARDS (*7, 28, 32, 34*)

Mercury poisoning may occur in mining and recovering mercury and in any industry in which mercury is used, as a result of handling it or being exposed to its vapors or dust. Mercury may enter the body through the skin, the gastrointestinal tract, or the respiratory tract. Chronic poisoning develops gradually and often without conspicuous warning signs. Some early symptoms are general weakness, exhaustion, inflammation of the mouth, loosening of the teeth, excessive salivation, emotional instability, and body tremors. Symptoms of acute poisoning include metallic taste, nausea, abdominal pain, vomiting, headaches, diarrhea, and sometimes cardiac weakness.

The immediate cause of industrial mercurial poisoning is the absorption and retention of small quantities of the metal or one of its many compounds over a long period of time. Aggravating causes are improper or insufficient ventilation in working areas and uncleanliness of workers. When mercury enters through the skin, it is more readily absorbed if the worker is perspiring or if the mercury is impure and dirty. There is wide variation in the susceptibility of individuals, but it is believed that 1 milligram of mercury per 10 cubic meters of air is considered safe.

Precautions that can be taken at mines, retorts and furnaces, and industrial plants are known, and with care the mining and handling of mercury can be made relatively safe. At all operations ventilation is important; all working areas should be kept well ventilated by large exhaust fans to draw the air away from the workers. Negative pressure should be maintained in furnaces and retorts to prevent the escape of fumes and dust, and workers should be equipped with dust masks. Personal cleanliness is essential to the prevention of poisoning; hands should be washed before eating or handling anything put in the mouth; the mouth should be rinsed before eating or drinking; hot-shower baths should be taken at the end of each workday; teeth should be brushed regularly; and clothing should be changed before going to work and at the end of the day. Work clothes should cover the body and should be tight-fitting at ankles, wrist, and neck. A close-fitting hat or cap also should be worn, and all work clothes should be washed frequently. As leather shoes will absorb liquids containing mercury, rubber-soled shoes or rubber boots are preferable. Periodic examinations by physicians and dentists are recommended, and the eating of substantial meals, and plentiful drinking of water and milk are helpful.

In plants manufacturing instruments and in laboratories, benches should be covered with a smooth impervious surface, sloping so that the mercury will drain into a suitable receptacle at the lowest point. Floors other than cement or concrete should be covered with linoleum, glued in place with coved edges slanting to one corner so that spilled mercury may flow to one point from which it can be easily removed. Floors should be washed frequently.

Mercury-vapor detector lamps or meters that indicate the amount of contamination should be used. Mercury decontaminants are available for spraying floors and walls, and a spray containing calcium polysulfide provides a coating which impedes mercury vaporization.

CHAPTER 2. HISTORY

For more than 2,300 years cinnabar and mercury have been known and used. The first recorded mention of mercury was by Aristotle in the fourth century B.C., when it was used in religious ceremonies. In the first century Dioscorides Pedanius and Pliny used mercury as a medicinal ointment. From the sixth century on, the Egyptians frequently mentioned mercury, its uses and preparations, as well as tin and copper amalgams. Amalgamation evidently was known to Pliny, who referred to the use of quicksilver in recovering noble metal from earth and also in gilding. Rhazes (852–932), Mesue (925–1015), and Avicenna (980–1037) used mercury ointment and bichloride in treating itch and various other skin diseases. Paracelsus (1493–1541) introduced the use of mercury in the treatment of syphilis.

Until 1557 when Bartolomé de Medina invented the Patio process for recovery of silver by amalgamation, the consumption of mercury was small and chiefly for medicinal and cosmetic purposes. However, following the introduction of the Patio process, large quantities of mercury were used for amalgamation purposes in Mexico and Peru and in other countries.

The introduction of mercury into scientific research occurred in 1643 with the invention of the barometer by Torricelli, who used mercury to determine the pressure of the atmosphere. In 1720 Fahrenheit invented the mercury thermometer. Professor Braune of St. Petersburg, Russia, first succeeded in freezing mercury in the winter of 1759–60, and this marked the acceptance of mercury as a metal. Joseph Priestly (1733–1804) initiated another important scientific use of mercury by sealing off water-soluble gases in gas analyses. In 1799 Howard invented fulminate, which has played an important part in the history of nations both in times of war and peace.

Three great mines dominated mercury production of the world prior to 1850—the Almaden in Spain, the Idria now in Yugoslavia, and the Santa Bárbara mine in Peru. Since 1850 four districts—Almaden, Idria, Monte Amiata in Italy, and California in the United States (*15*)—have supplied most of the world production of mercury.

Almaden, Arabic for "the mine," is in the Ciudad Real Province, Spain, about 150 miles southeast of Madrid. Mercury production began about 400 B.C. under the Moors (*51*) who were the first to distill mercury on a commercial scale. The Moors operated the mine until 1151, when Alfonso VII gave the mines to the Templars; later the mines were transferred to the military-religious order of Calatrava. When mercury began to be used for amalgamation, the Spanish rulers considered the mines a public utility, and by successive steps they dispossessed Calatrava, after a bitter dispute decided by the Pope. A 120-year lease to the German Fugger Brothers began in 1525, and reverberatory furnaces replaced the old pot stills. After 1645 operations were under the direction of the Finance Minister of the Spanish Government.

The old furnaces (fig. 1), built in 1651, were still in use in the early 1920's. The Council of Administration assumed control of the mine in 1918 and after its reorganization in 1923 adopted new methods of exploitation and modern equipment. Thereafter output rose sharply and reached 72,000 flasks, a new record, in 1927. During the next 10 years, production of the Almaden fluctuated, and operations were hampered by the Spanish Civil War as each side fought for ownership of the mine. Almaden was transferred to the Franco Government at the end of the war in the spring of 1939.

Since 1500, the first recorded production for the Almaden mine, the operation has produced 7 million flasks of mercury through 1957, almost three times as much as its nearest competitor—the Idria mine in Yugoslavia.

Next to the Almaden, the Idria mine, originally in Austria, later under Italy, and now under Yugoslavia, has had the longest production record in the world. The mine is in the foothills of the Julian Alps, Province of Slovenia, along the Idria River. The occurrence of quicksilver was first noted about 1470 by Virgilio Formentini, an Italian noble of Cividale, when the ground was under the jurisdiction of the Venetian Republic. Mining began soon afterward, and by the beginning of the 16th century operations were so successful that Maximilian, the emperor of Austria, took possession in 1509. However, in 1516, Idria was restored to Venice; mining prospered under the dominion of Venice to about 1580, when

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FIGURE 1.—Bustamente Furnace and Condensing System in Operation at the Almaden Mine, Spain, From 1651 Until Early 1920's. Furnace is Brickwork on Left, Clay Condenser Pipes in Center, and Condenser Chamber on Right of Photograph.

(Courtesy, Gordon I. Gould & Co.)

the mine again fell into the hands of the Hapsburgs and remained Austrian Crown property to World War I. By the treaty of Rapallo, November 12, 1920, between the Italian and Yugoslav Governments, the Idria mine passed into the possession of the Italian Government. The transfer of this mine removed Austria from the list of mercury-producing countries.

Italy controlled the Idria mine from World War I until the end of World War II. In early 1944 the mine was flooded and otherwise sabotaged by the Yugoslav Partisans. At the end of the war, the Idria mine was ceded to Yugoslavia.

Except for the Almaden mine, Idria has produced more mercury than any other mine in the world—a total of over 2½ million flasks through 1957.

The Santa Bárbara mine, Department of Huancavelica, Peru, was the world's leading mercury producer for many years and is the fourth largest mine in the world in total output. Cinnabar was discovered at Huancavelica shortly after the Spanish conquest of South America, and production began in 1566. Output increased rapidly and for most of the 17th century exceeded production of the Almaden mine. This district (*63*) has produced an estimated total of 1,470,000 flasks of mercury, 93 percent of which was produced from the Santa Bárbara mine during the 220 years from 1571 to 1790. Thereafter, only a negligible quantity of mercury was produced.

Virtually all of the known mercury deposits in Italy are in the Monte Amiata district in Siena and Grosseto Provinces about 75 miles north of Rome. The surface outcrops of the old Siele mine (*52*), about 6 miles south of Abbadia San Salvatore, were worked by the Etruscans several centuries B.C., but Monte Amiata district's modern history did not begin until 1868, when the Siele was rediscovered and opened. It was highly productive until about 1933. The original Siele was idle and possibly exhausted, but a nearby mine on the same mineralized zone, the Solforate del Siele, took its place. The Argus or Abetina, actually a continuation of the Solforate del Siele, was discovered in 1925 and until 1945 produced about 50,000 flasks. The Abbadia San Salvatore mine, near the town of the same name, is the farthest north of the productive mines in the district. It was discovered in 1894 and began large-scale production about 1901; thereafter, it was the largest and most consistent mercury-producing mine in Italy.

In 1920 Italy surpassed all other countries in output of mercury and maintained its rank through 1926. However, in 3 of the 7 years the output of the Idria mine was needed for Italy to outrank all other countries. In the 58 years, 1900–57, inclusive, Italy produced 2,333,000 flasks of mercury, including output of the Idria mine. Without the Idria mine, Italy's output would have been about 2 million flasks.

Production of mercury in the United States began in California shortly before 1850 and reached an annual peak of 80,000 flasks in 1870. Its early history was closely associated with the discovery of gold and the development of gold mining in California, and from 1850 until nearly 50 years later the State's output virtually represented the United States total. From 1850 to 1957, inclusive, 3,113,000 flasks were produced, three-fifths of which were accounted for in the 50 years, 1850 to 1899, inclusive, and two-fifths in the 58 years, 1900 to 1957, inclusive.

Two mines furnished most of California's production—the New Almaden mine, near San Jose, New Almaden district, Santa Clara County, and the New Idria mine, 67 miles from Hollister in San Benito County.

The New Almaden was the first mine on the North American continent to produce mercury, although occurrences in Mexico evidently were noted previously. Indians were claimed to have obtained cinnabar from a natural cave near the top of Mine Hill before the mine was located and to have used the cinnabar as a pigment. The mine was discovered in 1824 by Sunol and Chaboya, and from 1824 to 1835 several attempts were made to extract silver. In 1845 the ore was identified as cinnabar, and production began in 1846. Except for a period from November 1858 to January 1861 when the property was in litigation, the mine produced continuously from 1850 until 1926. It became internationally famous when Emperor William I of Germany acted as arbitrator between the English and Mexican claimants. Title to the property was awarded to the English company, and $1.5 million was paid to the Mexican claimants.

More than 90 percent of the total New Almaden output was before 1900. Output in 1850 was from ore averaging 37 percent; by 1863 the grade had dropped to 18 percent and by 1895 to less than 1 percent.

The second mine, the New Idria, in San Benito County, was discovered in 1853. Its early history is clouded by poor records and by a series of legal and other difficulties some of which led to bloodshed. Production started in 1854, and, except for 1921 and 1922 when the property was in litigation, has been continuous for more than 100 years. Unlike the New Almaden, two-thirds of New Idria's output came after 1900.

The decline in world output of mercury, which began in 1918, continued into the 1920's, and the 1921 output was the lowest on record to that time.

In the latter part of 1920 only two of the more important mines in the United States were operating—the New Almaden, California, and the Chisos, Texas. Under the tariff act of 1922, effective September 22, a duty of 25 cents a pound ($19 a flask) was placed on imported mercury.

In 1927 mercury prices gradually increased, and production in the United States rose 48 percent. Output increased through 1929, dropped in 1930, and rose in 1931 to the highest annual output since the war. A sharp decline in prices began in June 1931, and many mines were forced to close. The European price broke sharply in January 1932 and continued to decline; domestic output dropped to almost half the 1931 quantity, and the United States returned to its previous status as an importer. For most of the 20-year period, 1919–38, inclusive, the United States ranked third in world production.

The mercury industry became very active in the late months of 1936 and early months of 1937, mainly because of the civil war in Spain and political disturbances in other countries. Subsequently the outbreak of war in Europe in 1939 had a marked influence on the mercury industry. Mercury output in the United States in 1940 was the highest on record since 1883.

As operations at producing mines increased and idle and new mines were reopened, output rose without interruption through 1943.

Efforts of the Government were directed toward increasing supplies and reducing requirements to assure the filling of war and essential civilian needs. Conservation orders restricted the use of mercury for certain purposes and discontinued others; price-ceiling actions were taken and controls were placed on exports (see Legislation and Government Programs).

The disruption of ocean transportation and close relationship of Italy and Spain to the Axis Powers made it necessary for the United States to develop alternate sources of mercury supply. Mexico, for years the second largest mercury producer in the area, appeared to be the most promising source of appreciable quantities.

In July 1941 an agreement was reached for the United States to obtain surplus production of mercury placed under export control by the Mexican Government. Thereafter most of the metal exported from Mexico came to the United States.

Another source of mercury for the Allies was Canada. All known occurrences of mercury are in British Columbia, and a property at Pinchi Lake in the Omineca mining district was developed by the Consolidated Mining & Smelting Co. in 1940. Another deposit was developed by Bralorne Mines, Ltd., on Silver Creek east of Takla Lake, and production began the latter part of November 1943.

Metals Reserve Co. contracts for mercury production were granted to the two Canadian producers. With the easing of the mercury-supply situation in the United States, the contract between Consolidated and Metals Reserve Co. was terminated in September 1943, effective October 9. The contract with Bralorne was cancelled in September 1944.

Production in the United States declined in 1944 after cancellation of Government-purchase contracts. Prices began to rise the latter part of 1944 because of the mercury-battery program and reached a high of $166 in February 1945. The arrival of sufficient mercury supplies from Spain for the new battery caused a collapse in quotations, and the price dropped to $96 a flask in September. After cancellation of Government contracts for mercury batteries on termination of hostilities with Japan in August 1945, consumption dropped sharply, and an oversupply of mercury developed in the latter half of 1945.

The output from United States mercury mines trended downward in the years following World War II through 1950, when only 4,500 flasks were produced—the lowest in the 100 years covered by production records. Only one large mine, the Mount Jackson in Sonoma County, Calif., was productive throughout 1950. In 7 months following the outbreak of the Korean war in June 1950, the price of mercury virtually trebled, but production did not respond as it had in earlier periods of high prices. Output in 1951, however, increased 61 percent above 1950. Thereafter, production rose each year to 34,600 flasks in 1957.

The largest and principal use of mercury in the United States during the last half of the 19th century and the first part of the 20th century was in the amalgamation process for recovery of gold. Consequently, when the use of mercury for amalgamation purposes declined prior to World War I, there was an accompanying decline in mercury prices. However, the outbreak of war in 1914 greatly increased the demand for mercury for fulminate, drugs, and paint to prevent corrosion of ships.

Increased consumption of mercury in war materials resulted in rising prices throughout 1915, and by February 1916, the price had risen to $300 per 75-pound flask. War embargoes placed on the exportation of metal from foreign sources at the outbreak of war were relaxed by the British Government. Mercury arrived in the United States in sufficient quantity to fulfill war contracts, and prices fell to $75 in August 1916.

In the years after World War I the use of mercury returned to a peacetime pattern. More mercury went into pharmaceuticals, chemical-manufacturing processes and into electrical equipment. New applications included use in neon lights, radio tubes, and in automatic switches. Although the first mercury boiler was installed in 1923 and such use is nondissipative, each new installation requires considerable mercury. Use of mercury for amalgamation processes declined during this period, but the large quantities used for scientific and technical instruments more than compensated for this decrease.

In the first year of World War II, domestic consumption did not appreciably advance. Large Navy purchases of mercuric oxide for antifouling paint in late 1941, however, resulted in rapidly expanding consumption. During most of 1943 the principal quantities of mercury were consumed as a catalyst in the manufacture of chemicals for chemical warfare, and consumption rose. After successful production of the mercury-cell battery in 1944, the expectation that war demand for the battery would cause consumption to rise to new record levels was fulfilled in 1945, and consumption exceeded the previous record in 1943 by 15 percent.

Although domestic consumption of mercury dropped immediately following World War II, it rose in 1948 and 1949 due to mercury-boiler and chlorine and caustic soda installations. Since 1949, no new boiler plants have been installed, but a number of new plants that use mercury cells for the electrolytic production of chlorine and caustic soda have been constructed, and capacities at existing plants have been expanded. As a result, mercury required to replace losses at chlorine and caustic soda plants rose from about 800 flasks in 1948 and 1949 to 4,000 flasks in 1957. Substantial quantities of mercury also were used in electrical apparatus for agricultural purposes, and in industrial and control instruments.

CHAPTER 3. RESOURCES

BY

EDGAR H. BAILEY

GEOLOGY AND MINERALOGY

Mercury ores are formed relatively near the surface and, so far as now known, extend downward from the surface only to the maximum depth of about 2,400 feet reached at the New Almaden mine in California. The bulk of the ore that has been mined has come from depths of less than 1,000 feet. Nearly all deposits are confined to a belt of late Tertiary orogeny and volcanism that extends northward from the southern tip of South America along the western edge of that continent and North America to Alaska, swings westerly to Northeast Asia and seemingly bifurcates north of Japan. One branch follows the island arcs through Japan, the Philippines, and Indonesia to New Zealand and eastern Australia; the other branch follows the Himalayan and Alpine belt to terminate in Spain (fig. 2). Because the deposits were formed near the surface in orogenically active belts, it is likely that any ancient deposits that may have formed would have eroded, and all deposits that can be accurately dated are Pliocene or younger in age. Although most deposits are in belts of Tertiary and Quaternary volcanism, many of the major ones, for example, Almaden and Idria, are remote from any volcanic eruptive rocks, and the majority of deposits are at least a few miles from surface exposures of late Tertiary or Quaternary volcanics.

Host rocks for mercury deposits include nearly all known kinds of rocks of all ages, and the great deposits of the world are in very diverse environments. Structures responsible for ore localization also are highly variable; in some mines there are well-formed structural traps with caps of relatively impervious material, generally shale or gouge, but in some major deposits, for example, the Almaden deposit, no tight structural control is obvious. In general, however, deposits in similar rocks exhibit similar structural environments.

The similarity of mineralogy and diversity of geologic setting of mercury deposits is well shown by the description of the major districts of the world included in this report. Virtually all of the deposits in the United States, including Alaska, and many of those in Mexico, have been examined by the Federal Geological Survey.

Largely because of their near-surface environment, different mercury deposits have little in common other than their contents of cinnabar and a common gangue of silica or carbonate minerals. Pyrite, or more rarely marcasite, is a constituent of ores in rocks containing considerable iron, but in iron-poor rocks the iron sulfides are rare or absent. Stibnite accompanies the ore in some geologic provinces, and in one deposit the mercury-antimony sulfide, livingstonite, is the chief ore mineral. A little arsenic is not uncommon. Other metals, such as gold, silver, or base metals, are rarely present in more than trace amounts. An exception to this, however, is provided by the base-metal assemblage containing mercurial tetrahedrite, which has yielded only a small part of the mercury produced in the world but which has been mined for mercury in central Europe, northern Africa, and Chile. In addition, an insignificant amount of mercury has been recovered as a byproduct from the zinc smelters.

WORLD RESERVES

Measured, indicated, and inferred mercury reserves are adequate to supply world needs for at least 30 years, and the domestic reserve is satisfactory to fill domestic needs for a few years if foreign sources are not available.

A tabulation of measured, indicated, and inferred ore reserves that can be recovered at a cost of about $250 a flask is given in table 1. Because only a very few domestic and foreign mines make a practice of actually blocking out ore in advance of mining, very little of the ore listed as "known" (measured and indicated) is as well delineated as is the case for the ores of major metals. On the other hand, except for the Russian estimate, all ores listed in this category have been penetrated by mine workings or drill holes, and most involve relatively short projections from larger ore bodies. The figures on reserves in this report are for the most part compiled from various trade journals.

Much of the reserve is contained in the major mercury mines of the world, a few of which have accounted for perhaps as much as 80 percent of the total production.

TABLE 1.—*Mercury reserves*[1] *of the world, 1957, in thousands of 76-pound flasks*

	Measured	Indicated and inferred
Alaska	25	15
United States	100	175
Canada	150	150
Mexico	30	100
South America	4	10
Spain	[2] 100	1,000
Italy	500	1,000
Yugoslavia	150	300
Czechoslovakia	10	----------
U.S.S.R	[3] 850	500
Japan	30	50
China	----------	500
Turkey	----------	50
Philippines	45	45
Total	2,000	3,900

[1] Minable at about $250 a flask.
[2] Data inadequate and reserves known to owners may be much larger.
[3] Based on U.S.S.R. estimate, which seems large for amount of exploration that had been done at time of estimate.

NORTH AMERICA

UNITED STATES

The mercury deposits of the United States occur principally in the Far Western States, but notable exceptions are the deposits in Texas and Arkansas.

The total reserve of all classes of ore amounts to 315,000 flasks, of which approximately half is measured or indicated, and the remainder is inferred (table 2). The figures by States should not be interpreted as precise but as giving an estimate of the order of magnitude. The average grade of ore currently being processed in the United States, exclusive of Alaska, is about 8 pounds to the ton.

TABLE 2.—*Mercury reserves*[1] *of the United States, 1957, in thousands of 76-pound flasks*

	Measured and indicated	Inferred
Alaska	30	10
Arizona	2	3
Arkansas	----------	1
California	64	90
Idaho	20	6
Nevada	31	33
Oregon	8	7
Texas	2	7
Utah and Washington	----------	1
Total	157	158

[1] Minable at about $250 a flask.

The 1957 estimate of reserves indicates that the rate of discovery is keeping pace with production. Not reflected by the figures is the fact that much of the ore now classed as measured and indicated has a greater degree of assurance than in previous estimates.

The mercury reserves are largest in the States that have had the most production in recent years. Nearly all of the measured and indicated ore is in mines that are now being operated.

ALASKA

In Alaska mercury has been mined profitably only in the central Kuskokwim region of southeastern Alaska, although cinnabar has been rather widely found, particularly in placer gold concentrate. The deposits in this district that have been seriously explored or operated are the Red Devil, the Alice and Bessie, and the Decoursey Mountain mines; all have reserves. The Marsh Mountain mine in the Nushagak district also recently was explored successfully. The measured reserve in Alaska is about 25,000 flasks, most of which is contained in ore averaging 15 pounds or more of mercury to the ton.

The rocks of the Red Devil mine area consist of interbedded graywacke and shale of the Kuskokwim group of Cretaceous age cut by sills and dikes of hydrothermally altered biotite basalt. The ore occurs in irregular veins and veinlets in fault zones and at contacts between silicified basalt and less competent graywacke. Much stibnite accompanies the cinnabar, and quartz is the chief gangue mineral; also present are calcite and minor realgar and orpiment.

The measured reserve at the Red Devil mine is reported to include over 10,000 flasks in ore averaging about 15 pounds to the ton, and 3,000 flasks in ore averaging 40 pounds to the ton. Additional ore can be inferred and will doubtless be found as additional exploration is carried on in this newly-developed deposit.

The Alice and Bessie mine, also known as the Parks property, is about 3 miles northwest of the Red Devil mine. It has had only small production but contains a reserve of indicated ore.

The Decoursey Mountain mine is about 40 miles west-northwest of the Red Devil mine. The ore occurs in breccia zones in silicified and carbonatized basalt and adjacent silicified graywacke, and contains cinnabar and a little stibnite. Inferred reserves amount to several thousand flasks.

The Red Top mine is in southwest Alaska. It was recently explored, and ore estimated to contain 1,400 flasks of mercury was discovered.

FIGURE 2.—Mercury Deposits of the World.

ARIZONA (13)

Southern Arizona contains more than 20 small mercury mines and prospects. The larger mines are the Ord in the Mazatzal Mountains in western Gila County and the Sunflower and Pine Mountain mines lying a few miles west of the Ord mine in eastern Maricopa County.

Most of the deposits in Arizona occur along fault zones in Precambrian schists. The mineralogy of some of the ores is unusual; in the Dome Rock Mountains cinnabar occurs with gold, wulfenite, and copper minerals, and in the Mazatzal Mountains the lodes contain tourmaline, mercurial tetrahedrite, and other copper minerals. Although the ore bodies occur along well-defined structures and contain some rich ores, the overall grade has been too low to permit sustained profitable mining, and reserves of exploitable ore are small.

ARKANSAS

Arkansas contains, in the southwestern part of the State, a single mercury district. More than two dozen mines and prospects occur in the district along an east-northeastward trending belt over 30 miles long and less than a mile wide. The ore bodies, which are small, occur in sandstone of late Paleozoic age; some are pipe-like and formed at fault intersections, and others are tabular parallel to the bedding. The ore consists of cinnabar disseminated in sandstone. Minor amounts of several rarer mercury minerals have been found, and a little pyrite and stibnite accompany the ore. Gangue minerals are quartz and dickite. The ores as mined apparently contained only a few pounds of mercury to the ton but were hand-sorted to achieve a grade of 5 to 15 pounds to the ton.

The Arkansas ore bodies have been small, widely spaced, and of comparatively low grade. No appreciable reserves are known.

CALIFORNIA (1, 25)

In California the principal deposits occur in the Coast Ranges in a belt about 350 miles long, extending from near Santa Barbara on the south to Clear Lake on the north. In this belt, which has yielded over 80 percent of the United States production, there are 18 districts. The usual district contains one, or at most two, major deposits and a host of smaller satellitic deposits; a major exception is the Mayacmas district which contains several large deposits. The districts are remarkably evenly spaced at intervals of about 25 miles along most of the belt but are more closely grouped in the northern end. The Altoona district in northeastern Trinity County, and two other less productive districts near the California-Oregon boundary, are more closely related to the zone of mineralization in western Oregon. Other relatively unproductive districts are in eastern California and form a southern extension of a belt of deposits trending northerly through central Nevada.

The geology of the Coast Ranges, and of the mercury deposits within them, is exceedingly complex. The oldest and most widely exposed rocks belong to the Jurassic-Cretaceous assemblage known as the Franciscan group, which consists of highly deformed, though generally not metamorphosed, graywacke, siltstone, and greenstone, with minor limestone and chert. This group is intruded by tabular and plug-like masses of serpentine; locally their margins are hydrothermally altered to a rock consisting of silica minerals and magnesian carbonates, known as silica-carbonate rock, and many of the mercury-ore bodies occur in this rock. Overlying this basement complex are thick sequences of sediments ranging in age from Cretaceous to Pliocene, and, especially in the area between San Francisco and Clear Lake, there are extensive flows of younger lavas ranging in composition from basalt to rhyolite.

Although 60 percent of the production has come from ore bodies in silica-carbonate rock, ore bodies for some large deposits are in younger sediments and volcanic rocks. Where mineralization can be dated, it ranges from late Pliocene to Recent. Structurally the deposits show a variety of environments. Some are along faults, but none along the great San Andreas rift, some are along margins of serpentine intrusives, some are in fractured sediments, and some are in relatively unbroken Recent volcanics. No close relationship to either granitic intrusives or younger volcanic rocks can be demonstrated for the majority of the deposits. Cinnabar is the common ore mineral, but in a few deposits metacinnabar is more abundant, and in at least two smaller deposits native mercury is the predominant ore mineral.

Altoona District

The Altoona district, in the northeastern part of Trinity County is rather isolated from other more productive districts in California and in a different geologic province.

The principal mine in the district is the Altoona, where cinnabar and some native mercury occur in porphyritic diorite and minor serpentine of Mesozoic age. Recent unwatering and renewed exploration have revealed considerable ore of good grade both in the margins of old stopes and in newly discovered ore bodies.

Wilbur Springs District

The Wilbur Springs district contains a dozen mercury deposits, of which the largest, and the only one currently producing, is the Abbott mine. Reserves of ore in the district contain several thousand flasks of mercury.

The Abbott mine is near the northwest end of a tabular, northwest trending mass of serpentine which is 2½ miles long with a maximum width of about one-half mile. The mass is interlayered with shale and graywacke of Lower Cretaceous age, and is believed to be a surficial extrusion of serpentine deposited with the sediments. Parts of the serpentine are hydrothermally altered to form the opaline silica-carbonate rock that is the host for the ore. Cinnabar and minor metacinnabar are the ore minerals; gangue minerals are marcasite, calcite, and hydrocarbons with minor quartz.

Clear Lake District

The Clear Lake district extends around the southeastern arm of Clear Lake, which is about 75 miles north of San Francisco. It contains the Sulphur Bank mine and a few other mines with very small production. Graywacke, siltstone, and greenstone of the Franciscan group are overlain by late Tertiary and Quaternary continental sediments and volcanic rocks that range in composition from basalt to rhyolite. The ore deposits are Recent, and thermal waters are currently depositing some mercury and antimony. The district contains some measured reserves, and a large amount of submarginal ore.

At the Sulphur Bank mine the rocks consist of Franciscan sediments overlain by lake beds and landslide breccia which in turn are capped by a flow of augite andesite. The flow is at least as young as Quaternary and may be Recent. The ore deposits are clearly related to hydrothermal activity, and mineral-bearing hot springs still emerge in the pit area. Cinnabar is the dominant ore mineral, but metacinnabar is encountered in altered graywacke.

Knoxville District

The Knoxville district is an area 4 miles long and 3 miles wide that contains the Knoxville mine, the Reed mine, and several less productive mines. The dominant geologic feature of the district is a large mass of serpentine, the eastern margin of which is separated from sedimentary rocks of the Knoxville formation of Jurassic age by a fault. All of the large ore bodies found in the district have been in silica-carbonate rock formed from the sheared serpentine adjacent to this fault. Late Tertiary tuff and basalt blanket a small part of the area, and the ore of one of the small mines occurs in silicified tuff.

Ore reserves minable at about $250 a fla are small.

Mayacmas District

The Mayacmas district is the third m productive district in California, and unli most districts it contains several mines wi large production as well as dozens of small ones. The more productive mines are: O Hill, Great Western, Aetna, and Mirabel.

The rocks of the district are mostly gra wacke, shale, and greenstone of the Franc can group, which are mildly to intensely fold and cut by many faults and wide shear zon The axes of the folds and of the faults a shear zones trend west-northwest; large si like masses of serpentine intruded along t shear zones have a similar trend. Parts of t area are overlain by flat or gently inclin silicic flows and tuffs of Plio-Pleistocene ag and younger basalt flows cap some of the low hills in the eastern part of the district.

The mineralized area is 25 miles long and miles wide, but the more productive depos all lie within one-half mile of a straight li drawn through the length of the district. M of the ore bodies occur in silica-carbonate ro formed by hydrothermal alteration of mar nal parts of the serpentine, but ore bodies the Oat Hill mine lie along faults in t Franciscan graywacke, and at the Cloverd mine the ore is in Franciscan chert. Cinnab is the usual ore mineral, but native mercu is possibly more abundant than cinnabar in few deposits in the western part of the distri

Ore reserves are not as large as might expected in a district of such prominen chiefly because in most of the major depos little exploration has been done beyond t limits of mining.

Guerneville District

The Guerneville district is unusual in th it contains the Sonoma (Mt. Jackson-Gr Eastern) mine, but no other deposits of a consequence. The rocks of the area are chie graywacke and shale of the Franciscan gro serpentine, and silica-carbonate rock.

The mine contains a large reserve of averaging about 4 pounds of mercury to ton, and somewhat smaller blocks of richer o

New Almaden District

The New Almaden district, a belt abou miles long and 1 mile wide, contains the gr New Almaden mine, the Guadalupe mine, a several other mines with relatively small p duction.

The deposits of the famous New Almaden mine were first recognized to contain mercury ores in 1845, and except for very brief periods of inactivity in recent years, have been mined ever since. They occur in a block about a mile square that has been explored and mined through about 20 shafts and 35 miles of horizontal workings to a depth of 2,400 feet below the original outcrop. Cinnabar is the only important ore mineral, although native mercury occurs in some abundance in a few places. Accompanying sulfides, present in only small amounts, include pyrite, stibnite, chalcopyrite, bornite, galena, and sphalerite. Gangue minerals introduced with the cinnabar are quartz, dolomite, and hydrocarbons. The cinnabar that forms the ore bodies replaces silica-carbonate rock, formed by hydrothermal alteration of serpentine, along steep northeast-trending fractures. Ore bodies are formed in the silica-carbonate rock only near their contacts with rocks of the Franciscan group. Where these contacts are relatively flat, the ore lies in structural highs such as the apicies of domes or anticlines; where the contacts are steep the ore is apparently localized by the presence of a large number of fractures.

Ore mined during the early exploitation of the deposit contained, after sorting, more than 20 percent mercury, but the grade of ore gradually diminished until in World War II ore mined in open cuts averaged only a little above 2 pounds to the ton. The average grade of ore mined through the entire life of the mine was about 4 percent mercury. Many of the ore bodies were large as well as rich, the largest being 200 feet wide, 15 feet thick, and extending down the dip for about 1,500 feet.

Geologically the chances of finding sizable new ore bodies are good, but owing to the large amount of mining that has been done and the inaccessibility of many of the mine openings, exploration will be unusually costly. The old dumps contain a large tonnage of rock of submarginal grade.

The Guadalupe mine is about 4 miles west of the New Almaden mine and on the same geologic structure. The ore bodies are similar to those in the New Almaden deposit and have been mined to about the same depth. Some reserves of minable ore are known to exist, and much favorable ground remains unexplored on the Guadalupe property.

New Idria District

The New Idria district contains the New Idria mine and a dozen smaller mines.

The dominant feature of the geology of the area is a large, elliptical, plug-like mass composed largely of serpentine but also including some Franciscan rocks along its margin. This plug has been pushed up through the core of an anticline of younger sedimentary rocks, which near the plug are shale and sandstone of the Panoche formation of the Upper Cretaceous age. Parts of the serpentine are converted to silica-carbonate rock, and locally this contains ore, but most of the ore of the New Idria mine is in indurated Panoche shale. At the New Idria mine, cinnabar is the chief ore mineral, but in some ore bodies metacinnabar is an important constituent. Pyrite and marcasite are abundant in places, but generally are a minor constituent of the ore. Carbonate minerals and quartz are also locally common, but much of the ore contains no obvious nonmetallic gangue. Most of the ore occurs beneath a thrust fault near the margin of the plug in indurated and brecciated Panoche shale with the cinnabar confined to fractures and crystal coatings. Some occurs in wide cinnabar-carbonate veins. In the Franciscan sandstone above the thrust fault, ore bodies have formed along distinct veins and in places where cinnabar is disseminated through relatively porous graywacke. Where serpentine lies adjacent to the thrust fault, it has locally been altered to silica-carbonate rock which in places contains ore.

The New Idria district contains some minable ore and fairly large amounts of lower-grade material.

San Luis Obispo District

In northwestern San Luis Obispo County an elongate area of about 75 square miles contains several dozen relatively small mines, of which the principal ones are the Oceanic and the Klau mines.

Much of the area is underlain by sedimentary rocks of the Franciscan group and intrusive serpentine. These rocks are unconformably overlain by Cretaceous sediments in the eastern part of the area and Miocene sediments and diabase sills in the western part. Fold axes trend northwest, and the area is broken into slivers by a series of faults trending roughly parallel to the folds. Rhyolite stocks and dikes were intruded in late Tertiary or Quaternary time.

The district contains a small reserve of ore.

IDAHO

Idaho contains two mercury mines with significant production—the Cinnabar (Hermes) mine near Yellow Pine, and the Idaho-Almaden mine near Weiser. Reserves of minable ore in the Idaho deposits are appreciable, and both mines contain a substantial reserve of submarginal material.

The Cinnabar mine, formerly known as the Hermes mine, is in Paleozoic limestone and shale beds that are a part of a series of metamorphosed sediments forming a roof pendant in the granite of the Idaho batholith. The host rocks are argillized, sericitized, and silicified along a broad fault zone prior to the mercury mineralization. Cinnabar, the only ore mineral, occurs as fracture fillings and disseminations chiefly in the altered limestone; associated with it are pyrite, stibnite, realgar, and orpiment.

At the Idaho-Almaden mine the main ore body is of the opalite type and occurs as a blanket above beds of feldspathic sandstone which are part of the Tertiary Payette formation. The opalite mass generally has a blanket form and follows the nearly flat bedding in the central part of a downwarp, but locally it extends downward along faults. The dominant silica mineral is opal, but chalcedony also is common; clay minerals are abundant in places, but are inconspicuous in much of the opalite. Cinnabar, the only ore mineral, occurs disseminated in minute crystals in the opalite, and also occurs in steep opal veins filling fracture zones. A very small amount of pyrite accompanies the ore.

Reserves of ore at the Idaho-Almaden mine containing 3.6 pounds of mercury to the ton are reported to amount to at least one-half million tons, and even larger amounts of lower grade material are available. Ore occurring along faults beneath the opalite is reported to be of minable grade, but its extent has not yet been fully determined.

NEVADA (38)

Nevada contains more than 100 mines with some production of mercury, distributed among about 30 districts, most of which are confined to a northerly-trending belt in the central third of the State. Ore bodies are unusually diverse, for they include small ones containing some of the richest ores ever mined in the United States as well as large bodies of low-grade ore. Host rocks are equally varied, as they include sandstone, limestone, sinter, opalite, rhyolite, andesite, and granitic rocks. The mines in andesitic flows and breccias, however, have yielded two-thirds of the total production.

Reserves of known ore, both of minable and submarginal grade, are moderately large, and new discoveries made in the last few years indicate that additional deposits now unknown probably will be found.

Opalite District

The Cordero mine, in the Opalite district, has the largest production of any mine in Nevada.

The rocks of the area are andesitic f breccias, and tuffs of Tertiary age. Nea surface, parts of these are silicified to opalite, but the rocks below the shallow lite are largely argillized rather than silic The chief ore mineral is cinnabar, alth native mercury and mercury oxychloride found in small amounts in the near-su workings. Cinnabar occurs disseminated i porous altered volcanic rocks, accompani many places by microcrystalline hematite in veins with silica minerals and abun pyrite and some marcasite. The near-su opalite, consisting of both chalcedony and contains cinnabar disseminated through rock in an irregular fashion. The majo bodies, however, are stratigraphically b the opalite.

OREGON (24)

Although occurrences of mercury or Oregon are widely distributed, the produ deposits are in areas in the central, south and southeastern parts of the State. The jority of the deposits are in Tertiary roc pre-Miocene age, but in the Opalite distr southeastern Oregon large ore bodies occ tuffs and lake beds of late Miocene age. widespread Columbia River basalt of Mi age, andesite of Pliocene age in the high cades, and younger intrusives are remar unmineralized.

Southwestern Oregon

A mineralized belt in southwestern O extending from Medford to Cottage Gro cludes the two most productive mines i State, the Bonanza and Black Butte, as as a dozen other small mines and pros Most of the deposits are in sedimentary and lavas of Eocene age, but some smal bodies have been found in the under schists of Devonian age. Most of th bodies are formed along normal faults an accompanied by widespread veinlets of q and carbonates. As cinnabar is generall seminated in the country rock beyond th its of ore shoots, the exploited ore bodie bordered by unmined mineralized rock provides a sizable reserve of low-grade

Southeastern Oregon

In southeastern Oregon there are two tricts, each of which contains ore bodies tinctly different from those of the rest o State. The highly productive Opalite di in southern Malheur County contains the ite and Bretz mines with ore bodies in n flat-lying tuffs and lake beds, and in adc the district extends across the State bour into Nevada to include the Cordero mine.

Another district in southeastern Oregon is in the Steens-Pueblo Mountains in southern Harney County. It has yielded very little mercury but is of interest because of the abundance of mercurial tetrahedrite (schwatzite), which occurs in quartz veins with cinnabar, pyrite, chalcopyrite, galena, magnetite, and barite. Some of the cinnabar in the oxidized zone is clearly secondary, but some of the more crystalline cinnabar is believed to be primary.

Except for submarginal material, the Opalite mine is exhausted, but recent drilling at the Bretz deposit has found considerable ore of exploitable grade.

Central Oregon

An area in eastern Jefferson County and Crook County contains the Horse Heaven mine and nearly a score of small mines and prospects. Ore bodies are in andesite and basalt flows and tuffs of Eocene age or in younger intrusive plugs of andesite or rhyolite. Nearly all of the more productive ore bodies are in or near rhyolite plugs. The Horse Heaven ore bodies appear to be exhausted, and most of the smaller mines can operate only when the price of mercury is abnormally high.

TEXAS

Texas ranks second among mercury-producing States because of the large output from the Terlingua district.

Known reserves in Texas are small, but much of the relatively remote Big Bend area has not been intensively prospected.

Terlingua District

The Terlingua district is a narrow east-trending area about 20 miles long. The principal mines are the Chisos-Rainbow, Mariposa, and Study Butte mines. The layered rocks of the district consist of about 5,000 feet of Cretaceous limestone and shale overlain by early Tertiary volcanic rocks. These are intruded by dikes, sills, and lacoliths that have compositions ranging from basaltic to rhyolitic, with a widespread phase characterized by analcite. The district is dominated by an east-trending monocline, which is broken in places by northwest-trending graben. Smaller faults of northeasterly trend are abundant, and many of these are mineralized. Other structural features that have localized important ore bodies are collapse breccias in pipelike and tabular bodies.

Reserves are small, but many areas structurally favorable for ore are unexplored.

The Chisos-Rainbow mine lies immediately north of a prominent graben in gently folded and strongly faulted Cretaceous shale and limestone. Three types of ore bodies were mined: (1) Deposits in calcite veins; (2) deposits near the contact of the Devils River Limestone with the overlying Grayson formation of Late Cretaceous age; and (3) deposits in brecciated rocks.

At the Mariposa mine the deposits are similar to those found along the Devils River-Del Rio contact in the Chisos mine. Along northeast-trending faults of small displacement the limestone just below a clay was dissolved by hydrothermal solutions, producing elongate zones of altered clay that had sagged and collapsed into the limestone. These altered zones are locally mineralized with cinnabar. Near the surface, parts of the zones also contain notable amounts of calomel, mercury oxychlorides, native mercury, montroydite, and rarer mercury minerals.

The Study Butte mine is in a wedge-shaped sill of fine-grained quartz syenite intruded into calcareous shales of Upper Cretaceous age. Cinnabar occurs principally in the intrusive rock but also forms ore in the shales. In the intrusive rock, seams of cinnabar and pyrite ranging from a film to 1 inch in thickness are deposited along steep northeasterly-trending fractures. Commonly a few parallel veinlets several inches apart make a workable ore body.

UTAH

Nearly all of the mercury recovered in Utah has come from three mines and was produced prior to 1910. Most of the production came from the Sacramento gold mine, in the Mercur district in Tooele County. Here earthy cinnabar occurred in bands in altered limestone of Upper Mississippian age adjacent to a dike and fracture zone. The Lucky Boy mine near Marysvale in Piute County yielded mercury in the 1880's from tiemannite (mercury selenide) ore occurring in limestone. These deposits are apparently worked out, and there is no known reserve of mercury ore in Utah.

WASHINGTON

Although mercury minerals have been found in Washington in several places, deposits have been mined only in the Morton district in Lewis County. This district is unusual because some of the best ore occurs in seams of coal.

The mineralized area containing the mines and nearly a dozen other prospects extends northeasterly about 2 miles and has a width of about one-half mile. The rocks of this area are shale, tuffaceous sandstone, and coal, assigned to the Puget group of Eocene age, and intrusive basic sills and dikes. The beds strike northerly and dip at low angles to the east. Several faults formed at different times and having different kinds of displacement appear to have localized the ore. The largest production came from places where cinnabar occurred in brecciated sediments along a steep fault, but two of the richest ore bodies were in relatively unbroken sandstone beneath a clay gouge developed along a gently dipping thrust fault. Ore has been found over a strike length of 1,400 feet and a vertical range of 900 feet, although individual mine workings extend only half this far below the surface. The district contains furnace-grade ore bodies of moderate size and smaller pods of retort ore. Known reserves are small.

CANADA (*29, 57*)

The two main mercury mines of Canada, and many smaller deposits, lie along the Pinchi fault zone which trends north-northwest through central British Columbia. In 1956 new discoveries were reported in the Jumping Lake area of the Caribou mining division, which is in line with the Pinchi fault 170 miles southeast of Pinchi Lake. Other deposits, some of which have small production, occur some 300 miles farther south near Kamloops in line with the southward extension of the Pinchi fault. Still other occurrences are on southern Vancouver Island, in the Bridge River district in British Columbia, and at Groundhog Lake, South Lorrain, and Gowganda in northern Ontario. Mercury also occurs, probably in the form of amalgam, in the silver ores of Cobalt, Ontario.

The mercury reserve of Canada amounts to about 150,000 flasks contained in ore averaging 8 pounds to the ton.

The Pinchi Lake mine is in an area of interbedded Permian chert, quartzite, schist, limestone, and minor greenstone. Intrusive into these rocks are small masses of serpentine, now largely converted to silica-carbonate rock. At the mine the rocks are folded and broken, but in general their strike is northwest, and their dip is northeast. The faults have similar strike but dip southwest. Cinnabar, a little stibnite and pyrite, and a gangue of quartz and calcite occur in breccia zones along the faults and near the faults in fractured dolomitized limestone. Most of the cinnabar fills premineral openings, but locally some has replaced the limestone.

The Bralorne Takla mine is about 75 miles north along the Pinchi fault from the Pinchi Lake mine. In geology, mineralogy, and occurrence of ore bodies the Takla deposit is quite similar to the Pinchi Lake deposit. Reserve estimates have not been released by the owning company, but they are believed at least 10,000 flasks.

A dozen other mercury-bearing areas nea the Pinchi fault are known, and several o these have been explored. The numerous oc currences of cinnabar that have been foun along the 100-mile segment of the Pinchi faul zone since 1937 indicate that other minabl deposits will be found in this area when a mor exhaustive search is made.

Near Kamloops, cinnabar, which has bee found in at least six places, has been mine only at the Copper Creek deposit north o Kamloops. The ore contained about 1 percen mercury and occurred in dolomite veins i volcanic rocks.

A small production came from the Empir Mercury property in the Bridge River district 50 miles north of Vancouver, in 1938 and 1939 Other deposits nearby have been prospected.

MEXICO (*2, 31*)

The larger mercury deposits of Mexico ar in the States of Durango, Zacatecas, San Lui Potosi, Guanajuato, and Guerrero, but some or has been found in Chihuahua, Jalisco, Quere taro, Michoacan, Mexico, Morelos, and Oaxaca

Geologically the mercury deposits of Mexic exhibit much variety, with some in acid vol canic rocks and many others in sedimentar rocks. Of unusual interest are the uniqu mercury-antimony ore bodies of Huitzuco which contain the rare mineral livingstonite a the principal ore mineral, and the mercur chloride-oxide deposits of the Dulces Nombre mine, which are matched only by some of the ores of the Mariposa mine in Brewster County, Tex. Only the larger districts are described in the following paragraphs, as reliable data are not available for most of the smaller ones.

GUADALCAZAR DISTRICT

Most of the mines in this district lie northwest of the town of Guadalcazar in a series of limestone ridges. A central core for the ridges is granite. The granite is traversed by great lodes of pyrite, galena, chalcopyrite, stibnite, garnet, fluorite, quartz, and barite, and the iron gossans over these have yielded the fabulously rich silver ores of Guadalcazar that were largely worked out by 1750. Most of the mercury ores are in the limestone ridge west of the granite, but some mercury is said to have been found on all sides of it; no silver minerals have been found in the mercury lodes. The ore minerals of the mercury deposits are cinnabar, metacinnabar, including a zincian variety known as guadalcazarite and a selenian variety known as onofrite, and a little native mercury. Gangue minerals are gypsum, quartz, calcite, fluorite, barite, and some sulfur and orpiment.

Mercury reserves are small, but geologic study followed by drilling should lead to new discoveries. The gravels in the valleys near Guadalcazar contain enough gold, silver minerals, tin, and cinnabar to have warranted considerable sampling, and it has been estimated that they contain 600 million tons of gravel averaging about 0.003 percent mercury, and about 0.008 percent tin.

HUITZUCO DISTRICT

The mercury-antimony deposits at Huitzuco, in the northern part of Guerrero, were discovered about 1870 and first exploited soon thereafter.

In the Huitzuco area, folded and faulted Cretaceous limestone is intruded by small bodies of granite porphyry. Hydrothermal solutions have altered the limestone to dolomite and later to anhydrite, which near the surface has weathered to form gypsum. Surface waters have formed cavities in the gypsum which have become filled with gravel and surface rubble. Hydrothermal solutions then replaced some of the dolomite breccia and some of the rubble with livingstonite and stibnite, and continuation of the hydrothermal activity is indicated by the large amounts of hydrogen sulfide escaping into the deeper workings. Weathering decomposed the livingstonite to antimony oxides and cinnabar. A little pyrite is present in the primary ore, as is also sulfur, gypsum, graphite, and locally, fluorite. The primary ore, which contains about 1 percent mercury on the lower levels, provided the greatest production and has been systematically mined; the secondary ore is much richer, but erratically distributed. The primary ore has been followed to a depth of 820 feet in the La Cruz mine and has been found by drilling to go even deeper. Known reserves are small, and little underground exploration has been done except in the La Cruz mine. Added exploration in other places may disclose good ore deposits.

NUEVO MERCURIO DISTRICT

The Nuevo Mercurio district in northern Zacatecas contains 18 major mines and scores of small mines and prospects.

The rocks of the area are limestones, marls, and sandstones of Cretaceous age that have a general dip to the southeast but are locally crumpled into numerous small folds trending N. 70°E. These are cut by low-angle thrust faults and later steep transverse normal faults. The rocks were silicified along pre-ore faults and later became shattered at fault junctions. Calcite, and later cinnabar, was deposited in broken axial parts of the anticlines and in two zones of very coarse vuggy fault breccia. A little marcasite accompanies the ore, and small amounts of iron oxides and silica are widespread. Mining has been carried to a depth of about 500 feet, but the grade is appreciably lower in the deep parts of the two deepest mines. Additional prospecting in the area may find new deposits, but deeper exploration is likely to be disappointing.

SAIN ALTO DISTRICT

In the Sain Alto district the main deposit is in an area of Upper Cretaceous sandstone and of shales nearly surrounded at a distance of several miles by Tertiary rhyolite flows and tuffs. The major ore bodies are simple cinnabar impregnations in sandstone and cinnabar-calcite veinlets in joints in the sandstone and are generally localized beneath shale or fault gouge. Some quartz accompanies the cinnabar. Other deposits of small economic importance are in the rhyolite, where cinnabar and abundant silica fill breccia zones at the intersections of cross faults.

HUAHUAXTLA DISTRICT

The Huahuaxtla mercury district, in northern Guerrero, contains only one productive group of deposits, now integrated into a single mine, although there are numerous small prospects of little value. No reserves are known, but the persistence of the ore-controlling fault, and the abundance of ore bodies along it, suggest that additional ore could be found.

The rocks of the area are Upper Cretaceous limestone overlain by thick shale, with a northwest strike and a gentle northeast dip. These rocks are cut by many normal faults, some of which also have strike-slip movement. Much of the ore occurs in a fault gouge 30 feet thick along the Huahuaxtla fault, which has a limestone footwall and a shale hanging wall. Cinnabar is the important ore mineral; however, because of its dark color it has often been misidentified as metacinnabar, which is also present in small amounts. In the near-surface workings, mercury, mercury oxide, mercury chloride, and various mercury oxychlorides were once remarkably abundant. Some marcasite and pyrite accompany the sulfide ores, and gypsum and calcite are also present.

CANOAS DISTRICT

The deposits at Canoas, in southern Zacatecas, occur along zones of fracturing at shallow depths in a dome of latite. The latite is extensively altered to clay minerals, and very fine-grained cinnabar and abundant opal and chalcedony occur along fractures where the rock is intensely altered to montmorillonite. Most of the production has come from stockwork ore lying within 100 feet of the surface. The richer surface ores in the known mineralized area are mined out, but perhaps parts of the dome contain sufficient widespread cinnabar to support a large-scale open-cut mining operation at times of high prices. Geological studies indicate that there are several very favorable places for ore near the known deposits but hidden beneath a shallow cover of rocks that are younger than the latite.

CUARENTA DISTRICT

The Cuarenta district, in the northern part of Durango, contains only three small mines, the deepest of which reaches a depth of a little more than 300 feet.

The rocks of the area consist of granite cut by diabase dikes and unconformably overlain by limestone conglomerate and younger rhyolite flows and tuffs. These are cut by minor faults, and small ore bodies occur near the granite-conglomerate unconformity, particularly under the diabase dikes. Some disseminated ore was found in the conglomerate, and parts of the conglomerate may contain enough cinnabar to sustain a low-grade open-cut operation.

CENTRAL AMERICA

HONDURAS

At least two small mercury mines in central Honduras have yielded a few flasks of mercury. Near Jalaca, 33 miles north of Tegucigalpa, cinnabar, native mercury, and calomel occur in veins and fractures in limestone of Early Cretaceous age. Deposits have been found in a half dozen places along a belt extending east of Jalaca for at least 3 miles. West of Jalaca about 3 miles is the La Canada mine, said to have been worked on a small scale in colonial times. A small production came from an ore body measuring about 50 by 40 by 5 feet in silicified limestone beneath shale. Nearby are other occurrences.

About 15 miles northwest of Santa Bárbara is the Paz mine, from which some ore was taken in the 1880's. In this area are scattered showings of ore containing native copper, tetrahedrite, cuprite, malachite, azurite, and cinnabar in a gangue of calcite and quartz. The tetrahedrite is probably the mercurial variety, schwazite, and part, if not all, of the cinnabar is formed through oxidation of the tetrahedrite. The ore occurs in veins along bedding planes and faults.

SOUTH AMERICA

In recent years South America has not been an important source of mercury, but at various times between 1600 and 1800 the great Santa Bárbara mine in Peru was the world's largest producer. During World War II a few thousand flasks a year were recovered as a byproduct of gold mining at the Los Mantos mine in Chile. All the other South American countries lying along the Andes except Bolivia have yielded small amounts of mercury, chiefly in the colonial period when few production records were kept.

Reserves of ore in South America are small amounting to no more than a few thousan flasks, and it is doubtful if even the old Sant Bárbara deposit contains large reserves o rock averaging over 1 pound of mercury t the ton.

BRAZIL

Cinnabar or native mercury has been re ported from at least a half-dozen localities i Brazil, but apparently none of these is worth of exploitation.

CHILE (59)

Mercury has been mined in Chile on a ve minor scale for local use since the end of tl 18th century. In the World War II period few thousand flasks a year were recovere chiefly as a byproduct of gold-copper minin at the Los Mantos mine in the Punitaqui di trict, and from other scattered small deposi occurring in a belt 300 miles long extendin from Copiapo to Illapel in north Chile. many of the deposits the primary ore mine is mercurian tetrahedrite, which on weathe ing yields cinnabar, but at the Los Mant mine, some of the cinnabar is believed p mary.

PUNITAQUI DISTRICT

The Los Mantos mine, which is the larg producer of gold in Chile, is about 35 mi south of Ovalle. This mine, as well as seve smaller gold-copper mines, is in a group Mesozoic volcanic and sedimentary rocks tl are partly granitized and converted schists near an intrusive contact with gra diorite. Most of the ore is confined to a w vein following a shear zone that is nea parallel to the contact but a few hundred f west of it. The main vein contains qua chalcopyrite, pyrite, magnetite, hematite, b ite, and mercurian tetrahedrite and cinnal Supergene minerals are azurite, malach chalcocite, limonite, manganese oxides, powdery cinnabar. Because the company m tains about 1 year's supply of measured g copper ore, the deposit contains a small amo of measured ore from which mercury can be recovered.

The Punitaqui district contains, in addition to the Los Mantos mine, several other gold-copper mines and the Azogues mine, which is primarily a mercury mine. The Delirio-Republicane mine ore is similar to that of the Los Mantos deposit, although nearly all of the cinnabar in it is supergene. The ores containing the most mercury average a few pounds per ton with mining widths of 3 to 50 feet, but no attempt has yet been made to recover the mercury as a byproduct. The Azogues mine is just north of the mercury-rich part of the Los Mantos deposit, and the ores are similar. It was operated many years ago as a mercury mine, but the production from it, which must have been small, is not recorded.

In the Sierra La Plata, a few miles south of Copiapo, cinnabar occurs at the Regalona prospect, which has no production, and at the Alianza mine, which has yielded a small production. The ore at the latter consists of powdery cinnabar and supergene copper minerals in a barite gangue.

COLOMBIA

A discontinuous belt of cinnabar occurrences is reported to extend north-south through Colombia from Santa Rosa in Antioquia to Mireflores in Tolima, but little mercury has been recovered from them.

ECUADOR

Although no mercury has been produced in Ecuador for many years, in the colonial period it was apparently recovered from deposits in Cretaceous sandstone of the Cerro de Husizhun near San Marcos in the vicinity of Azogues, and in several other localities.

PERU (*3, 63*)

Between 1570 and 1815 Peru frequently exceeded Spain in mercury production because of the enormous output from the Santa Bárbara mine, but since its apparent exhaustion about a century ago Peru has produced very little mercury. Quicksilver ores have also been mined on a small scale in several other places in Peru, but only the one large mine and a few small ones close to it have had any appreciable production. Reserves in Peru must be regarded as small, as repeated attempts to reactivate the one large mine have been unsuccessful.

HUANCAVELICA DISTRICT

The Huancavelica district, which contains the Santa Bárbara mine, is in an area where the oldest rocks are folded and faulted limestone, sandstone, shale, and interbedded volcanic flows and tuffs of Jurassic and Cretaceous age. These are overlain unconformably by conglomerate and tuff of early Tertiary age, which in turn is overlain by Tertiary flows of rhyolite, basalt, and andesite. All of these rocks are intruded by volcanic breccias, interpreted as vent deposits, and by small dacite plugs and dikelike intrusions near the Santa Bárbara mine. The folded sediments and volcanics are cut by a series of steep reverse faults.

Cinnabar was the chief ore mineral; native mercury was very minor. Associated sulfides include abundant pyrite, rarer galena, sphalerite, and arsenopyrite, which was especially abundant on the lower levels. Realgar and orpiment are abundant in places on and near the surface and are believed to have formed from the arsenopyrite. Nonmetallic gangue minerals, which are sparse, include quartz, calcite, barite, and hydrocarbons.

The Santa Bárbara deposit appears to be worked out, and because of the exceedingly low cost of labor in the heyday of the mine, little low-grade material was probably left during its exploitation.

The mineralized Huancavelica belt extends north-south about 50 miles and has a width of about 2 miles, but virtually all production has come from the part extending only a few miles north and south of the Santa Bárbara mine. Within one-half mile of the Santa Bárbara mine are three mines—the Botija Punco, Pucacapa, and the San Roqua—that are of interest because they may have some potential for future production even though their aggregate past production does not amount to one-tenth that of the Santa Bárbara mine. In these the ore occurs in fractures in favorable parts of three beds of marly limestone, rather than in sandstone as at the Santa Bárbara mine.

OTHER DISTRICTS

Mercury ores have been found in a dozen other places on both sides of the Andean divide through the length of Peru; occurrences and small mines exist in the Departments of Amazonas, Cajamarca, Libertad, Ancash, Huanuco, Junin, Ayachuco, and Puno. Several of these have yielded a little mercury as a result of native efforts to mine them, but no accurate records of production are available.

VENEZUELA

Mercury was first recovered in Venezuela in 1941 at the San Jacinto mine, although this and other localities have been known for at least 50 years.

At the San Jacinto mine the ore occurs as veins of cinnabar, pyrite, quartz, and a hydrocarbon in a mineralized bed that is a part of a folded sequence of sediments ranging in age from Eocene to Miocene. The ores have been found on the hanging wall side of a reverse fault over an outcrop length of less than 1 mile.

Cinnabar is also reported to occur with sulfur deposits from still-active thermal springs near Chaguaramas. In addition, cinnabar is rumored to occur along the Rio Parapapoi in the Gran Sabana region and in the headwaters of Rio Caura, both in the State of Bolivar, and near Barrancas in the State of Monagas.

EUROPE

Europe has been the main source of mercury for the world, with most of the output coming from a few great mines. The Almaden mine in Spain is still the world's leading source, although the aggregate production from a few mines in the Monte Amiata district in Italy has been larger in the last few years. The Idria mine, now in Yugoslavia, has the second largest production record. Germany was a major source two centuries ago and under Government subsidy had some production in World War II; however, the mines contain only submarginal ore. The U.S.S.R. has vigorously and successfully sought new deposits. Reserves in Russian deposits may amount to as much as 1 million flasks, but the ores are fairly low grade. Other deposits which have had a small production are found in France, Hungary, Czechoslovakia, Rumania, and Portugal.

CZECHOSLOVAKIA

Since World War I Czechoslovakia has had a small but fairly constant annual production, largely from deposits of mercurial tetrahedrite having some cinnabar in the near-surface oxidized ores. Near Jahlava (formerly Iglo or Iglau), in south-central Czechoslovakia, bedded siderite lodes mined as iron ore have yielded mercury as a byproduct for many years. The mercury occurs in tetrahedrite with pyrite, quartz, and barite; cinnabar and amalgam occur near the surface. The iron deposits of Horowitz in Bohemia also contain small amounts of cinnabar, native mercury, and calomel. At Dobsina, in the province of Abauja, mercurial tetrahedrite occurs in veins in schists and gabbro. At Mernik and Teplou, a French company mined and treated mercury ores from 1923 until World War II.

Reserves are unknown, but Czechoslovakia contains so many occurrences of mercury ores that it is reasonable to suppose it will maintain its current rate of production for many years.

GERMANY

Germany has not been an important producer of mercury since the second half of the 18th century, when it supplied most of northern Europe. The old Landsberg mine is in western Germany about 30 miles west-southwest of Bingen, and nearby are other deposits worked many years ago. Cinnabar occurs here in veins and impregnations in sedimentary rocks of early Permian age accompanied by pyrite, chalcopyrite, tetrahedrite, galena, stibnite, and manganese minerals. Nonsulfide gangue minerals are calcite, quartz, barite, and hydrocarbons. Several rarer mercury minerals also occur in these deposits. The deposits are described as being very rich near the surface and diminishing in grade at depth; none of the stopes extends more than 650 feet below the surface. Under normal conditions, the remaining ores are doubtless too low in grade to be exploited.

East of the Saar Basin, other deposits are reported at Potsberg, Ratweiler, Erzweiler, Baumholder, and Königsberg.

At Bensberg, 15 miles east of Cologne, for several years mercury was recovered annually from zinc smelting.

In the Soviet Zone, deposits are known near Hartenstein, northeast of Schneeberg, at Krauznach, and in many places in the Harz Mountains. So far as is known, these are small and have not been exploited by the U.S.S.R.

ITALY (*4, 52*)

In recent years Italy has been the foremost mercury-producing nation in the world. Its production comes from two major mines and several smaller ones in the Monte Amiata (Firenze) district.

The mineralized area of the Monte Amiata district is large, extending about 25 miles north-south and having a width of about 5 miles. The district is underlain by sedimentary rocks consisting of shale, sandstone, and limestone, ranging in age from Triassic to Quaternary. All but the Quaternary rocks contain mercury deposits, but most of the large ore bodies are in Eocene rocks. The sedimentary rocks are mildly folded and cut by two major sets of faults. The most prominent set trends north, and the alinement of mineral deposits, hot springs, and gas seeps suggests that the major control for the entire district is one of these that is at least 25 miles long. Monte Amiata, for which the district is named, is a large volcano whose vent appears to lie a bit west of the fault zone near its northern end. The age of the volcano and of the trachyte erupted from it is not perfectly known but is probably Quaternary. The area

OTHER DISTRICTS

Quicksilver has been produced on a small scale in the province of Castellon, in eastern Spain, and occurrences of cinnabar are known near La Creu in Valencia, and near Orihuela in the Province of Alicante.

U.S.S.R. (*20, 21*)

Much of the mercury produced in Russia has come from the mines in Nikitovka, about 35 miles north of Stalino, in the Donets basin area of southern Russia. Current reserves, as calculated from an old Russian estimate minus subsequent production, indicate the deposit may still contain 250,000 flasks of mercury in ore averaging nearly 5 pounds of mercury to the ton.

In the Nikitovka deposit cinnabar occurs along a breccia zone, in cracks, and as impregnations in carboniferous strata near the crest of an anticline. Some of the ore is in coal. Accompanying sulfides are stibnite, pyrite, and galena. The gangue is chiefly quartz, but some stilbite and sulfur accompany the ore.

An aggressive program of exploration for new mercury deposits which was begun in the late 1920's resulted in the finding of many new deposits, some of which were quickly put into operation in the early World War II period.

The Khaidarkan deposit is in Kirghizia, about 50 miles southwest of Fergana in south-central Russia. In 1935, prior to any production, this deposit was estimated by Russian geologists to contain 600,000 flasks of mercury. Cinnabar, stibnite, fluorite, and quartz occur in veins in highly folded and faulted middle Paleozoic limestone and shale. The deposit was in production in 1942, but its current status is unknown.

The Chagan-Uzun deposit is in the southeastern Altai Mountains in the Oirotia region at an altitude of about 10,000 feet. Here cinnabar occurs with pyrite and stibnite in breccia veins cemented by carbonates in sedimentary rocks ranging in age from Cambrian to Devonian.

Cinnabar has been obtained from placer deposits in several places in the Ural Mountains. The most productive placers are on the Travyanka River, 12 miles from Karaoul, and near the Vikolsk and Volshanke Rivers in the Bogoslov district. Lumps of pure cinnabar weighing as much as 1 pound are reported to be common in these placers. Cinnabar in veins occurs on the eastern side of the Urals in the Verkh district, 20 miles from Neviansk.

Cinnabar has also been found in the Trans-Baikal Province, Nertchinsk district, at Idekansk, not far from the Serentuev mine. It has been mined in the Caucausus in the dist of Dughesten, near the village of Geptze, the mines here have not been worked for m years. Cinnabar also occurs at Fikhot, r Maikop, in the Kuban Province. Deposit the Salair region of the Ik River valley h been described. Cinnabar has also been peatedly reported to occur in Kamtchatka, though no specific locality has been noted.

YUGOSLAVIA

In recent years Yugoslavia has mainta a steady production of mercury. Most of production came from the famous Idria m but less well-known deposits occur througl much of Yugoslavia, and several of these merly were significant producers. Meas and indicated reserves at Idria total a 100,000 flasks, and considerably larger rese can be inferred.

IDRIA MINE

The great Idria mine, which is second to Almaden in total mercury production, i miles north-northeast of Trieste in the ext northwestern corner of Yugoslavia. Ore rently mined averages about 8 pounds of cury per ton, but at deeper levels only ri ore can be handled as mining cost wil greater owing to the large amount of w

The Idria deposit is close to the interse of the east-trending Julian Alps and the s east-trending Dinaric Mountains; accordi the geology is complex and of the Alpine with folds and thrust faults and later no faults. The nearest granitic rock is a s intrusion about 20 miles north of the de The rocks of the mine area are chiefly mian to Cretaceous shale, sandstone, and mite, and Tertiary flysch of sandstone, s and conglomerate. Ore extends alon highly broken fault zone for 4,600 feet a a depth of at least 1,312 feet. The chie mineral is cinnabar, although considerabl tive mercury occurs locally, and other mercury minerals have been reported. Th nabar forms rich ore where it impreg sandstone, good ore in brecciated dolomite lower-grade ore in carbonaceous shale. bodies generally occur beneath a cappin dense shale, and lower-grade ore occurs i shale at the apices of tight folds. Ga minerals, which are sparse, are pyrite, ca dolomite, chalcedony, quartz, gypsum, an cally, fluorite. Carbon is abundant in the shale, but hydrocarbons, such as idrialit rare.

OTHER MINES IN NORTHERN YUGOSLAVIA

The Potoknig mines, 31 miles north of bljana, were operated between 1760 and

1900, but apparently they are now abandoned. Cinnabar occurs here in bituminous limestone in bunches and in veinlets in breccia. At Litija, where cinnabar occurs with galena in a shattered graywacke, mercury was recovered for several years as a byproduct of lead mining, but the cinnabar did not persist downward.

CENTRAL YUGOSLAVIA

At Maskara are copper-antimony deposits from which mercury has been recovered. The principal lodes, which are traceable for several miles, contain mercury-bearing tetrahedrite, siderite, barite, quartz, and calcite, and lesser amounts of pyrite, chalcopyrite, cinnabar, and native mercury. They have been mined to a depth of more than 300 feet.

At Zec Planina, 22 miles west of Sarajevo, cinnabar occurs with beds of hematite in Upper Permian limestone. Some rich ores were found, but the deposits proved to be shallow, and the mines have been abandoned. Cinnabar also occurs with hematite, tetrahedrite, and barite at Kresevo.

EASTERN YUGOSLAVIA

The chief deposits in eastern Yugoslavia are in the Mt. Avala district about 15 miles southeast of Belgrade. The deposit is similar to several of the larger California deposits, where cinnabar occurs in fractures in silica-carbonate rock formed from serpentine. It differs from these deposits as galena and barite accompany the ore, and marly limestone is a common wall rock. The deposits are apparently small and contain no appreciable reserves.

SOUTHERN YUGOSLAVIA

Cinnabar occurs in veins in limestone at Prizren near the northern Albanian border. These deposits were reported to have considerable promise, but no production has been reported from them.

ASIA

Mercury ores occur in an east-trending belt extending across the central part of Asia from Turkey to Japan, in the Philippines, and on several of the larger islands of Indonesia. In the last few centuries before 1900, China was a large mercury producer. Turkey has produced little mercury in the last 20 years. Reserves in Japanese deposits are not large, and the ores are very low grade.

CEYLON

Quicksilver is reported to have been recovered from mines near Colombo, and in 1943 promising deposits were reported to have been discovered in the Kalpitiya district of Ceylon's Northwestern Province.

CHINA (*6*)

In China there are a large number of quicksilver deposits in a zone more than 400 miles long and 60 miles wide extending from southeastern Szechuan Province and western Hunan Province through Kweichow Province into Yunnan Province. Two of the most important mines are the Wan-Shan-Ch'ang and Ta-Tung-La mines in eastern Kweichow. The geology of these is similar, with shales overlying nearly flat beds of early Paleozoic limestone. Cinnabar, with a little quartz, pyrite, stibnite, and hydrocarbon, occurs in a breccia layer in the limestone beneath the shale. The deposits have been estimated to average about 1 percent mercury, but as only small home retorts are used in treating the ores, they are extensively sorted and upgraded prior to retorting. The dumps, which contain millions of tons of rock, have been worked by the wives and children of the miners for centuries, and probably contain only specks of cinnabar.

The Pai-Ma-T'ung mines, north of Knei-Yang-Fu in central Kweichow, are also in limestone, but little else is known of their geology.

The mercury potential of China is probably very large, but the existing literature is not sufficiently detailed to support an estimate as to whether the known deposits could support mining by modern methods; however, the two attempts made since 1900 have been unsuccessful.

INDONESIAN ARCHIPELAGO

Cinnabar has been found in many of the larger islands of the Indonesian Archipelago, but only Borneo has had any appreciable production. The deposits of Sarawak are near Tegora and Gading in faulted sandstones and shales. The chief ore mineral is cinnabar, although both native mercury and calomel have been reported. At Gading, pyrite, some stibnite, and quartz accompany the ore. In 1947 an ore shipment from Tandjoang in Borneo averaged 13 percent mercury.

In Malaya, alluvial cinnabar occurs in northwest Pahang, though not in minable amounts. In the Andaman Islands an unknown quantity of mercury was recovered many years ago. On Sumatra, cinnabar occurs in crystalline schists near Sibelaboe, and in placers in River Gloegoer and in River Salak. In Java, quicksilver is reported to occur at Semarang. In Papua, mercury has been found on the Mambare River near Mt. Scratchley, at Marani in Cloudy Bay, on Normandy Island, and on the Brown River.

JAPAN (46)

Geographically the mines of Japan are in two groups: One group of 9, which includes all of those known for centuries, is along a narrow belt that extends from the eastern tip of Kyushu across Shikoku and into Honshu; the other group is in Hokkaido, where 10 mines occur in the northeastern part, 4 are on the western flank of the central mountains, and 1 is in the southwestern part. The principal production has come from the still active Itomuka mine in Hokkaido and the Yamato mine in Honshu, but during the last 30 years nearly all of the mines have contributed to the total output. The more productive deposits are in Mesozoic andesite; others are in tuff and shale of Tertiary age; still others are in Mesozoic granite; and some with small production are in older sediments.

Reserves of measured and inferred ore are about 30,000 flasks in ore averaging about 2.5 pounds of mercury to the ton.

At the Itomuka deposit, Hokkaido, cinnabar and native mercury, with a ratio of about 2:1, occur along a group of shear zones in Mesozoic andesite that is extensively altered to clay minerals. Marcasite is abundant, and some pyrite is also present; other gangue minerals are quartz, chalcedony, opal, and calcite. Chalcopyrite and stibnite are rare.

The Yamato deposit is a hydrothermally altered zone in Tertiary quartz diorite along a thrust fault that dips at about 30°. Cinnabar and a little native mercury occur in three parallel veins averaging about 1½ inches thick. Opal, chalcedony, quartz, and calcite are the principal gangue minerals, and small amounts of pyrite, marcasite, and stibnite occur in the ore.

KOREA

In north Korea in P'yongan-namdo and Hwanghae-do, several deposits contain cinnabar and native mercury, accompanied by pyrite. The cinnabar occurs in quartz veins in mica schist and in calcite veins in limestone of Cambro-Ordovician age.

No mercury deposits have been found in south Korea.

PHILIPPINES

Although cinnabar was known to occur in the Philippines as early as 1885, no exploitable deposits were discovered until 1953. In that year prospecting located outcrops of mercury ore at the barrio of Tagburos north of Puerto Princesa, Palawan. The Tagburos deposit is in an area where there are many mounds of siliceous sinter deposited by recently active hot springs; however, the deposit being mined is in silica-carbonate rock formed by the hydrothermal alteration of serpentine rather than in sinter. Because of the dense jungle and deep soil, local details of the geology cannot be observed on the surface, and the ore controls and other geologic features of the deposit will become known only when the deposit is better exposed.

Reserves already found during the early development of this deposit are at least 30,000 flasks in ore averaging 5 pounds or more of mercury to the ton.

A second property, 3 miles west of the Tagburos mine and known as the Sogud, was explored in 1955. Reserves of about 15,000 flasks in ore averaging 8 pounds to the ton are said to have been found in the surficial part of the deposit.

TURKEY

At Konya (formerly Koniah), about 14(miles south of Ankara, cinnabar occurs in vein lets and nodules in silicified limestone; stibnit locally accompanies the ore. Other deposit developed are on the northeast end of th Karaburun Peninsula, west of Izmir (Smyrna) Here the ore was low grade, but it was profit ably mined in open cuts. The cinnabar i reported to occur with pyrite in quartz vein in schist.

At Halikoy, east of Izmir, cinnabar occur in a gouge zone composed of gray clay at contact between granite and muscovite schis Seventy thousand tons of reserves that contai 8 pounds of mercury to the ton is reporte The gouge zone is 5 to 30 centimeters thic Other undeveloped mercury deposits are know in this area.

AFRICA

Mercury has been recovered in northe Africa in Algeria and Tunisia and in sout ern Africa in the Transvaal region; most the intervening area is geologically unfavor ble for mercury deposits. Both the total pr duction and the reserves of Africa are insi nificant.

ALGERIA

Mercury deposits have been worked on small scale in Algeria as early as 1861. C nabar veins have been found in many plac and some production has been obtained as byproduct from the treatment of complex le zinc ores.

The Ras-el-Ma deposit, 15 miles southe of the port of Philippeville in northeast Algeria, is the only deposit that has been erated on a major scale. In 1942 the m was reported to have reserves of at least 13, flasks in ore averaging 10 pounds of mercury to the ton. The ore consists of cinnabar in barite veins localized near the contact of Eocene limestone and talc schist.

Mercury was recovered in the World War I period as a byproduct of smelting complex ores of galena, sphalerite, tetrahedrite, stibnite, and small amounts of cinnabar. The Taghit mine, 22 miles from Batna, was the principal source of these ores, which contained 5–15 percent zinc and a little more than 1 percent mercury.

Cinnabar is reported to occur in cinnabar veins and in complex lead-zinc ores in many other localities in Algeria; apparently the quantity or grade of ore available is not good enough to encourage exploitation.

TUNISIA

Mercury has been recovered in Tunisia as a byproduct of lead ores from the Oued Maden mine in northwestern Tunisia close to the Algerian border. The ore occurs in limestone and consists of galena, sphalerite, cinnabar, and metacinnabar; the mercury content is about 10 pounds to the ton.

Cinnabar is reported to occur with tetrahedrite in fluorite veins in Jurassic limestone at Djebel Oust.

UNION OF SOUTH AFRICA

Between 1940 and 1946 mercury was recovered from a deposit near Monarch Kop in the Murchison Range of the northern Transvaal. The cinnabar occurs with lenticles of quartz and carbonate in a chlorite-carbonate schist through a thickness of 15–20 feet.

Other occurrences have been noted in the Kapp Valley, in the Lebombo Mountains, south of Madelane station on the Pretoria-Delgados Bay railway, and at Mosita, 50 miles southwest of Mafeking in Bechuanaland. At the Erasmus mine in the Marico district, cinnabar is associated with galena and sphalerite.

OCEANIA

Mercury ores have been mined in Australia and in New Zealand. The geology of the Australia-New Zealand belt is favorable for mercury deposits, and doubtless other deposits will be found in the future; however, prospecting is slow and difficult because of the cover of deep tropical soil and dense vegetation.

AUSTRALIA

Cinnabar is fairly widespread in Australia, especially in the eastern part. The largest production has been made in the Kilkivan area, 50 miles west of Gympie in Queensland, but other deposits in Queensland, New South Wales, and Victoria have a small production. At Kilkivan small rich ore shoots in biotite granite were mined in 1874–1892. At the Wolfe lodes, 7 miles south of Kilkivan, cinnabar-calcite veins in conglomerate, sandstone, and shale have been explored to a depth of 240 feet. An unusual ore containing cinnabar and visible gold in calcite occurs 1½ miles east of Messengers on King Bombi Creek. At Ewengar, 12 miles from Copmanjurst, the Pulganbar Co. mined a copper-mercury lode prior to 1916. The ore zone is 3 to 18 inches wide and consists of chalcopyrite, pyrite, and cinnabar in a gangue of calcite and quartz. Near Yulgilbar Station, Clarence River, cinnabar veins in granite have been mined. In Victoria, some mercury has been produced from cinnabar occurring in "bands" in Silurian slates near Silver Creek, a western tributary of the Jamieson River. Other minor occurences have been reported from South Australia, Western Australia, and Tasmania.

NEW ZEALAND

The Puhipuhi deposit on North Island about 95 miles north of Auckland, which was worked in 1918–22 and 1941–45, consists of a cone of sinter only a few feet thick, deposited on andesite and overlain by post-ore basalt. Cinnabar occurs in fractures and other openings in the sinter, and it is most abundant under a foot-thick layer of iron oxides. At nearby Mt. Mitchell, cinnabar is in patches in a sinter on the present surface, and although no extensive mining has been done here, the deposit is reported to contain 1 million tons of ore. At Ngawha, 22 miles west of Puhipuhi, cinnabar impregates sinter and acid-leached lakebeds. Associated minerals are native mercury, sulfur, marcasite, hydrocarbons, chalcedony, and a little stibnite. Other deposits in North Island that have been worked on a small scale are the Ascot mine near Karangshake and a deposit along the bank of the Mangakirtkiri stream in the Thames district. Cinnabar also has been found in considerable quantity in gold placers in South Island at Nevis, Nokamai, Waipori, and Waitshuna, but there has been no mercury production from these.

CHAPTER 4. TECHNOLOGY

PROSPECTING AND EXPLORATION (*17, 38*)

Prospecting for cinnabar deposits is aided greatly by a knowledge of the geologic factors affecting cinnabar deposition. Information compiled from geologic studies of cinnabar deposits throughout the world has led to the formation of theories that are of valuable assistance in planning exploration of cinnabar deposits.

Although cinnabar occurs in rocks of all types and ages, virtually all mercury deposits are in regions of Tertiary or Quaternary volcanic activity. In any particular area, there are rock types, geologic structures, or stress conditions that influence mineral deposition. The most prevalent conditions for cinnabar deposition are fault breccias capped by fault gouge and porous or brecciated rocks overlain by impervious shale. Rocks that are relatively impervious rarely contain mercury ore bodies unless their composition has been altered by the mineralizing solutions.

The effects of the solutions accompanying mercury deposition vary according to the volume of solution and the type of rock penetrated. Outcrops produced probably are harder or softer than the associated rocks. In the silicified ore zones—the so-called opalitic mercury deposits—the outcropping is usually prominent, whereas in argillaceous-altered zones the outcrops may be hidden and indicated only by surface depressions.

Mercury prospecting commences with the locating of the outcrop by observation, tracing float, or panning. Observation and tracing float will usually disclose hard outcrops, but panning may be necessary for finding altered zones. Because of its high specific gravity, cinnabar pans readily to produce a conspicuous red concentrate.

Although geochemical methods are rarely used in prospecting for cinnabar, they offer certain advantages. The Bureau of Mines method of assaying cinnabar (described under Assaying) permits determining mercury concentration as low as 10 parts per million. Thus, geochemical methods provide a permanent record that is based on facts rather than on personal estimates. In addition, accurate detaile analyses of mineralized zones will indicate th possible locations of ore concentration.

Inasmuch as cinnabar in opalite outcrop may turn a grey or black color on exposure t sunlight, fresh surfaces should be examined The intensity of the red color and the size o the cinnabar crystals may provide an estimat of the grade of the material. The estimate however, should always be checked by an assa until more information on the outcrops is ob tained. A low assay of surface material doe not necessarily mean no or low-grade ore be cause of the strong influence of structure con trol.

Exploration of mineralization beneath th outcrop or for extension of known mineralize zones is by churn, diamond, or long-hole dril ing; by drifting, cross-cutting, sinking, or rai ing.

Drilling is a relatively cheap and effectiv method of exploring wide mineralized zone occurring either on the surface or undergroun The relatively shallow, blanketlike, Idah Almaden mercury deposits were explored b percussion wagon drilling. The drilling pa tern used for one of the ore bodies is shown i figure 3. Percussion drilling generally wa successful; however, diamond drilling resul were poor, core recovery was low, costs we excessive, and many holes were not complete Subsequent mining has confirmed the accura of the percussion-drill samples (*88*).

Owing in part to the erratic nature of ci nabar deposits and in part to the poor reco ery of drill core and cuttings, the preferr method of underground exploration is driftin or other methods necessary to follow the stru ture. Careful attention should be given to t geology and the procuring, identifying, an assaying of samples.

The comparatively high cost of mercury e ploration is sometimes alleviated by the di covery of small ore bodies that can be treat in a relatively inexpensive retort to produce finished salable product. The usual cost concentrating, shipping, and smelting—co mon in processing many other minerals— eliminated, and funds are provided for fu ther exploration.

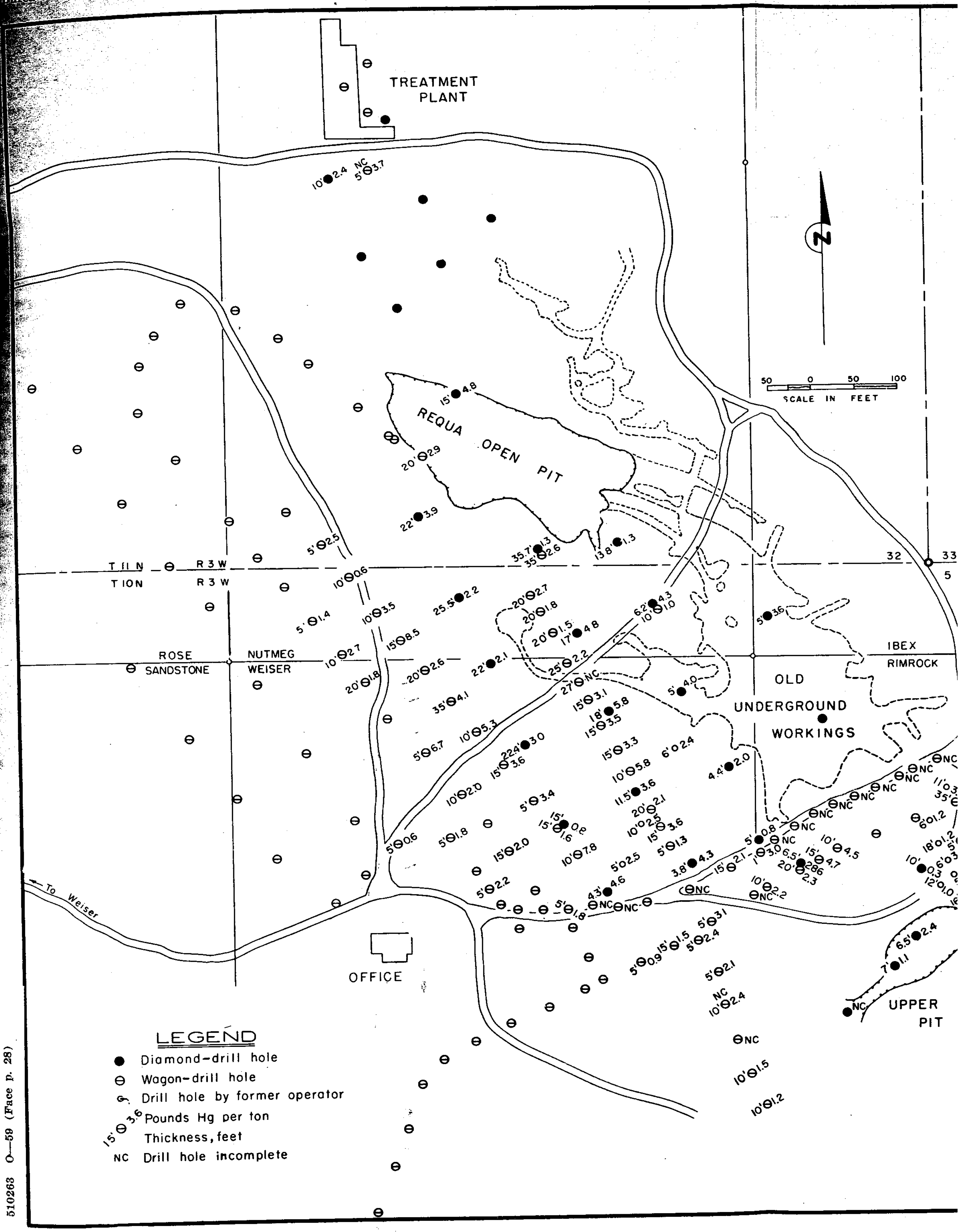

FIGURE 3.—Exploration Drilling, Idaho-Almaden Mine.

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MINING

Mercury ore is mined by both surface and underground methods. Of the two types, underground mining accounts for about 60 percent of the ore and 70 percent of the mercury production in the United States. The mode of occurrence of the mercury deposit determines the method of mining; yet, with either type, the small irregular deposits preclude the large-scale operations and extensive mechanization characteristic of American mining.

Operations in the United States range in size up to 300 tons of ore per day at underground mines and up to 175 tons per day at open pits. Output of ore at underground mines is less than 5 tons per man shift, whereas in open-pit mining output runs 30–40 tons per man shift; consequently, at the lower-cost open-pit operations, ore averaging as low as 3 pounds of mercury per ton is mined, compared to ore averaging 8 pounds per ton at underground mines.

SURFACE MINING

Mercury deposits at or near the surface are mined by open-pit and glory-hole methods. Before mining ore, any barren or subgrade material overlying the deposit is removed. The ore is then drilled and broken by conventional methods.

Broken ore is loaded by power shovels or mechanical loaders into gasoline- or diesel-powered trucks for transportation to the mill. Whenever possible, selective mining is practiced; submarginal material is removed by similar methods, except that it is either stockpiled or wasted.

IDAHO-ALMADEN MINE

The Idaho-Almaden mercury mine in Washington County, Idaho, is an excellent example of a typical modern open-pit operation (*88*).

In most of the ore at the Idaho-Almaden, the cinnabar is finely divided and appears as a delicate pink pigment associated with opal, chalcedony, feldspar, and traces of pyrite. A flat bed of siliceous sinter, relatively impermeable, somewhat brittle, and resembling a soft shale, acts as a cap rock to localize mineralization. Generally, mineralization is irregular. There is no completely barren ground in the mineralized mass, and mining dilution is by low-grade mineralized rock.

Four ore bodies for open-pit mining were outlined and were designated A, B, C, and D. The A, B, and D ore bodies generally are blanketlike deposits that range in area to as much as 350,000 square feet and vary from 3 to 45 feet in thickness. C orebody occurs as fissure filling in a fractured zone and contains neither opalite nor chalcedony. Total reserves, as of April 1956, were about one-half million tons of ore, containing an average of 3.5 pounds of mercury per ton.

Preparation for mining consisted of stripping the overburden and the major portion of the cap rock, which ranged from 0 to 30 feet thick and averaged 5½ feet. It amounted to 1 ton for each 2.5 tons of ore estimated. Initial stripping was done under contract, with large earth-moving equipment. Immediately before mining the remaining waste, cap rock is removed.

Blasthole drilling is done with a mobile percussion-drill rig, and with the same tools used for exploration. Two-inch holes are drilled in a 6-foot grid pattern, then blasted selectively according to sample assays. Waste, if near the periphery of the pit, is left in place; if surrounded by ore, it is blasted after the ore has been mined.

Mining is carried forward in benches, which vary in height from 12 feet in D pit to 22 feet in A pit; the height of the bench depends on the terrain and depth of the ore.

Originally, blastholes were loaded with 40-percent stick powder (1 stick of 60-percent powder per hole for the primer) and were blasted electrically, using 0 and No. 1- and 2-delay blasting caps. Because of its easier and better loading qualities in ragged holes, 60-percent-strength bag powder has been substituted for the 40-percent stick powder. An average of 50 holes is blasted per shot, breaking about 1,500 cubic yards, or between 2,000 and 2,500 tons. Explosive requirements average 0.4 pound per cubic yard. Little secondary blasting is necessary, except in D pit, where the ground breaks in large blocks and several-ton sandstone boulders are left.

Ore is loaded with a crawler-mounted, 2-yard rocker shovel into 2-ton dump trucks (fig. 4). Two shovel loads are required to fill each truck. One shovel and two dump trucks supply the operation.

The truck haul is short—200 yards from A pit, one-fourth mile from B pit, one-half mile from C pit, and three-fourths mile from D pit —to the blending apron beside the crushing plant. The maximum haulage grade is 6 percent. Each load to the coarse-ore bin or to the stockpile is weighed.

The blending apron is an 80- by 80-foot concrete slab with a storage capacity of more than 10,000 tons. It is a dual-purpose installation set beside the crusher hopper. As a surge platform, ore stored here permits a 5-day-per-week mining operation to supply a 7-day-

FIGURE 4.—Loading Ore, Idaho-Almaden Mine.
(Courtesy, Mining World)

per-week furnacing operation. As a grade-control platform, ore piled as mined from the separate pits can be fed according to grade. The average storage load on the apron is 500 to 1,000 tons. Although steam pipes are embedded in the apron as a precaution against freezing of the ore, no heating has been necessary.

Rock containing less than 2 pounds of mercury per ton is wasted or used for road ballast. Better grade rock (from 2 to 2.5 pounds of mercury per ton) is sent to low-grade stockpiles for future treatment.

Drainage is no problem because the mining area is above the water table.

Five men comprise the mine crew—one wagon-drill operator and one helper, two truck drivers, and one heavy-tractor operator. Two laborers, employed as members of the plant crew, serve both mine and plant, with time charged according to work performed. All labor is paid on an hourly basis.

The general superintendent is in charge of all operations, and his time and that of the sample foreman-office manager are charged cording to duties performed.

UNDERGROUND MINING

Underground methods of mining mer ore are not uniform, as variations in th currence of the ore and in the strength o rocks influence the choice or modificatio method used. At the larger undergr mines, square-set, stulled, or shrinkage ing is commonly used.

In mining large ore bodies deposited in cia or areas of fractured rock, square-set preferred. Alternative methods may be in some cases, but they require extensive aration of the block to be mined. In ad to assuring general safety and relia square-sets can be added in any directi follow the ore.

Only when mines are close to the surf when the ground gets heavy is it necess fill. Usually, as soon as the stope is w out, the empty stopes are filled or allo cave.

Underground openings created by mining flat dipping ore bodies with relatively narrow widths are commonly supported by stulls. Large flat stopes in heavy ground require a combination of stulls with attached posts and caps to support lagging.

After the ore has been broken by conventional drilling and blasting, it is removed by scrapers, by direct drop to draw points, or by mechanical loaders into cars. The cars are trammed to the surface or to the shaft for hoisting to the surface.

The methods and procedures used at three of the large underground mercury mines in the United States offer typical and descriptive examples.

ABBOTT MINE

The ore bodies at the Abbott mine, Lake County, Calif., are contained in complex zones of dikes and sills of serpentine breccia. Cinnabar occurs with abundant marcasite and some sulfur or fracture fillings in the opalized and altered breccia in tubular, pipelike, or podlike ore bodies along low-dipping parts of contacts, faults, and fault intersections. The ore bodies vary greatly in size and extent.

Production is entirely from underground workings that extend laterally for about 3,000 feet and to a maximum depth of about 500 feet. The main shaft, which is open to the 300-foot level, has two hoisting and one manway compartment, each 4 by 4½ feet, inside timbers. Mine cars are caged and hoisted to the surface by a double-drum, 75-hp. electric hoist.

Mineralized areas are developed by crosscutting, drifting, and raising. Drifts and crosscuts are 5 by 7½ feet in cross sections with timbers placed on 5- or 6-foot centers when needed. Round timbers, framed at the mine, are used for drift sets. Raises are two and three compartment, with one chute and one manway or two chutes and one manway, and range in size from 4 by 8 feet to 4 by 12 feet, inside timbers.

Crosscutting and drifting are done with hand-crank drifters using 1¼-inch lugged steel and throw-away type detachable bits. A jackleg drill is also used. Raising is done with stopers and 1-inch quarter octagon steel and detachable bits. Blasting requires 40 and 65 percent dynamite in 1⅛- by 8-inch sticks, detonated electrically. Rocker loaders are used for mucking in drifts and crosscuts, and broken material is trammed by battery locomotives to shaft stations or to surface-ore bins.

Stope sizes vary greatly and the comparatively flat dip (35°–45°) of the ore bodies requires a modified method of square-set stoping to suit the particular ore body. Typical examples are the Back Dike ore body with a maximum strike length of 300 feet, dip length of about 320 feet over a vertical extent of 235 feet, and an average thickness of 8–10 feet from which about 30,000 tons have been produced; and the "19" ore body which has a strike length of 175 feet, and average thickness of 8–10 feet, from which 16,250 tons have been produced. Round timbers are used and set on 5-foot centers. Mucking is done with air and electric two-drum slusher scrapers. Little backfilling is used.

Compressed air is supplied by 315, 365, and 500 c.f.m. compressors, each unit driven by a diesel engine. A 315 c.f.m. compressor is maintained as a standby unit. Water for domestic and plant use is pumped to storage tanks from three wells. Mine water, 30–40 g.p.m., is pumped to the surface from the 300 level by a 15-hp., two-stage centrifugal pump.

Electric power is generated by two 100 kw. generators driven by two belt-connected 100-hp. diesel engines, one 75-kw. diesel generator, and two 125-kw. diesel-electric units. Normal daily operating requirements are about 200 kilowatts.

Production is at a daily rate of 50–60 tons of ore averaging 10–11 pounds of mercury per ton. The mine is operated on a 6-day-weekly basis.

Company operations require, in addition to the general manager, a force of 55 men, including a geologist, mine foreman, clerk, hoistman, timber framers, bulldozer operator, mechanics, miners, and mill men.

NEW IDRIA MINE

The principal mercury deposits at the New Idria mine, San Benito County, Calif., consist of cinnabar, with minor amounts of metacinnabar, occurring as veins and stockworks in fracture zones in altered shale and sandstone. Ore bodies vary greatly in size from narrow veins of limited extent to mineralized zones several hundred feet in length and width.

Underground operations are conducted from the No. 10 adit level, the main haulage level. Principal production is from stopes above this adit, although in several areas winzes are sunk on ore bodies extending below the level. Drifts are driven 10 by 8 feet in cross section, using two drill jumbos equipped with power-feed drifters, 1⅛-inch lugged steel, and throw-away type bits. Blasting is done with 40-percent gelatin dynamite detonated by the conventional fuse and cap. Rocker shovels are used to load muck into side-dump mine cars of 1½- and 2½-ton capacity. Battery-type locomotives provide underground transportation with maximum hauls to about one mile.

Drift timbering comprises standard sets of framed 10 by 10 inch timber set on 5-foot centers. Two by 6-inch lagging is used, and in heavy ground, floor segments are used to prevent buckling under pressure. Rough timber is trucked in from Santa Cruz and cut to the required size in the company's timber-framing plant.

Stopes are artificially supported by square-set timbering in the larger stopes and steel supports for narrow veins. Square-sets are 5 by 5 by 7½ feet high. Fill is used to support heavy ground. Jacklegs and stopers are used for drilling, holes are detonated by fuse and caps, and mucking is with slusher scrapers.

Single- and double-compartment timbered raises and winzes are driven; the single compartment is 6 by 5 feet inside timbers, and the double compartment is 12 by 5 feet inside timbers. Electric blasting is used only in winzes and shafts. Air hoists are used to hoist muck and lower timber and supplies.

Compressed air is furnished by three 600-c.f.m. two-stage compressors, driven by 125-hp. electric motors. Water is supplied through pipelines from the company's reservoir. Forced ventilation is provided by electric-driven mechanical blowers.

Production from underground workings is at a 2,000-ton monthly rate. The ore averages about 8 pounds of mercury per ton. No work is being done in the New Idria open pit, but supplementary tonnage comes from open-pit operations at the San Carlos mine and from custom ore.

Company operations require, in addition to the general manager and superintendent, a force of 135 men, ranging from geologists through miners and plant operators to cooks and waiters. Work is on a 6-day basis, but due to the isolated location of the property, work continues for 12 days followed by a 2-day layoff.

CORDERO MINE

Cinnabar, associated with marcasite, in the Cordero mine, Humboldt County, Nev., occurs as disseminations and as veinlets and bunches in altered rhyolite along the hanging wall of a well-defined, steeply-dipping fault. Ore bodies which have formed along fractures and crossfractures vary considerably in size.

Underground operations are from the main shaft which has been sunk to the 800 level. Levels from the shaft were driven at 75- to 80-foot intervals down to the 600 level, which is 500 feet below the surface, and at 100-foot intervals below the 600 level. The shaft has one hoisting compartment, a counterweight compartment, and a manway. Ore is hoisted in an automatic-dump skip operated by a two-drum electric hoist.

A new shaft, southeast of the main shaft, was completed in 1957. It is a 5- by 11-foot, three-compartment shaft with a double hoisting compartment and a manway. Ore is hoisted in 2-ton capacity skips operated by a two-drum, 150-hp. electric hoist. The headframe is made of steel. The shaft was raised from the 600 level to the surface and sunk from the 600 to the 900 level.

Development of the mineralized zone on successive levels is by drifting and crosscutting, followed by raising and stoping. Drifts and crosscuts vary in size from 5 by 7 feet in waste to 7 by 9 feet in ore. Timber is used in heavy ground and caved areas with regular sets of 8- by 8-inch timber set on 5-foot centers. Timber is framed at the mine. Jacklegs using ⅞-inch hexagon steel and throwaway type detachable bits are used for drilling. Blasting is done with 40-percent gelatin dynamite using conventional fuse and cap. Mucking is done with rocker loaders into 1-ton end dump cars that are hand trammed to shaft stations and dumped into skip pockets. Underground hauling distances are comparatively short.

The stoping method used depends upon the size of the ore body to be mined, but it is usually square-set with occasional shrinkage and sublevel stopes. The comparatively soft and altered rhyolite requires a reverse procedure in the usual method of square-setting by starting from the top of an ore body and mining down. Eight-inch-square timbers are used for sills with 8-inch round timbers, 7½-foot posts and 5½-foot caps on 5-foot centers for stope sets. Cribbing is often required, and backfilling is used in areas of heavy ground. Jacklegs are used for drilling in stopes; mucking is by slusher scraper or by direct drop to draw points.

Compressed air is supplied by a 550-c.f.m. stationary compressor driven by a diesel engine. A 365-c.f.m. stationary diesel-driven compressor is maintained for standby use. Water is supplied from wells on the property supplemented by 20 g.p.m. from the mine.

Electric power is generated by a 5-cylinder 250-kw. diesel generator and two 100-kw. diesel generators. An older 200-kw. diesel generator is used as a standby unit.

Production is chiefly from the 600 and 700 levels and amounts to 120 tons of ore per day which averages about 11 pounds of mercury per ton. The mine is operated on a 2-shift 6-day week, with repair and maintenance work done on the third shift.

Company operations require, in addition to the general superintendent, a force of 85 men, consisting of 55 men underground, 12 men at the furnace plant, and 18 men for the powerhouse, engineering staff, office, and maintenance.

BENEFICIATION

The roasting of mercury ores is such an efficient method of extracting mercury that beneficiation of mercury ores has not been used extensively. However, with the gradual depletion of the higher grade ores, concentration of low-grade mercury ores prior to roasting or leaching is assuming new and more importance.

Various methods of beneficiating mercury ores have been used. These include hand sorting, crushing and screening, jigging, tabling, and flotation.

Hand sorting of mercury ores has been used to advantage when either mercury-bearing or mercury-barren material can be recognized and removed. It is customary in large operations to remove the barren material and furnace the enriched product, whereas in small operations the mercury-bearing material is sorted out and retorted.

At most operations the purpose of crushing, which is sometimes followed by screening, is to prepare a properly sized feed for the retort or furnace. However, during the crushing of many types of ore, the cinnabar breaks more readily and into smaller particles than the associated gangue minerals so that partial separation of the valuable from the waste minerals may be done by screening and discarding the oversize low-grade material.

Many attempts have been made to concentrate mercury-bearing material by jigging and tabling; although some upgrading was accomplished at low cost, mercury recovery was poor. The principal objections to gravity methods of beneficiation are excessive mercury losses and inferior grade of product.

Flotation is the most efficient method of beneficiating mercury ores and produces 25–50 percent concentrates with mercury recoveries of about 90 percent. Another advantage of flotation, especially of low-grade material, is the high ratio of concentration which permits the reduction by a proportionate amount of the size and costs of the subsequent mercury-extraction installation.

Through research by the Bureau of Mines, universities, and industry, the flotation of cinnabar mercury ores has been studied and developed (*61*, *85*).

In a typical flotation concentrator (fig. 5), after the ore is crushed it is reduced to flotation size by grinding in a ball or rod mill in closed circuit with a classifier. The classifier overflow, minus-48 to minus-65 mesh, flows by gravity or is pumped to the conditioner where the flotation reagents are added.

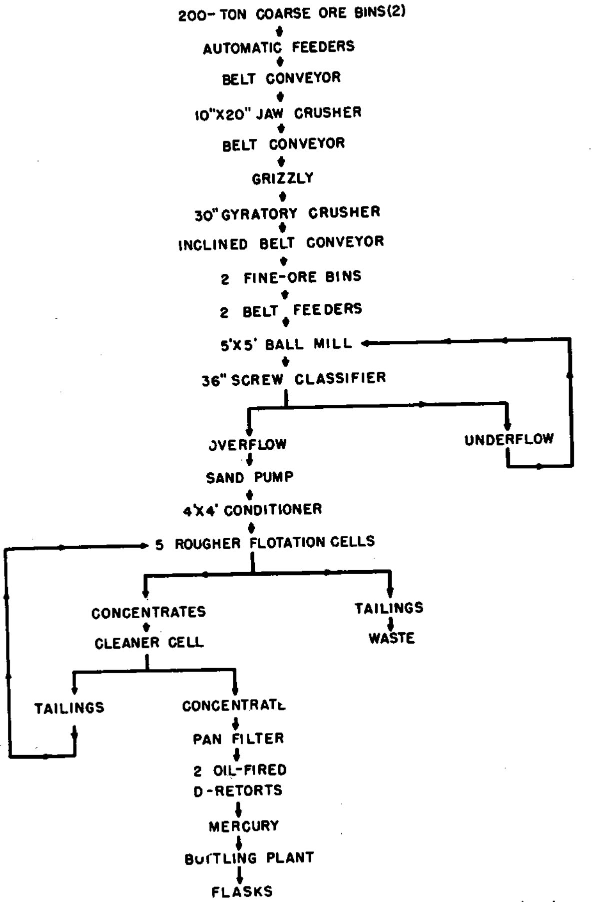

FIGURE 5.—Flowsheet, Mercury Flotation Concentrator.

For some ore, the cinnabar must be activated with copper or lead salts for flotation. When this is necessary, the activators are added to the pulp in either the grinding circuit or in the conditioner. The usual collector reagent for cinnabar is one of the xanthates which is added to the pulp in the conditioner.

The conditioned pulp then goes to the rougher flotation circuit where pine oil or other frothing reagent is added, a rougher concentrate is removed, and a tailing is discarded. The rougher concentrate is treated in one or more cleaner flotation circuits to produce a finished concentrate and a tailing that is returned to the rougher flotation for further treatment. After filtering, the concentrate is roasted or leached for extraction of the mercury.

In the pilot-plant flotation of cinnabar ore from the Hermes mercury mine in Idaho, the material was upgraded from 0.41 percent to

46.80 percent mercury with a mercury recovery of 94.2 percent (*89*). Equally noteworthy was the high ratio of concentration as the weight of the flotation concentrate was less than 1 percent of that of the original feed.

LEACHING (*39*)

The only hydrometallurgical process for extracting mercury is based on the solubility of metallic mercury or cinnabar in a solution of sodium sulfide and sodium hydroxide. Mercury is recovered from solution by precipitation with aluminum or in an electrolytic cell.

Although leaching was used successfully to recover mercury from amalgamation tailings in 1915, no commercial-scale plants for leaching cinnabar were constructed until the new plant for leaching mercury concentrates was built at the Hermes mine in Idaho in 1957.

At the Hermes plant, the arsenic is removed, with virtually no loss in mercury, from the flotation concentrate by leaching it with a caustic solution. The concentrate is then treated with a solution of Na_2S:NaOH in the ratio 4:1 which removes about 99 percent of the mercury. Mercury is recovered from solution by electrolytic precipitation.

Preliminary operational data of the Hermes pilot plant indicate that mercury recovery by leaching followed by electrolytic precipitation costs about the same as roasting, mercury recoveries are about equal for the two processes, and the arsenic problem is eliminated in the leaching treatment.

ROASTING (*10, 14, 18, 39*)

Recovery of mercury from ore and concentrate by roasting is essentially a distillation process and consists of heating the cinnabar to volatilize the mercury followed by condensation of the mercury vapor.

Either mechanical furnaces or retorts are used to roast mercury-bearing materials. The significant differences in the two types of roasting are: Furnacing is a continuous operation, the material is heated directly by the gases of combustion, and the volume of furnace gas is large, whereas retorting is a batch operation, the material is heated by indirect firing, and the volume of retort gas is small.

Except for the type of furnace used, mercury-recovery plants are essentially the same. Each plant has facilities for storing, crushing, conveying and feeding ore; a furnace; a dust collector; a condensing system; a gas fan; a gas tower and stack; a calcine bin; a hoeing machine; bottling equipment; and an apparatus for regulating and controlling pressures and temperatures throughout the plant.

Flowsheets of plants with multiple hearth and rotary furnaces are shown in figures 6 and 7. Figure 8 shows a typical mercury plant with a rotary furnace.

MECHANICAL FURNACES

MULTIPLE HEARTH

The multiple hearth or Herreshoff furnace consists of a series of vertically spaced hearths of firebrick enclosed by a cylindrical brick wal[l] within a metal shell (fig. 9).

The layout of a multiple-hearth furnace plant is shown in figure 10.

Ore is fed into the furnace either at th[e] inner or outer edge of the top hearth. Rabbl[e] arms connected to a vertical shaft in the center of the furnace rake the ore across th[e] hearths as the shaft rotates. The ore passe[s] downward through the furnace by being rabbled across the hearth and passing through a[n] opening to the hearth below until it reache[s] the bottom hearth where the calcine is discharged into a bin under the furnace. During the passage, the ore is preheated on th[e] upper hearths, is roasted on the middle hearths and is cooled on the lower hearths. To maintain a uniform bed of ore on each hearth, th[e] particle size of the feed is smaller than tha[t] for rotary-type furnaces and ranges from 5/ inch in the small furnaces to 1¼ inches in th[e] large sizes.

Firing is done directly on the roastin[g] hearths through ports in the shell. Both low pressure and high-pressure oil burners a[re] used, but the high-pressure type is preferre[d] because of lower fuel consumption.

Standard capacities of multiple-hearth fu[r]naces range from 20 tons per day in the 1[0]-foot-diameter, 4-hearth furnace to 125 tons pe[r] day in the 14-foot, 3-inch-diameter, 13-heart[h] furnace (see table 3). Other sizes are avai[l]able to meet requirements. Although the rate[d] capacity of all types of mechanical furnace[s] is determined by size, the moisture conten[t] size, and character of ore also affect the ca[]pacity.

TABLE 3.—*Standard sizes of multiple-hear[th] furnaces*

Outside diameter of shell, feet	Number of hearths	Capacity pe[r] day, tons
3 (i.d.)	8	
10	4	
10	6	
13½	6	
16	6	75–1
14¼	13	1

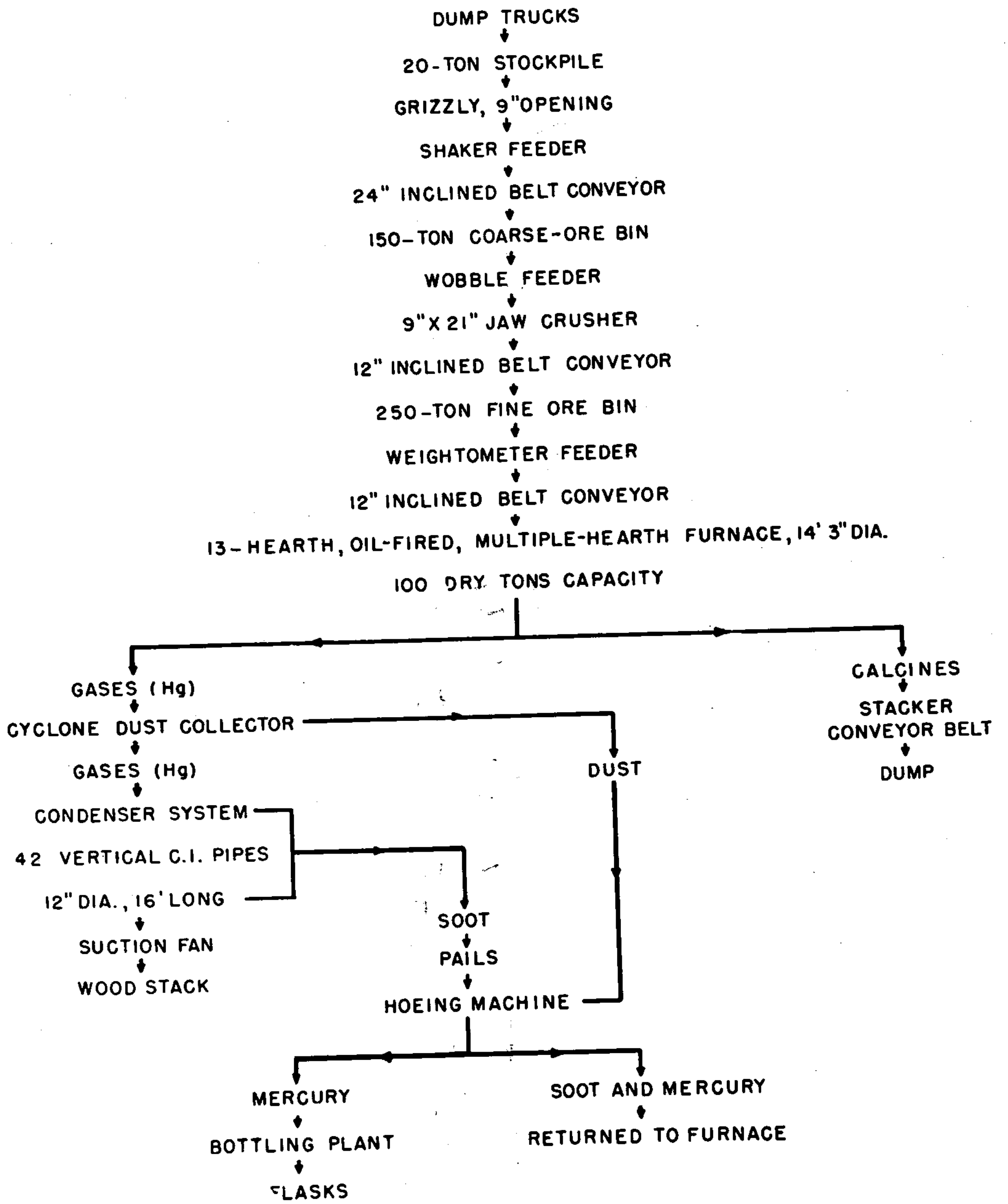

FIGURE 6.—Flowsheet, Multiple-Hearth Furnace Plant.

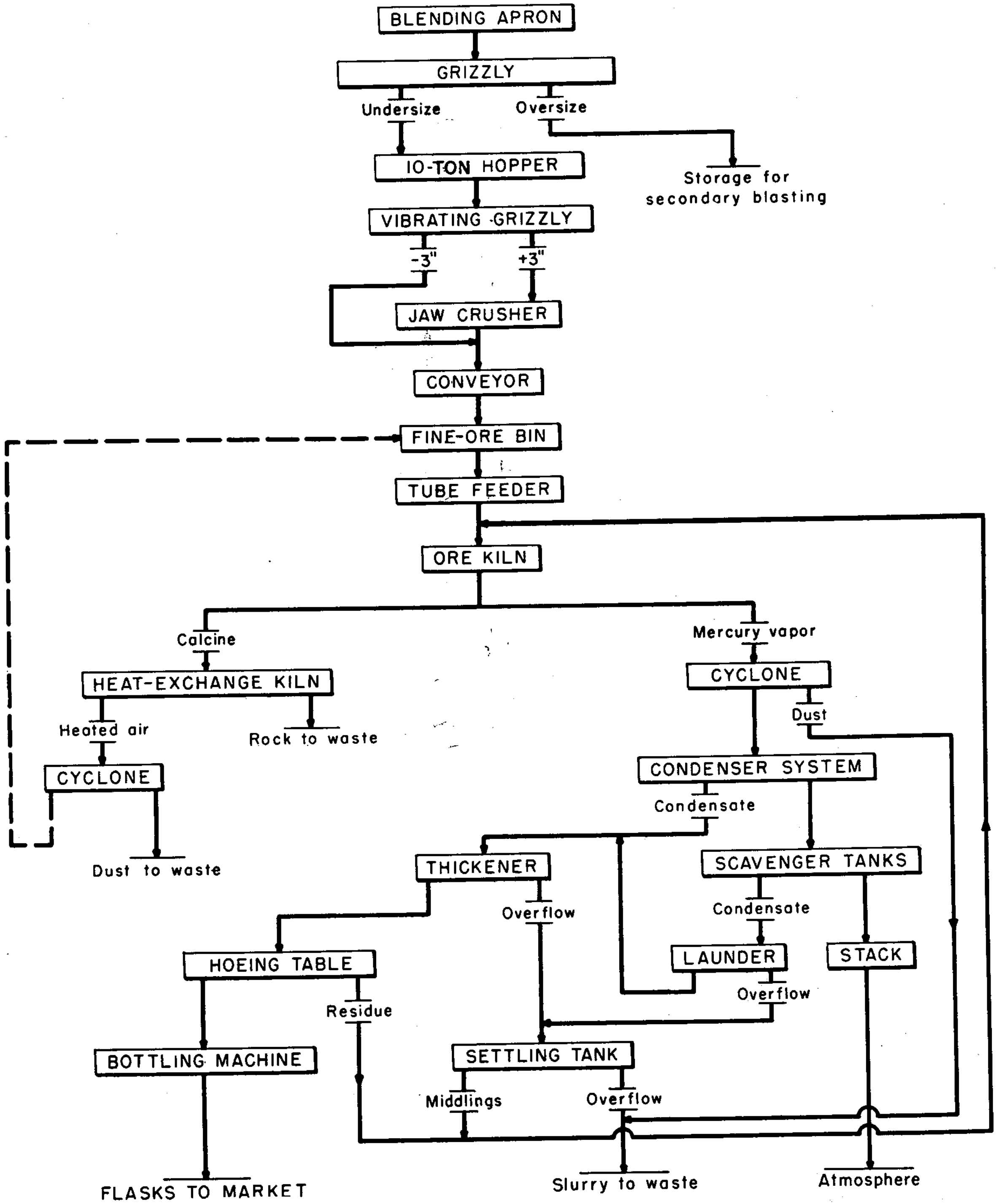

FIGURE 7.—Flowsheet, Rotary Furnace Plant.

FIGURE 8.—Idaho-Almaden Mine and Plant.

(Courtesy, Rare Metals Corp. of America)

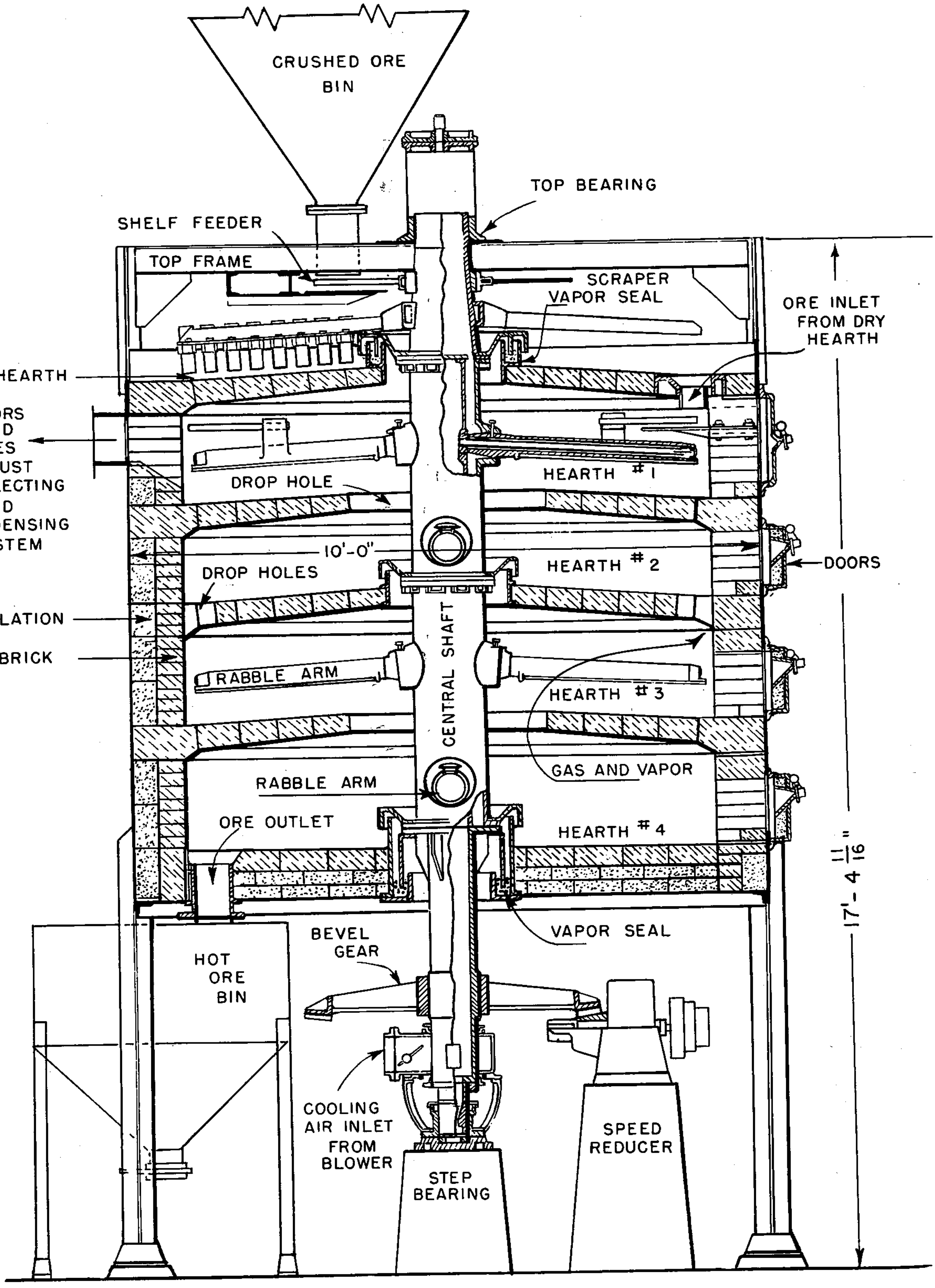

FIGURE 9.—Section Through Multiple-Hearth Furnace.

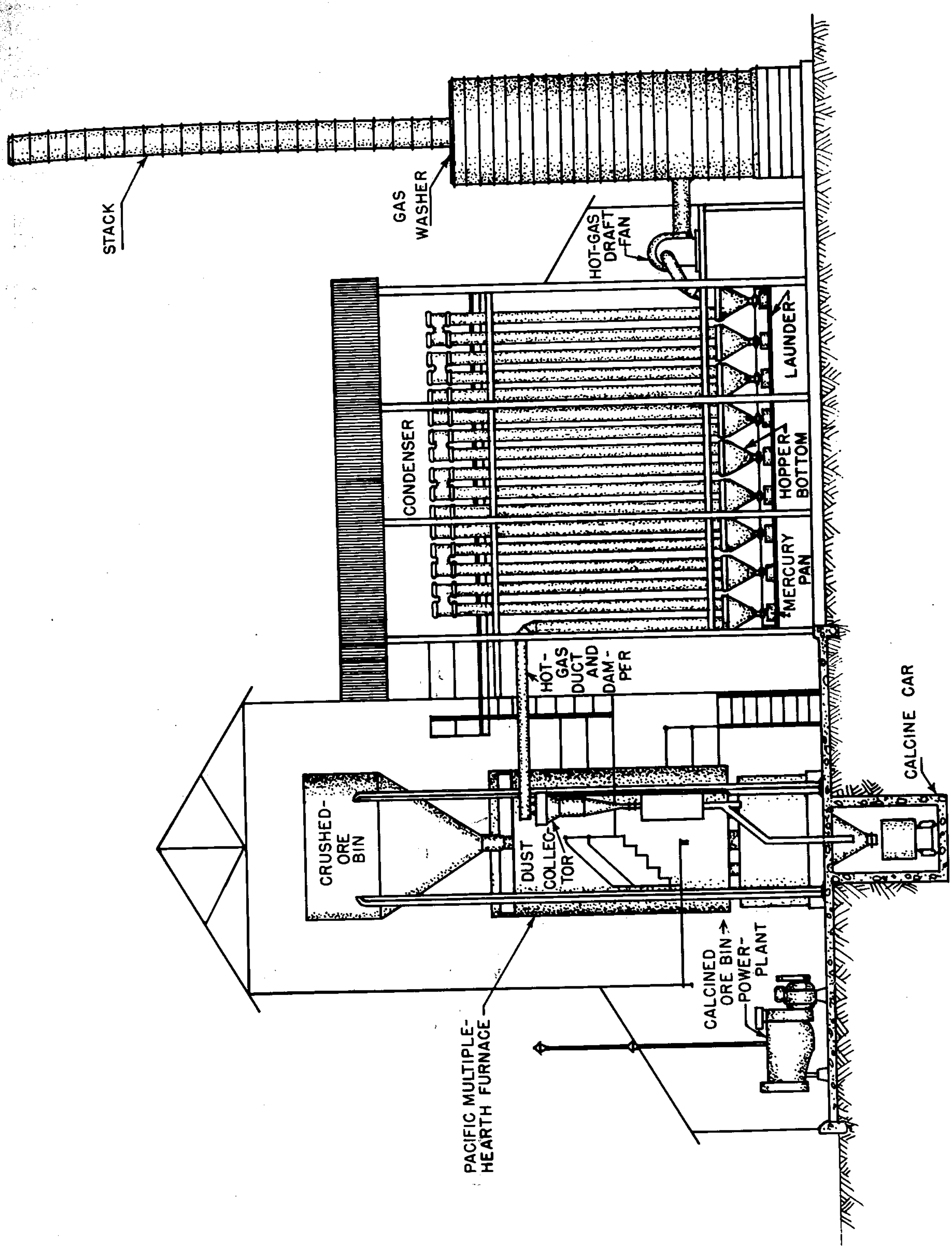

FIGURE 10.—Layout—Multiple-Hearth Furnace Plant.

ROTARY

The rotary-type furnace for roasting mercury ore is essentially a tubular-steel shell lined on the inside with firebrick or other refractory material. Gas seals are provided at each end of the shell to prevent leakage of mercury vapor out or cold air in. The shell is inclined slightly from the horizontal, and as it rotates about the long axis, ore passes from one end of the furnace to the other (fig. 11).

Ore is fed into the upper end of the kiln and moves toward the heat source at the lower end. The depth of the ore bed and the rate of ore flow through the furnace are controlled by varying the inclination and the rotation of the kiln. Inclination of the shell ranges from ½ inch per foot for the longest to 1¼ inches per foot for the smallest size furnace; rotation speeds vary from 30 to 90 seconds per revolution.

It is unnecessary to size the feed for the rotary furnace, and material up to 3 inches can be roasted in the larger furnaces. In the smaller furnaces the feed size is determined by the feeder and ranges up to 1½ inches.

Although various kinds of fuel have been used in rotary furnaces, oil is the most common. Like the multiple-hearth furnaces, both low-pressure and high-pressure oil burners are used. The burner equipment is placed at the lower end of the furnace in a brick-lined steel hood.

Fuel consumption in mechanical furn varies with the character of the ore, siz furnace, and percent utilization of capac consumption ranges between 4 and 8 gal and averages about 6 gallons of oil per of ore.

Rotary furnaces have rated capacities r ing from 6–10 tons to 165–240 tons pe hours with larger sizes to meet requirem (see table 4). For these capacities the di sions range from 21 inches in diameter 20 feet in length to 72 inches in diameter 100 feet in length. As indicated in the tiple-hearth furnace section, actual capac are dependent upon factors other than di sions.

TABLE 4.—*Standard sizes of rotary furna*

Diameter, inches	Length, feet	Capacity day, to
21	20	
24	24	
30	32	
36	42	
42	52	
48	64	6
54	72	8
60	80	10
66	90	13
72	100	16

The layout of a rotary furnace pla shown in figure 12.

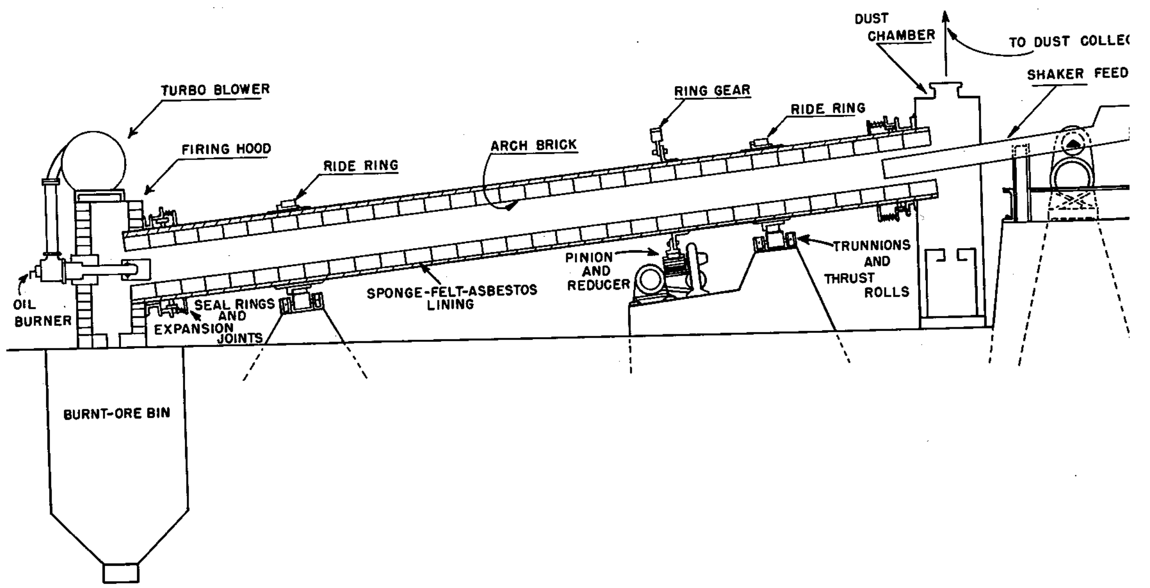

FIGURE 11.—Section Through Rotary Furnace.

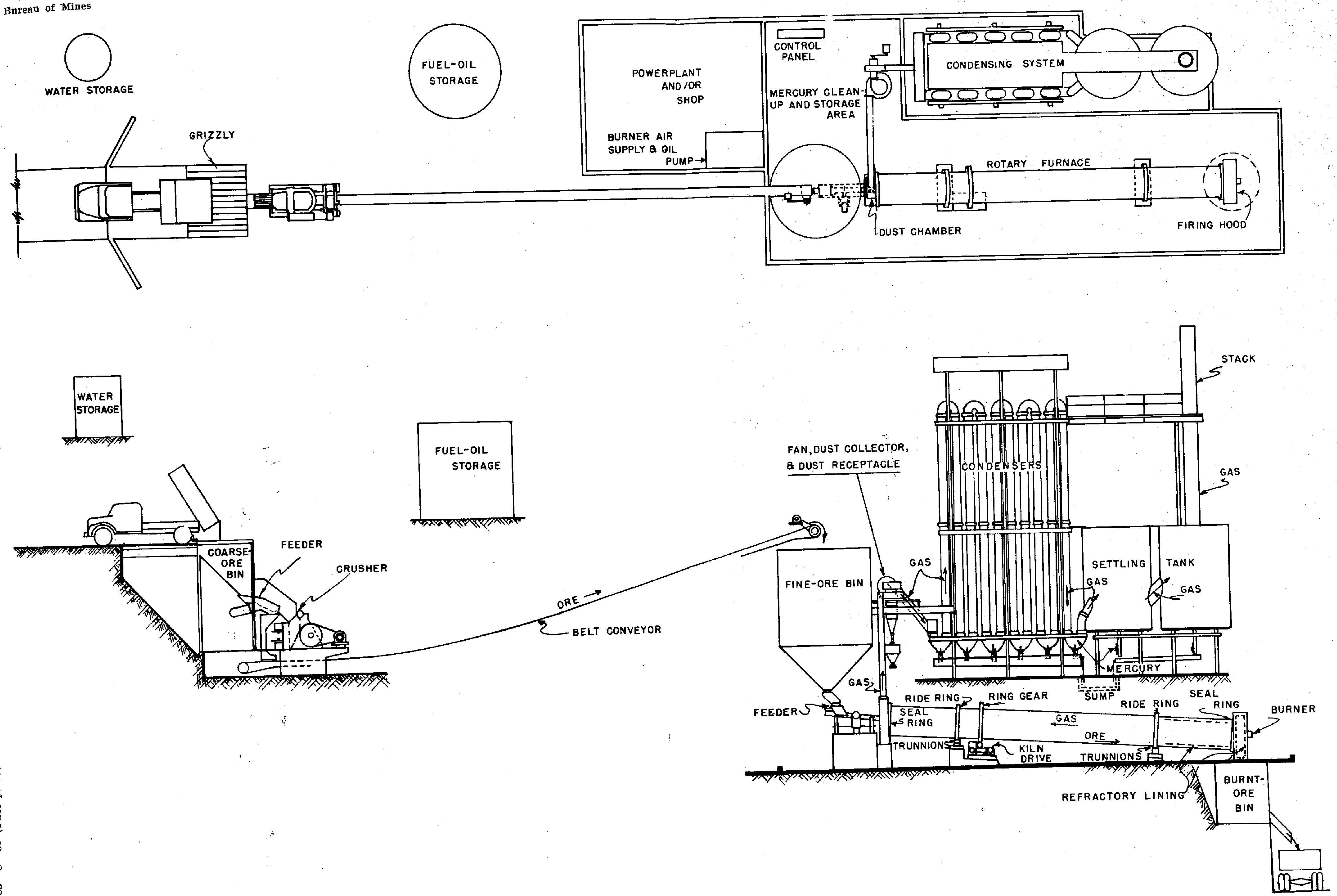

Figure 12.—Layout—Rotary Furnace Plant.

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RETORTS

Retorts are inexpensive installations for small operators, either as a production unit or a prospector's tool. They are used also to treat concentrate from milling operations, mud and soot from furnace operations, and to recover mercury from scrap and mercurial salts. One of the most objectionable features of retorts is the manual charging of ore and discharging of burnt ore.

Although many types have been used, the preferred retorts are made of cast iron with a D or cylindrical cross section (fig. 13). One end of the retort is flanged for a head, and the other end is closed. A cast-iron pipe, which is connected to the retort through the closed end and discharges the mercury gas into a tank, box, or other receptacle filled with water, forms the condenser.

Retorts are supported by brickwork or other masonry, with the firebox below or to the side of the retort. Installations range from 1 or 2 for the D retorts up to 12 units or more for the round pipes. Also, the round retorts may be installed horizontally or inclined.

For best operation the feed for retorts should not exceed 1½ to 2 inches in size. With clean ore, D retorts have a capacity of 750 to 1,000 pounds every 12 hours, whereas the capacity of round retorts is lower and averages 250 to 300 pounds every 12 hours.

In contrast to furnace operations where a large volume of air is available to oxidize the sulfur, retorts have only a limited quantity. Consequently, it is often necessary to add lime or iron to the retort charge to combine with the sulfur in the ore. This is particularly important when the sulfur content of the ore is high.

MERCURY COLLECTING AND AUXILIARY EQUIPMENT

DUST COLLECTORS

Solid particles are removed from mercury-laden furnace gases by passing the gases through a dust-collecting unit. Unless the dust is removed from the gases before they enter the condensing system, the dust accumulates in the condensers, impeding gas flow, decreasing cooling efficiency, and contaminating the liquid mercury.

The dust collector and connected dust bin, located between the furnace and the condensing system, are provided with seal valves to permit emptying of the bin without interfering with the gas flow.

Excessive quantities of mercury in the dust are prevented by keeping gas velocities high and temperatures above the condensation point of mercury in the collector. Mercury occurs in the dust as condensed metal and as fine particles of cinnabar carried over in the gases from the furnace. As the quantity of dust collected is usually small, it can be discarded with little loss in mercury; however, at some operations the dust is retreated to recover the contained mercury.

Cottrell electrical-precipitation units have been used to strip the gases of the entrained dust, but as the installation and maintenance costs of the Cottrell precipitators were high, the less expensive but efficient cyclone type of collector was developed and adopted.

Of the two kinds of cyclone collectors—the single-cone large-diameter type and the multitube type with its series of small cones—the former is preferred because of lower operating costs, resistance to plugging, and longer operating life.

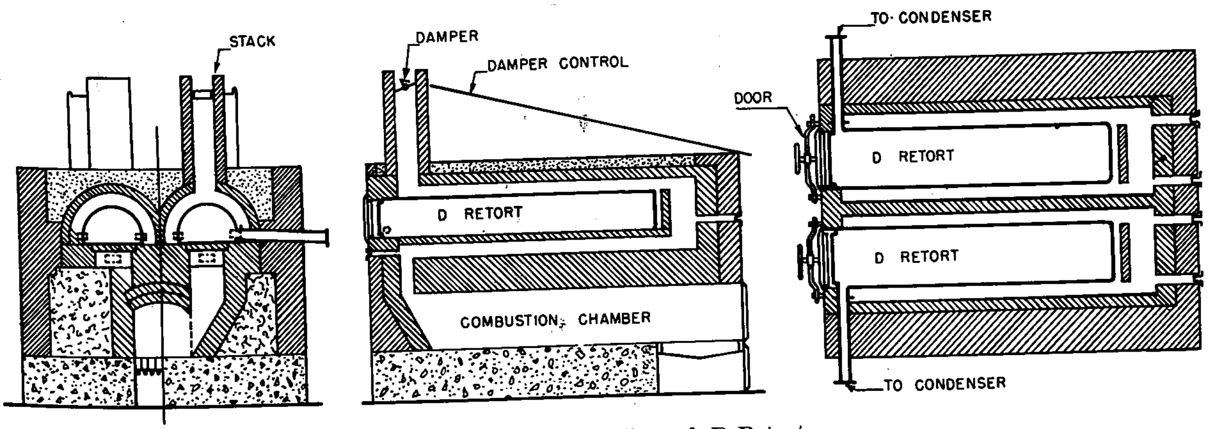

Figure 13.—Section Through D Retort.

(Courtesy, Pacific Foundry Co.)

From the dust collector the gases pass through a dampered branch pipe into the condensing system.

CONDENSERS

The mercury vapor in the gases from the dust collector is cooled in condensers below the dewpoint to form liquid mercury. The dewpoint varies with the proportion of mercury vapor in the gases and rises with an increase in mercury concentration.

A typical condensing system consists of banks of cast-iron pipes connected at the top with cast-iron return bends and at the bottom with cast-iron hoppers (fig. 14). The mercury that condenses in the pipes is collected under a water seal in a launder or bucket at the bottom of the pipes. Readily accessible clean-out ports are provided with each return bend and hopper.

In addition to cast-iron condensers, mild-steel plate, monel metal, stainless steel, and tile condensers have been used. Cast iron is usually the most economical and efficient material, and mild-steel plate may be used when the ore being treated is low in sulfur content. Both of these metals are subject to the corrosive action of the acid formed from the sulfur in the cooler, wet portion of the condensing system. Monel metal and stainless steel pipes provide excellent service, but they are expensive compared with iron and are also subject to corrosion when the ore treated contains volatile chlorides. Although tile con-

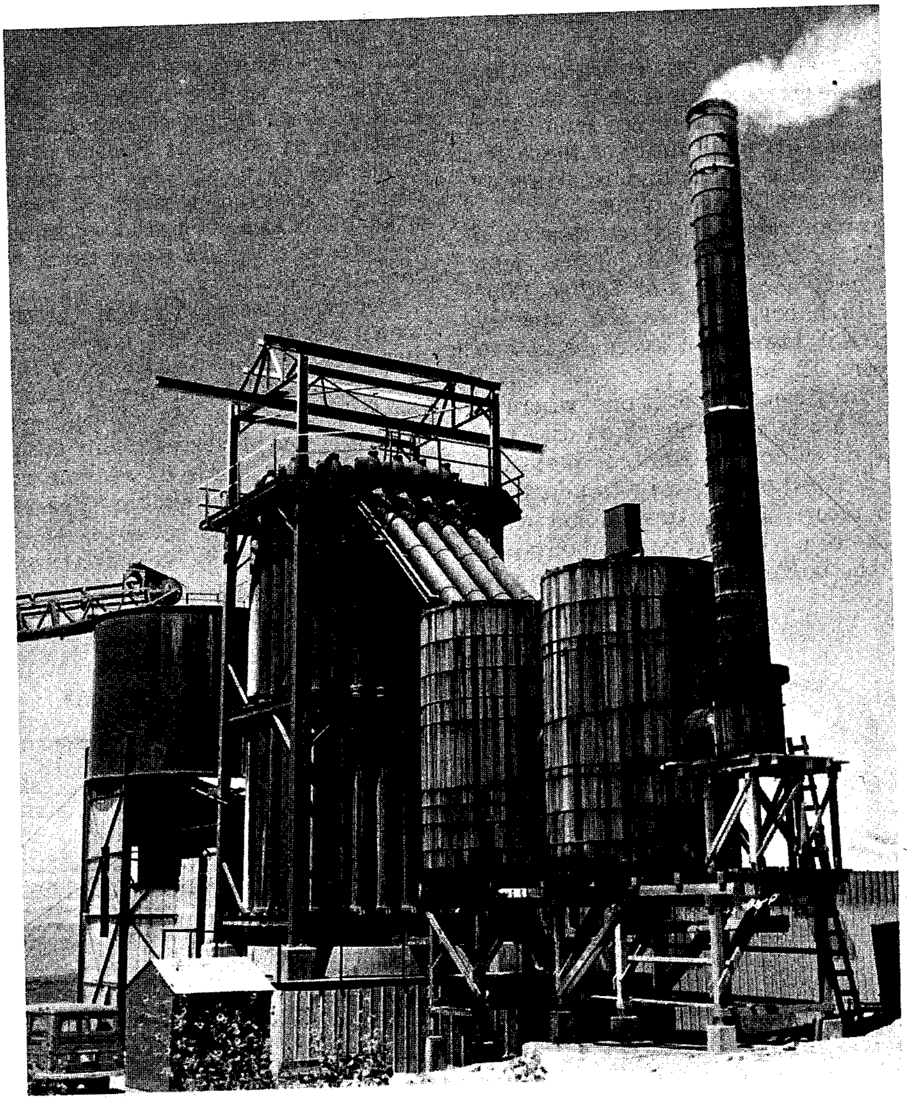

FIGURE 14.—Condensing System.

(Courtesy, Rare Metals Corp. of America)

densers are more resistant to corrosion than metal condensers, they are poor conductors of heat and are subject to cracking.

The size of the condensing system is determined by the quantity and type of mercury ore treated (table 5). For the same tonnages, a wet sticky ore requires a larger condensing system than a dry hard ore. Consequently, the plant capacity is affected unless the condensing system is adequately sized and proportioned to the type of feed.

Even though the condenser design provides for maximum air circulation and cooling around the individual pipes, the capacity of the system can be increased by cooling the pipes with water sprays.

TABLE 5.—*Standard sizes of cast-iron condensing systems*[1]

Type[2]	Tonnage	Pipes[3] (number)	Hoppers[4] (number)	Returns[5] (number)	Total length, ft.[6]	Total weight, lbs.[7]
SRSD	6–10	10	6	5	227	27,250
SRDD	10–15	14	4	4	289	32,000
SRDD	15–30	18	5	5	366	40,500
DRDD	30–50	28	8	8	568	62,750
DRDD	45–65	36	10	10	727	64,000
DRDD	65–100	44	12	12	886	97,250
QRDD	85–130	60	16	16	1,210	133,000
QRDD	105–150	64	20	16	1,298	143,500
QRDD	130–200	76	20	20	1,528	167,500
QRDD	165–240	120	32	32	2,420	266,000

[1] Variation in type and length of system are frequently made to adjust for variations in local conditions.
[2] SRSD is a single row of pipes, single decked (1–18 ft. joint, 18 ft. high). SRDD is a single row of pipes, double decked (2–18 ft. joints, 36 ft. high). DRDD is a double row of pipes, double decked. QRDD is a quadruple row of pipes, double decked, over a tank cleanup system.
[3] Pipes are cast iron, 16 in. i.d., 18 ft. long, 0.52 in. walls, bell and spigot ends.
[4] Hoppers are cast iron, 16 in. i.d., return els, with bottom outlet for water seal and cleanup.
[5] Returns are cast iron, 16 in. i.d., return els, with cleanout holes over each stand of pipes.
[6] Length of cast-iron portion of condensing system, only.
[7] Weight of cast-iron portion of condensing system, only.

EXHAUST FANS

The flow of gases through the furnace and the condenser is controlled by an exhaust fan that may be placed between the furnace and the dust collector, between the dust collector and the condenser, or between the condensers and the settling tanks or stacks.

In most installations the fan is between the dust collector and the condensers; at that location the temperature of the gases is high enough to keep the gases dry and noncorrosive; and as nearly all of the dust has been removed from the gases, abrasion of the fan by dust is prevented.

Fans made of corrosion-resistant metal, or protected with a corrosion-resistant material such as rubber, may be placed between the condenser and the stack. Advantages of installing the fan at that position include less volume of gas at lower temperatures and prevention of mercury-vapor leakage because the condensers are under a negative pressure.

Electric motors are used to drive exhaust fans. To permit proper draft control, the motors are connected to the fans through a variable-speed device that can be adjusted quickly for changing conditions.

SETTLING TANKS AND STACK

Any mercury that remains in the gas from the condenser is recovered by passing the gases through wooden settling tanks or cooling towers. Recovery of mercury in the gases in the tank results from a reduction of gas velocity and a slow percolation of gas through a wetted wooden grill or baffles.

These tanks not only serve as a safety unit in the event of poor operation in the other units, but they also provide a check on the overall operation of the plant.

Gases from the tanks are wasted into the atmosphere through a wood stack placed on or beside the tank. Mercury losses in the waste gases are negligible when the temperature of the waste gas is kept below 120° F.

SOOT AND BOTTLING MACHINES

The impure mercury product obtained from the condensers, commonly known as soot or mud, is agitated with lime in soot machines to recover the mercury.

During the agitation of the soot-lime mixture in the machine—a circular pan with rotating blades and paddles—the finely divided mercury particles coalesce; liquid mercury collects in a slot at the low point of the pan and flows through a gooseneck to a mercury sump. Residue from the operation is returned to the furnace or treated in a retort for recovery of the contained mercury.

Mercury from the sump is cleaned by passing it through filters into a sump tank. From the sump tank the clean mercury is drawn into a 1-flask volumetric container and flows by gravity into a flask (fig. 15).

CONTROL AND EFFICIENCY OF OPERATION

The principal control in mercury-furnace plants is regulation of temperature and pressure throughout the system. Temperatures are automatically and continuously recorded and controlled by instruments, or determined by thermometers installed to measure gas temperatures at various points (fig. 16).

Pressures in the system are measured by draft gages that also detect changes in pressure caused by leaks or stoppages in the system.

Other operational controls include measuring the quantity, grade, and moisture content of the ore; fuel consumption; and the carbon dioxide content of the furnace gases.

With careful control of properly designed plants, mercury recovery averages 95 percent or more. The major loss of mercury occurs in the stack gases, with minor losses in the calcine, dust, and spillage. Because of the simpler system involving smaller quantities of gas, retorts are slightly more efficient than furnaces and mercury recovery usually equals or exceeds 98 percent.

ASSAYING (*18*)

The two most widely used methods of assaying for mercury employ distillation-amalgamation and distillation-titration techniques. Although both methods are accurate, the distillation-titration analytical procedure developed by the Bureau of Mines is more rapid.

In the amalgamation method, the sample is heated with fluxes to volatilize the mercury which amalgamates with silver or gold foil.

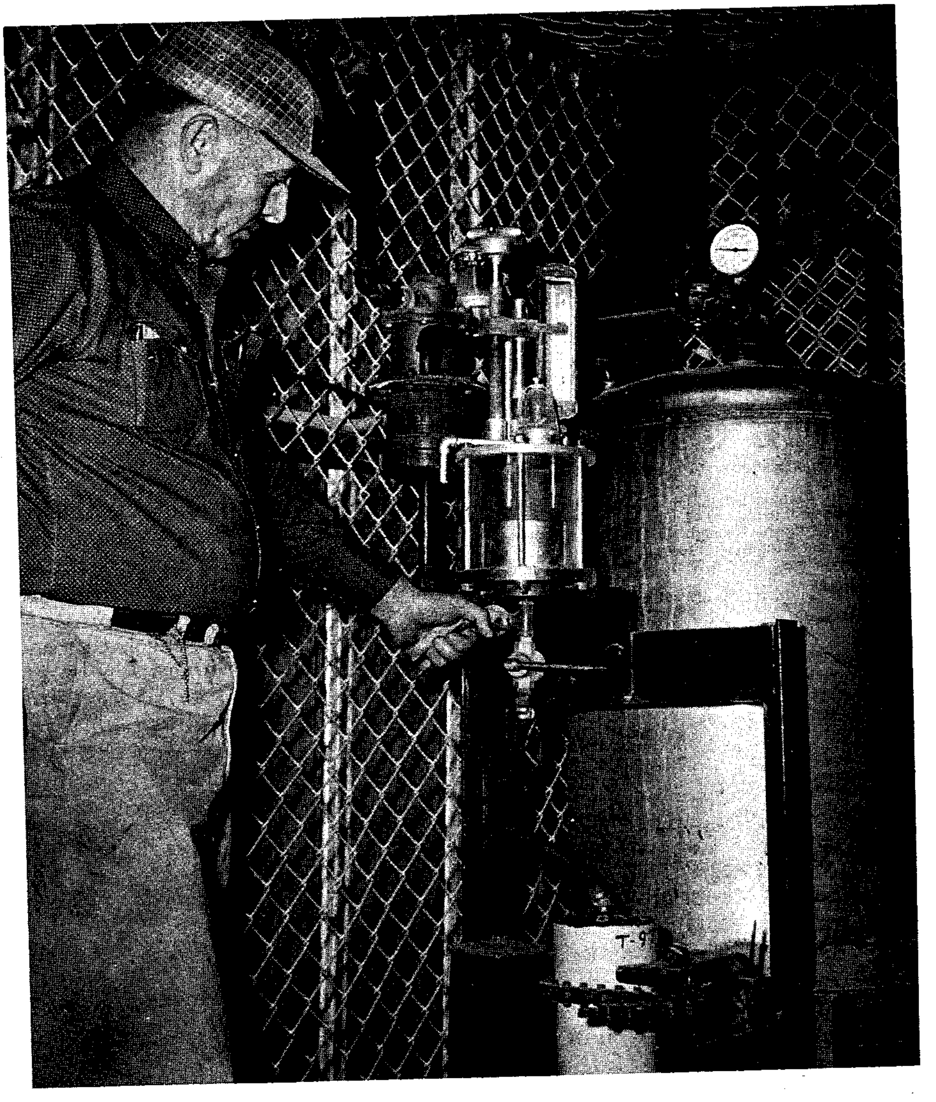

FIGURE 15.—Bottling Mercury.

(Courtesy, Rare Metals Corp. of America)

...mercury content of the material is deter-...d by weighing the foil before and after ...nalysis.

...e titration method consists of heating the ...ple in a test tube to volatilize the mer-... collecting the mercury on the upper cool ...s of the tube, dissolving the mercury with ... nitric acid, and of washing the solution ...o a beaker. Potassium permanganate is ...ded to the solution to oxidize all of the mercury to the mercuric state; peroxide is then added to the solution to destroy excess permanganate. After adding an indicator, ferric sulfate or nitrate, the solution is titrated with potassium thiocyanate to an end point having a faint pink color. When a ½-gram sample and 1/400 normal titrating solution are used, each cubic centimeter of titrating solution is equivalent to 1 pound of mercury per ton.

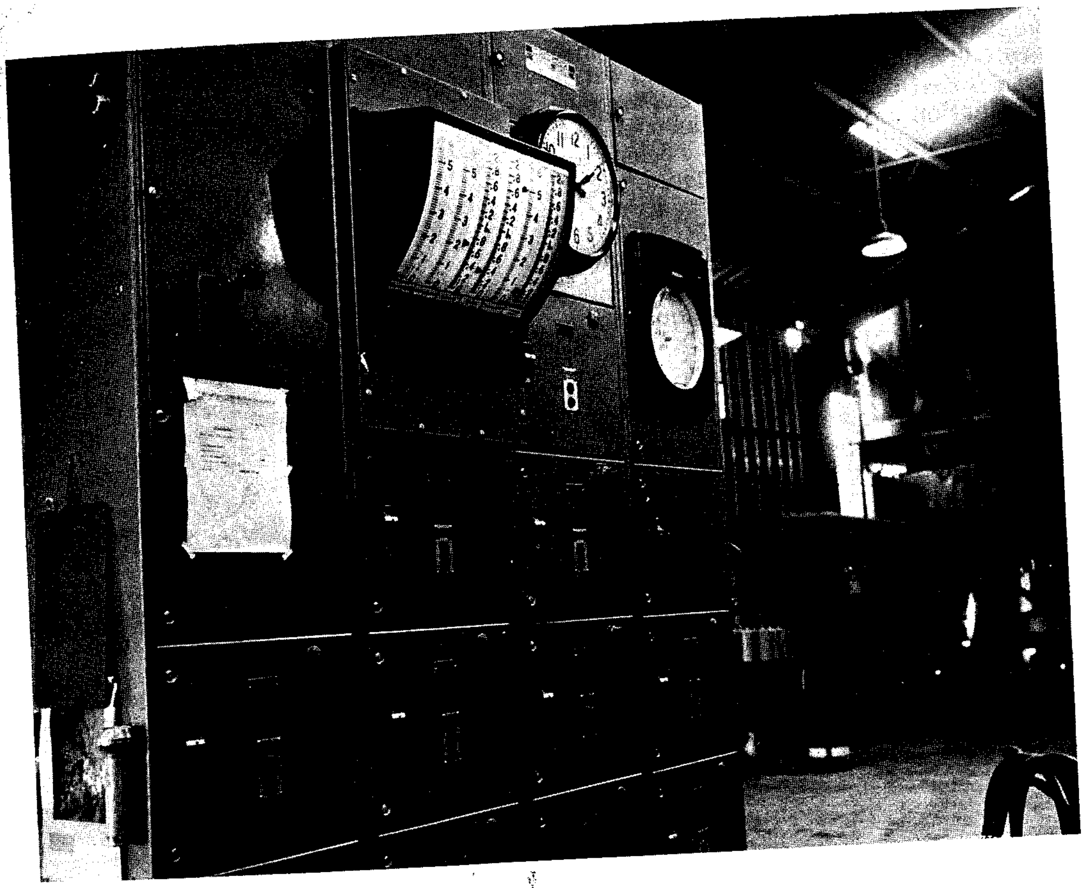

FIGURE 16.—Plant Control Panel.

(Courtesy, Rare Metals Corp. of America)

CLEANING AND PURIFICATION OF MERCURY (*27, 36, 86*)

Dust, oil, water, rust particles and other similar contaminants may be removed from mercury by filtering it through a pinhole in a paper cone, a fritted glass crucible, a cloth, or a chamois skin. Although these methods do not remove dissolved base metals, if, after filtering, the mercury has a bright clean appearance, it contains less than 1 part per million of any base metal.

Mercury can be purified by distillation, nitric-acid wash, electrolytic processes, or oxidation with air. Distillation is effective, but for complete reliability, triple distillation is necessary. The disadvantage of the nitric-acid wash is that the acid also attacks the mercury. Oxidation alone or in combination with distillation or nitric-acid wash is efficient and reliable. Noble metals such as gold, silver, and the platinum group are removed only by distillation of the mercury (fig. 17).

Removal of base metals from mercury is commonly done by washing the mercury with a solution of nitric acid containing mercurous nitrate. A little hydrogen peroxide added to the acid solution assists in the cleaning of mercury containing sulfides.

Oxidation of base-metal impurities may be accomplished by drawing air through the mercury in a heavy-walled separatory funnel, by agitating the mercury with air in rotating cylinder, or by bubbling air through the mercury during distillation.

The principal factor in any cleaning or purification process is that mercury with a bright and clean appearance contains less than 1 part per million of any base metals. In addition, unless high-purity mercury is desired, small quantities of gold, silver, and platinum group metals are not detrimental.

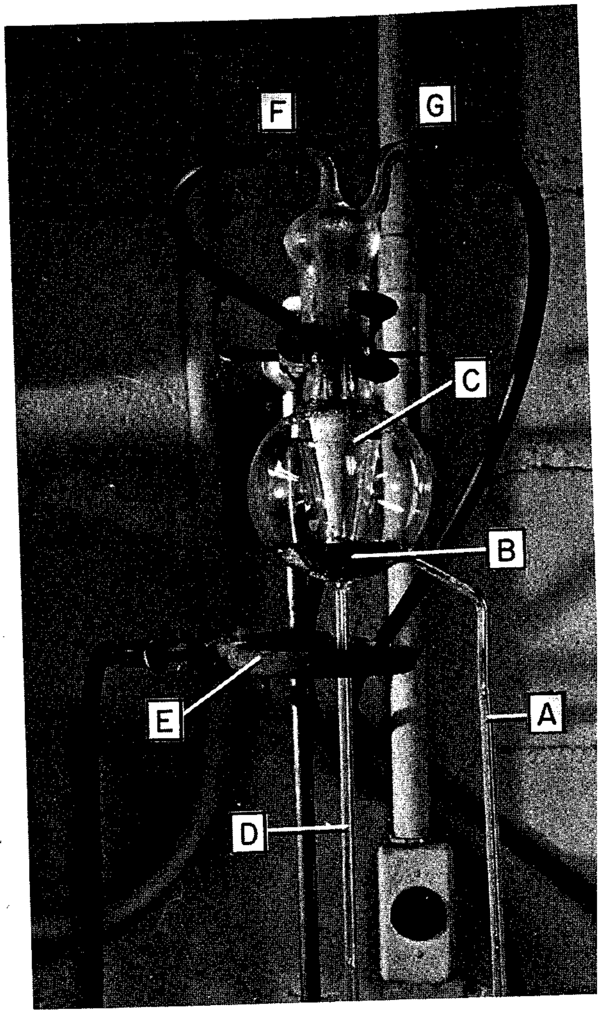

FIGURE 17.—Mercury Distallation Apparatus. (*A*—Mercury Feed Inlet, *B*—Mercury Reservoir, *C*—Condenser and Funnel, *D*—Barometric Discharge Leg, *E*—Gas Burner, *F*—Cooling Water Inlet, *G*—Cooling Water Outlet.)

(Courtesy, F. W. Berk & Co., Inc.)

CHAPTER 5. SUPPLY AND DISTRIBUTION

WORLD PRODUCTION

NORTH AMERICA

UNITED STATES

As with most metals, mercury production tends to follow prices; in figure 18 actual prices, prices adjusted by the Bureau of Labor Statistics wholesale price index, production, and consumption are compared. Four periods of high prices and three production highs are shown. Following the most recent price advances, output did not rise as in earlier years.

The first production peak was the result of increased demand and of advanced prices coinciding with World War I. The second production peak coincided with the period of high world prices established and maintained by the Spanish-Italian mercury cartel—Mercurio Europeo. World War II was responsible for the third set of price and production peaks, and the Korean war started the price uptrend that began in the latter part of 1950.

Mercury output did not respond to the most recent high prices as at the outset of World War II. Higher grade reserves had been mined in the war, and subsequent rising living costs cut the real price for the metal; moreover, domestic producers had witnessed a collapse in prices more than once in World War II, and they needed some assurance of price stability before they expanded production. Such assurance was given when the Government established a guaranteed-price Mercury Purchase program beginning July 1954 and scheduled to end December 31, 1957, and on March 21, 1957, extended to December 31, 1958. The program, described under Legislation and Government Programs, however, established the price at considerably under prevailing market levels, which were at peaks never previously attained.

During the 25-year period 1933 to 1957, inclusive, mercury production in the United States fluctuated from a high point of 52,000 flasks in 1943 (under the stimulation of war demand and high prices), the highest rate in 61 years, to a low point of 4,500 flasks in 1950 (following reduced postwar demand and prices), or to the lowest level in 100 years of recorded output.

In 1931, prior to the beginning of the 25-year period, domestic mines were experiencing their best production rate—25,000 flasks—since 1918. The large output in 1931 was a direct result of the maintenance by the international mercury cartel, beginning in 1928, of the highest prices since 1918. Under the high world prices enormous stocks accumulated, the price dropped sharply in mid-1931, and production in the United States declined to less than 10,000 flasks in 1933. In the next 6 years (1934–39) production averaged 17,000 flasks annually.

When World War II began in Europe in September 1939, prices rose sharply; production responded immediately and moved rapidly up to a total of nearly 52,000 flasks in 1943, or to the highest annual rate since 1882 (53,000 flasks). As a result of the substantial production gains, the United States produced enough mercury for its own needs in 1940 to 1942, the only years in which the United States was self-sufficient in the entire 25 years under discussion; in 1940 the United States also had a noteworthy surplus available for export.

After World War II domestic mercury prices returned to prewar levels against the general trend for commodities. The BLS wholesale price index (based on 1947–49=100) in 1948 was double that in 1939, so that the mercury price in terms of other commodities was at only half the prewar average. Because of the foregoing relationship mercury output fell from the aforementioned 20th century peak of 52,000 flasks in 1943 to 4,500 flasks in 1950—the lowest annual rate on record.

In mid-1950 when the United States became involved in war in Korea, considerable speculative buying of mercury both in and out of the United States developed. Consumption demand also expanded, and mercury prices rose to an alltime peak of \$325–\$330 a flask in early November 1954. Production trended upward without interruption from 1950, and output of 35,000 flasks in 1957 was the highest annual rate in 13 years.

Tables 6, 7, and 8 give pertinent information on mercury production in the United States from 1850 through 1957; table II shows world production from 1925–57.

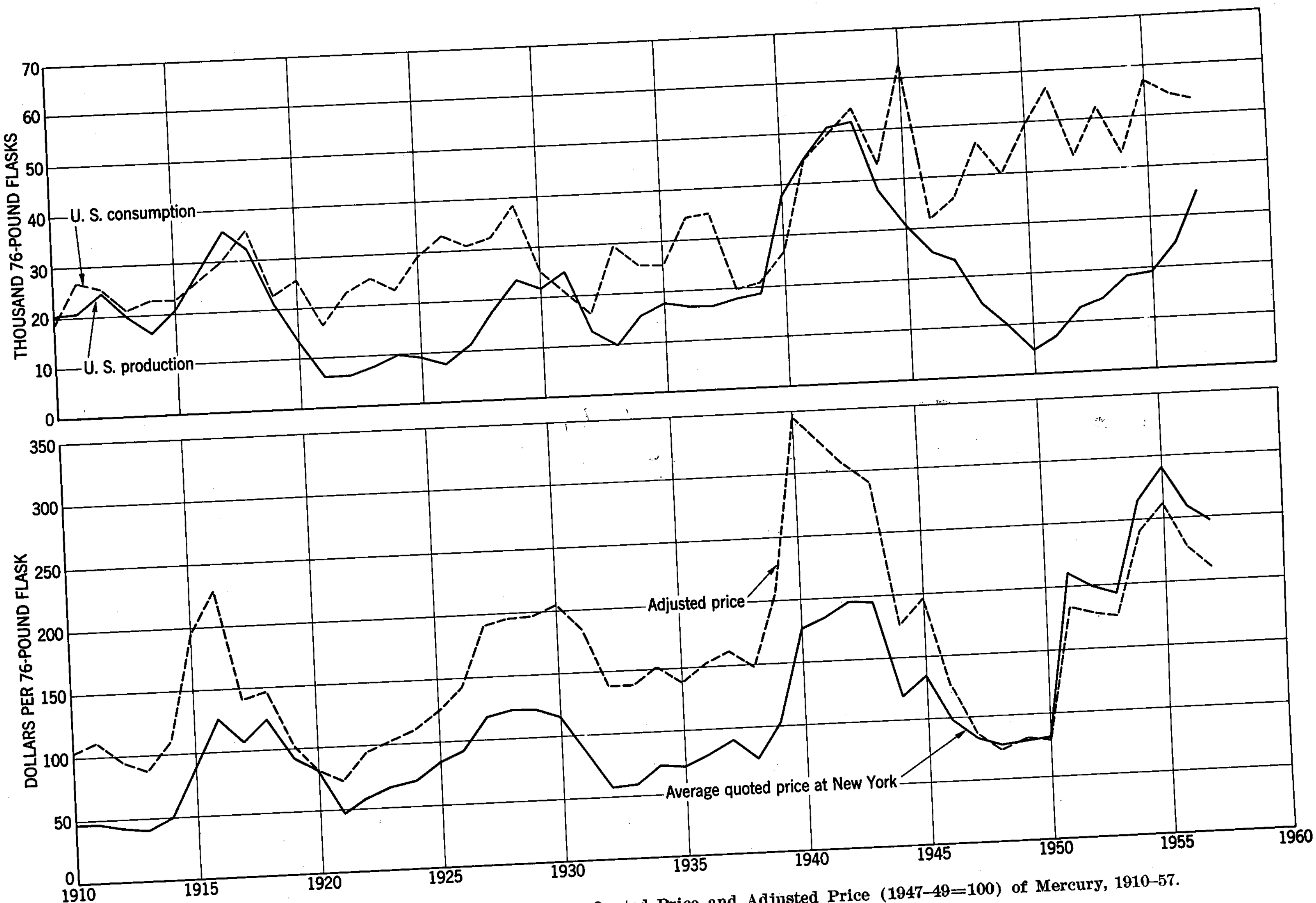

FIGURE 18.—Trends in Production, Consumption, Quoted Price and Adjusted Price (1947–49=100) of Mercury, 1910–57.

Table 6.—*Salient statistics of the mercury industry in the United States, 1910–57, in 76-pound flasks*

Year	Number of producing mines	Production: Flasks	Production: Pounds per ton of ore treated [1]	Imports for consumption (flasks)	Exports (flasks)	Apparent consumption (flasks)	Price: Average per flask at New York	Price: Adjusted by wholesale index [2]
1910	19	20, 330	12. 5	9	1, 898	18, 441	$47. 69	$104
1911	25	20, 976	11. 5	6, 209	287	26, 898	47. 16	112
1912	20	24, 734	12. 1	1, 088	306	25, 516	43. 03	96
1913	24	19, 947	11. 1	2, 259	1, 125	21, 081	40. 07	88
1914	30	16, 330	10. 1	8, 090	1, 427	22, 993	48. 95	110
1915	39	20, 756	9. 9	5, 551	3, 328	22, 979	88. 17	195
1916	66	29, 538	9. 0	5, 585	8, 763	26, 360	127. 16	229
1917	51	35, 683	9. 7	5, 138	10, 636	30, 185	107. 72	141
1918	47	32, 450	5. 9	6, 631	3, 057	36, 024	125. 12	147
1919	34	21, 133	8. 5	10, 495	8, 987	22, 641	93. 38	104
1920	17	13, 216	9. 2	13, 982	1, 533	25, 665	82. 20	82
1921	11	6, 256	12. 6	10, 462	388	16, 330	46. 07	73
1922	10	6, 291	10. 1	16, 697	287	22, 701	59. 74	95
1923	14	7, 833	11. 4	17, 836	314	25, 355	67. 39	103
1924	13	9, 952	10. 0	12, 996	205	22, 743	70. 69	111
1925	13	9, 053	10. 1	20, 580	201	29, 432	84. 24	125
1926	17	7, 541	10. 8	25, 634	114	33, 061	93. 13	143
1927	26	11, 128	8. 1	19, 941	(3)	[4] 30, 900	118. 16	191
1928	54	17, 870	7. 9	14, 562	(3)	[4] 32, 300	123. 51	196
1929	63	23, 682	6. 0	14, 917	(3)	[4] 38, 500	122. 15	197
1930	75	21, 553	4. 9	3, 725	(3)	[4] 25, 200	115. 01	205
1931	77	24, 947	6. 6	549	[5] 4, 984	20, 512	87. 35	184
1932	95	12, 622	8. 3	3, 886	[5] 214	16, 294	57. 93	138
1933	75	9, 669	8. 2	20, 315	(3)	[4] 29, 700	59. 23	138
1934	93	15, 445	8. 2	10, 192	(3)	[4] 25, 400	73. 87	152
1935	90	17, 518	8. 6	7, 815	(3)	[4] 25, 200	71. 99	138
1936	87	16, 569	7. 5	18, 088	263	34, 400	79. 92	152
1937	101	16, 508	6. 6	18, 917	454	35, 000	90. 18	161
1938	91	17, 991	6. 8	2, 362	713	19, 600	75. 47	148
1939	107	18, 633	7. 3	3, 499	1, 208	20, 900	103. 94	207
1940	159	37, 777	6. 3	171	9, 617	[6] 26, 800	176. 87	346
1941	197	44, 921	5. 1	7, 740	2, 590	[6] 44, 800	185. 02	326
1942	184	50, 846	5. 1	[7] 38, 941	[7] 345	[6] 49, 700	196. 35	306
1943	146	51, 929	6. 3	[7] 47, 805	[7] 385	[6] 54, 500	195. 21	291
1944	102	37, 688	9. 4	19, 553	750	[6] 42, 900	118. 36	175
1945	68	30, 763	10. 8	68, 617	1, 038	[6] 62, 429	134. 89	196
1946	51	25, 348	12. 0	13, 894	907	[6] 31, 552	98. 24	125
1947	37	23, 244	12. 5	13, 008	884	[6] 35, 581	83. 74	87
1948	20	14, 388	10. 2	31, 951	526	[6] 46, 253	76. 49	73
1949	23	9, 930	10. 3	103, 141	577	[6] 39, 857	79. 46	80
1950	16	4, 535	9. 3	56, 080	447	[6] 49, 215	81. 26	79
1951	47	7, 293	6. 5	47, 860	241	[6] 56, 848	210. 13	183
1952	39	12, 547	7. 0	71, 855	400	[6] 42, 556	199. 10	178
1953	49	14, 337	7. 8	83, 393	546	[6] 52, 259	193. 03	175
1954	71	18, 543	8. 1	64, 957	890	[6] 42, 796	264. 39	240
1955	98	18, 955	6. 4	20, 354	451	[6] 57, 185	290. 35	262
1956	147	24, 177	7. 5	47, 316	1, 080	[6] 54, 143	259. 92	227
1957	120	34, 625	8. 4	42, 005	1, 919	[6] 52, 889	246. 98	210

[1] Excludes furnace cleanup, tailings, placer mercury, and a substantial part of the dump material treated in most years.
[2] Quoted price divided by Bureau of Labor Statistics wholesale price index (1947–49=100).
[3] Not separately classified for 1927–30 and 1933–35.
[4] Estimated by Bureau of Mines.
[5] From a special compilation, Bureau of Foreign and Domestic Commerce.
[6] Actual consumption.
[7] Large quantities reexported in 1942 and 1943 are included in imports, but not exports.

TABLE 7.—*Production of mercury in the United States, 1850–1957, by States, in 76-pound flasks*

Year	Alaska	Arizona	Arkansas	California	Idaho	Nevada	Oregon	Texas	Utah	Washington	Other [1]	Total
1850				7,773								7,773
1851				27,962								27,962
1852				20,132								20,132
1853				22,431								22,431
1854				30,201								30,201
1855				33,217								33,217
1856				30,197								30,197
1857				28,390								28,390
1858				31,204								31,204
1859				13,086								13,086
1860				10,066								10,066
1861				35,230								35,230
1862				42,276								42,276
1863				40,798								40,798
1864				47,801								47,801
1865				53,349								53,349
1866				46,856								46,856
1867				47,309								47,309
1868				48,042								48,042
1869				34,033								34,033
1870				30,275								30,275
1871				31,894								31,894
1872				31,829								31,829
1873				27,824								27,824
1874				27,939								27,939
1875				50,581								50,581
1876				73,194								73,194
1877				79,917								79,917
1878				64,300								64,300
1879				74,169								74,169
1880				60,320								60,320
1881				61,251								61,251
1882				53,079								53,079
1883				47,032								47,032
1884				32,123								32,123
1885				32,284								32,284
1886				30,178								30,178
1887				33,983			65					34,048
1888				33,469								33,469
1889				26,658								26,658
1890				23,077								23,077
1891				23,055								23,055
1892				28,177								28,177
1893				30,362								30,362
1894				30,616								30,616
1895				36,304								36,304
1896				30,967								30,967
1897				26,867								26,867
1898				31,297								31,297
1899				29,647				1,007				30,654
1900				26,490			201	1,812				28,503
1901				26,896			76	2,951				29,923
1902				29,163				5,354				34,517
1903				30,727		65		5,062	14			35,868
1904				29,073		17		5,310	741			35,141
1905				24,311			42	4,661	1,118			30,132
1906				20,043			3	4,698	996			25,740
1907				17,202				3,637	431			21,270
1908		(2)		16,760			(2)	2,351			381	19,492
1909				15,866		312	487	4,133				20,798
1910				16,985		69		3,276				20,330
1911				18,612		69		2,295				20,976
1912				20,254		2,516		1,964				24,734
1913		224		15,386		1,623		2,714				19,947
1914		11		11,154		2,062		3,103				16,330
1915		(2)		14,095		2,296	(2)	4,359			6	20,756
1916		5		20,768		2,169	299	6,223		74		29,538
1917		39		23,623	5	984	383	10,649				35,683
1918				22,366	21	1,030	693	8,340				32,450
1919				15,005		746	429	4,953				21,133
1920				9,719		82	24	3,391				13,216
1921				3,015	1	(2)	(2)	(2)			3,240	6,256
1922				3,360		(2)	2	(2)			2,929	6,291
1923				5,375	(2)	(2)	(2)	(2)			2,458	7,833
1924		(2)		7,861	(2)	(2)	(2)	(2)			2,091	9,952
1925		30		7,514	(2)	532		(2)			977	9,053
1926	(2)	(2)		5,651	6	194		(2)		482	1,208	7,541
1927	(2)	(2)		5,672		419	2,055	(2)		559	2,423	11,128
1928		(2)		6,977		2,867	3,710	(2)		(2)	4,316	17,870
1929	(2)	(2)		10,139		4,764	3,657	(2)		1,397	3,725	23,682
1930	(2)	(2)		11,451		3,282	2,919	(2)		1,079	2,822	21,553
1931	(2)	(2)	(2)	13,448		2,217	5,011	(2)		560	3,711	24,947
1932	(2)	(2)	(2)	5,172		474	2,523	(2)		407	4,046	12,622
1933			(2)	3,930		387	1,342	(2)	(2)	(2)	4,010	9,669
1934		(2)	488	7,808		300	3,460	(2)		330	3,059	15,445
1935		(2)	304	9,271		190	3,456	(2)		106	4,191	17,518
1936		(2)	(2)	8,693		211	4,126	(2)	25	(2)	3,514	16,569
1937		37	(2)	9,743		198	4,264	(2)		(2)	2,266	16,508
1938	(2)		(2)	12,277		336	4,610	(2)		(2)	768	17,991
1939		(2)	364	11,127	(2)	828	4,592	(2)			1,722	18,633
1940	162	740	1,159	18,629	(2)	5,924	9,043	(2)	53	(2)	2,067	37,777
1941	(2)	873	2,012	25,714	(2)	4,238	9,032	(2)	19	(2)	3,033	44,921
1942	(2)	701	2,392	29,906	(2)	5,201	6,935	(2)	(2)	(2)	5,711	50,846
1943	786	541	1,532	33,812	4,261	4,577	4,651	1,769				51,929

See footnotes at end of table.

TABLE 7.—*Production of mercury in the United States, 1850–1957, by States, in 76-pound flasks*—Con.

Year	Alaska	Arizona	Arkansas	California	Idaho	Nevada	Oregon	Texas	Utah	Washington	Other[1]	Total
1944	(2)	548	191	28, 052	(2)	2, 460	3, 159	1, 095	----------	----------	2, 183	37, 688
1945	(2)	(2)	(2)	21, 199	627	4, 338	2, 500	(2)	----------	----------	2, 099	30, 763
1946	699	95	11	17, 782	868	4, 567	1, 326	----------	----------	----------	----------	25, 348
1947	127	----------	----------	17, 165	886	3, 881	1, 185	----------	----------	----------	----------	23, 244
1948	100	----------	----------	11, 188	543	1, 206	1, 351	----------	----------	----------	----------	14, 388
1949	100	----------	----------	4, 493	----------	4, 170	1, 167	----------	----------	----------	----------	9, 930
1950	----------	----------	----------	3, 850	----------	680	5	----------	----------	----------	----------	4, 535
1951	----------	(2)	----------	4, 282	357	1, 400	1, 177	(2)	----------	----------	77	7, 293
1952	28	----------	----------	7, 241	887	3, 523	868	----------	----------	----------	----------	12, 547
1953	40	----------	----------	9, 290	(2)	3, 254	648	(2)	----------	----------	1, 105	14, 337
1954	1, 046	163	----------	11, 262	609	4, 974	489	----------	----------	----------	----------	18, 543
1955	(2)	477	----------	9, 875	1, 107	5, 750	1, 056	(2)	----------	----------	690	18, 955
1956	3, 280	(2)	----------	9, 017	3, 394	5, 859	1, 893	(2)	----------	----------	734	24, 177
1957	5, 461	28	----------	16, 511	2, 260	6, 313	3, 993	(2)	----------	(2)	59	34, 625

[1] Includes States shown as "(2)".
[2] Included with "Other." Bureau of Mines not at liberty to publish separately.

TABLE 8.—*Production of mercury in the United States, 1850–1957, by periods and States, and percent of United States total, in 76-pound flasks*

	1850–1932		1933–1957		1953		1954	
	Flasks	Percent	Flasks	Percent	Flasks	Percent	Flasks	Percent
Alaska	122	----------	14, 282	2. 49	40	0. 28	1, 046	5. 64
Arizona	2, 272	0. 09	4, 505	. 79	----------	----------	163	. 88
Arkansas	329	. 01	11, 075	1. 93	----------	----------	----------	----------
California	2, 353, 154	92. 67	342, 117	59. 58	9, 290	64. 80	11, 262	60. 74
Idaho	50	----------	24, 353	4. 24	(1)	(1)	609	3. 28
Nevada	29, 983	1. 18	74, 765	13. 02	3, 254	22. 70	4, 974	26. 82
Oregon	22, 983	. 91	76, 328	13. 29	648	4. 52	489	2. 64
Texas	121, 260	4. 78	25, 877	4. 51	(1)	(1)	----------	----------
Utah	3, 300	. 13	109	. 02	----------	----------	----------	----------
Washington	5, 845	. 23	768	. 13	----------	----------	----------	----------
Undistributed	----------	----------	----------	----------	1, 105	7. 70	----------	----------
	2, 539, 298	100. 00	574, 179	100. 00	14, 337	100. 00	18, 543	100. 00

	1955		1956		1957		Total 1850–1957	
	Flasks	Percent	Flasks	Percent	Flasks	Percent	Flasks	Percent
Alaska	(1)	(1)	3, 280	13. 57	5, 461	15. 77	14, 404	0. 46
Arizona	477	2. 52	(1)	(1)	28	. 08	6, 777	. 22
Arkansas	----------	----------	----------	----------	----------	----------	11, 404	. 37
California	9, 875	52. 10	9, 017	37. 30	16, 511	47. 69	2, 695, 271	86. 57
Idaho	1, 107	5. 84	3, 394	14. 04	2, 260	6. 53	24, 403	. 78
Nevada	5, 750	30. 33	5, 859	24. 23	6, 313	18. 23	104, 748	3. 36
Oregon	1, 056	5. 57	1, 893	7. 83	3, 993	11. 53	99, 311	3. 19
Texas	(1)	(1)	(1)	(1)	(1)	(1)	147, 137	4. 73
Utah	----------	----------	----------	----------	----------	----------	3, 409	. 11
Washington	----------	----------	----------	----------	(1)	(1)	6, 613	. 21
Undistributed	690	3. 64	734	3. 03	59	. 17	----------	----------
	18, 955	100. 00	24, 177	100. 00	34, 625	100. 00	3, 113, 477	100. 00

[1] Included under "Undistributed." Bureau of Mines not at liberty to publish separately.

Alaska

Most of the mercury produced in Alaska has come from the Red Devil and Decoursey Mountain mines in the Sleitmute and Decoursey Mountain area of Southwestern Alaska. During part of World War II these two mines operated under contracts with the Metals Reserve Co. They closed when the contracts terminated in 1944, but they later resumed operations and produced intermittently thereafter. Although reported production in Alaska began in 1926, it was small and sporadic until 1940. From 1940 to 1949, inclusive, production was continuous and averaged about 450 flasks annually. Alaskan mines were idle in 1950 and 1951, resumed output in 1952, and produced 1,046 flasks in 1954, second only to the previous record output in 1945.

The plant, camp buildings, and mill at the Red Devil mine were destroyed by fire in October 1954. Production in Alaska thus was sharply curtailed in 1955, but new construction was virtually completed at the yearend, and operations were resumed in March 1956. Alaskan output reached a new peak in 1956 when 3,280 flasks were produced; however, the 1957 production of 5,500 flasks established a new record.

Arizona

Virtually all of the mercury produced thus far in Arizona has come from deposits in the Mazatzal Range, on the northeastern boundary between Maricopa and Gila Counties, and from the Dome Rock Mountains, Yuma County; production also has come from the Phoenix Mountains, Maricopa County. Mercury also occurs in Copper Basin, southwest of Prescott, Yavapai County, and it has been noted in Pima County.

Recorded production began in 1908 at a mine near Quartzite, Yuma County. Output in the Mazatzal Range began in 1913. Production in Arizona, except in 1913, did not exceed 100 flasks in any year until 1928, and the State's largest total was recorded in 1929 when output was entirely from Gila and Maricopa Counties. Output was sporadic after 1929 and until 1940. During World War II years, on the other hand, Arizona had its most consistent production. In 1940–44 output averaged nearly 700 flasks annually. Only a few flasks were recovered in 1947 to 1953, inclusive. Mines in Gila and Maricopa Counties were active again in 1954 and 1955, accounting for outputs of 163 and 477 flasks, respectively, and small quantities were reported in 1956 and 1957.

Arkansas

Cinnabar was discovered near the southern border of the Ouachita Mountains in southwestern Arkansas in 1930 (*23*).

The mercury deposits lie in a narrow belt, 26 miles long and about 6 miles in maximum width, which extends from eastern Howard County across Pike County and into western Clark County. The first output in 1931 was very small. Thereafter, production was continuous through 1946, in which year the quantity produced was again exceedingly small. There has been no production since 1946. The record annual rate was 2,400 flasks in 1942. Pike County deposits were more numerous than those of other counties and produced more mercury than the others; the county was productive in every year in the State's period of activity. Howard County produced in 1934 and 1935 and Clark County in every year 1938 to 1945, inclusive.

California

A little mercury was produced in California before 1850, but the continuous record for the State covers the period beginning in 1850 only. From then and for nearly 50 years, California's output virtually represented the United States total (table 9). The historical record shows that Oregon produced a small amount of mercury in 1887, that Texas began a long period of production in 1899, and that no other State was productive up to that time. Before 1864 most of the mercury was used in placer gold mining, but in the next five years mercury was in demand for gold-quartz mining and hydraulic mining (*18*). California's peak output of nearly 80,000 flasks in 1877 coincided with the height of hydraulic mining.

The declining production in California and the United States, except in emergency periods, was caused by a number of factors, in-

TABLE 9.—*Role of California in U.S. mercury production, 1880–1957, by decades, in 76-pound flasks* [1]

Decade	California (flasks)	Percent of U.S. total	United States (flasks)
1880–89	41, 000	100	41, 000
1890–99	29, 000	100	29, 100
1900–09	23, 700	84	28, 100
1910–19	17, 800	74	24, 200
1920–29	6, 500	58	11, 300
1930–39	9, 300	54	17, 100
1940–49	20, 800	64	32, 700
1950–57	8, 900	53	16, 900

[1] Annual average.

ing falling requirements for gold and silver production, exhaustion of some of the largest and richest mercury reserves in domestic mines, and expansion of production from higher grade and more extensive reserves in other areas in the world, principally Spain and Italy.

California's output from 1850 to 1929, inclusive, totaled 2,323,000 flasks. The leading mines in that period were as follows:

Mine	*County*
New Almaden	Santa Clara
New Idria	San Benito
Oat Hill	Napa
Knoxville	Do.
Guadalupe	Santa Clara
Great Western	Lake
Sulphur Bank	Do.
Aetna	Napa
Great Eastern (including Mt. Jackson).	Sonoma
Oceanic	San Luis Obispo
Mirabel	Lake
Altoona	Trinity
St. John (Vallejo)	Solano
Klau (Carson)	San Luis Obispo
Cloverdale	Sonoma
Abbott	Lake

Those 16 mines accounted for 96 percent of California's total production in 1850 to 1929, inclusive. Thereafter, most of them continued to be important producers. From 1930 to 1957, inclusive, the following 20 mines, listed in order of output, accounted for 92 percent of California's total output of 372,000 flasks:

Mine	*County*
New Idria (including San Carlos)	San Benito
Mt. Jackson (including Great Eastern).	Sonoma
Sulphur Bank	Lake
Abbott	Do.
Reed	Yolo
New Almaden	Santa Clara
Mirabel	Lake
Oceanic	San Luis Obispo
Mt. Diablo	Contra Costa
Oat Hill	Napa
Klau (Carson)	San Luis Obispo
Buckman Group (including Culver Baer) formerly Cloverdale.	Sonoma
Guadalupe	Santa Clara
Knoxville	Napa
Great Western	Lake
Mahoney (Buena Vista)	San Luis Obispo
Altoona	Trinity
Contact and Socrates	Sonoma
Rinconada	San Luis Obispo
Aetna	Napa

Twenty-nine counties have produced some mercury; these are: Colusa, Contra Costa, Del Norte, El Dorado, Fresno, Inyo, Kern, Kings, Lake, Marin, Mendocino, Merced, Modoc, Mono, Monterey, Napa, Orange, San Benito, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Shasta, Siskiyou, Solano, Sonoma, Stanislaus, Trinity and Yolo. In addition, occurrences of mercury have been reported in Almeda, Alpine, Calaveras, Glenn, Humboldt, Los Angeles, Mariposa, Nevada, San Bernardino, San Francisco, and Tuolumne Counties.

Idaho

Recorded production of mercury in Idaho began when a small quantity was produced in 1917. Output was negligible and sporadic through 1926 and was confined to the Yellow Pine district, Valley County. There was no production in the State in 1927 to 1938, inclusive. Output, however, started on a considerably larger scale in 1939 and has continued, except for 1949 and 1950, to the present. From 1917 through 1926 output averaged only 5 flasks annually; from 1939 to 1957, inclusive, on the other hand, it averaged 1,300 flasks annually.

The Idaho-Almaden mine, 11 miles west of Weiser, Washington County, was discovered in 1936, began to produce in 1939, and was closed in 1942. A large furnace was installed at the Hermes mine, Yellow Pine district, in 1941 and produced first in early 1942. The Hermes mine produced nearly 4,300 flasks in 1943 and ranked second among mercury-producing properties in the United States in that year. This output also was the largest annual quantity produced thus far in Idaho. The mine, renamed Cinnabar, was closed in August 1956 because of a fire. The Idaho-Almaden resumed production in 1955.

Nevada

Since 1945 Nevada has ranked next to California in mercury production in every year except 1948, when Oregon temporarily regained second position. Unlike California, however, where the same mines usually were dominant, the several periods of expanded output in Nevada usually resulted from new or increased production at different mines. The periods of expanded output roughly coincided with the peaks for the United States as a whole.

First recorded production occurred in 1903 and 1904; since 1909 production in the State has been uninterrupted. Output of slightly over 2,500 flasks in 1912 was the peak until 1928. The major part of the State's relatively high quantities in the 5-year period beginning 1912 was from the Mercury Mining Co. and Nevada Cinnabar mines in the Union district south of Ione, Nye County. The former mine produced 7,290 flasks (*38*) and the latter 4,136 flasks to the end of 1943. Production at the two properties since 1925 has been relatively small.

Nevada's output dropped from an annual average of 2,100 flasks in 1912 to 1916, inclusive, to 350 flasks in 1919 to 1927, inclusive, and rose to nearly 3,300 flasks in 1928 to 1931, inclusive. Chiefly responsible for this period of large output were the following mines in order of importance:

Mine	*County*
Juniper (Nevada Quicksilver including Montgomery).	Pershing
B & B	Esmeralda
Pershing	Pershing
Castle Peak	Storey
Red Rock	Esmeralda

Output was low in the thirties but rose again in response to the high prices that came with the beginning of World War II in Europe. An alltime peak of 5,900 flasks was established in 1940 and output averaged 4,400 flasks annually in 1940 to 1947, inclusive. Principal producers in this period were, in order of importance, as follows:

Mine	*County*
Cordero	Humboldt
Pershing	Pershing
Red Bird	Do.
Blue Can & Baldwin	Humboldt
Blue Bird	Do.
Mina Mercury	Mineral
Mt. Tobin	Pershing
Silver Cloud	Elko
Wild Horse	Churchill
White Peak (including Red Ore)	Humboldt
Red Rock	Esmeralda
Cahill	Humboldt

These 12 mines accounted for 90 percent of the State's total for the period, and the remainder came from a large number of smaller mines. The Cordero mine began to produce in 1941; from then on it produced more than any other mine in Nevada; from 1945 on it accounted for 80 to 100 percent annually of the State total and never ranked below fourth in the United States as a whole. In 1949, 1952, 1955, and 1956 it ranked first in output in the United States.

The following counties have been productive: Churchill, Elko, Esmeralda, Eureka, Humboldt, Lander, Lincoln, Mineral, Nye, Pershing, Storey, and Washoe. Occurrences have been noted also in Clark, Ormsby, and White Pine counties. Output of 6,300 flasks in 1957 established a new peak.

Oregon

Outside of California the first recorded production in the United States was in Oregon in 1887. Activity was irregular thereafter until 1915 when continuous production began and was interrupted only by the inactivity of 1925 and 1926. Until 1927 no more than 700 flasks had been produced in a single year. From 1927 to 1945, inclusive, on the other hand, output fell below 2,000 flasks only in 1933 (1,300 flasks) and reached a peak of over 9,000 flasks in 1940 and 1941. In these 19 years five mines dominated production, with 96 percent of the total for the State. They were, in order of output:

Mine	*County*
Bonanza	Douglas
Opalite	Malheur
Horse Heaven	Jefferson
Black Butte	Lane
Bretz	Malheur

Four of the mines produced little metal in most of the period since 1945. The Bonanza has been the leading producer in Oregon since 1939, except in 1950 when it was idle. The Bonanza produced 24,471 flasks (*64*) from 1937 to 1944, inclusive, and not more than 2,000 flasks before 1937. From 1946 to 1953, inclusive, Bonanza accounted for more than 90 percent of Oregon's output, and from 1954 to 1956, inclusive, it produced more than half of the State's total. The Horse Heaven mine produced 15,097 flasks (*65*) in 1934 to 1944, inclusive. The Opalite district, in Malheur County, Oreg., and Humboldt County, Nev., produced 22,174 flasks of mercury from 1927 to 1940, inclusive, nearly all of which came from the Opalite and Bretz mines (*33*). This period was the most productive, thus far, in the Oregon part of the district. It is estimated that Black Butte had produced more than 13,000 flasks of mercury to the end of 1938 (*24*). In the next 3 years more than 1 thousand flasks were produced. The Bretz mine, inactive since 1944, produced in 1956 and 1957.

Counties in Oregon that have produced mercury are as follows: Clackamas, Crook, Douglas, Grant, Harney, Jackson, Jefferson, Josephine, Lake, Lane, and Malheur. Occurrences have been noted in Baker, Coos, Curry, Multnomah, Tillamook, and Wheeler counties.

Texas

Forty-seven years of continuous, important mercury production began in Texas in 1899. Output was slightly over 1,000 flasks in that year, rose to a peak of 10,600 flasks in 1917, and in the 47-year period fell below 1,000 flasks in only 5 years. There was no output in 1946 to 1950, inclusive, and thereafter it was small and irregular until it was expanded in 1955. Despite the fact that Oregon passed Texas in annual production in 1936 and Idaho and Nevada passed Texas in 1939, in total output through 1957, Texas ranked second only to California. California's total to the end of

56, however, was more than 18 times that Texas; Texas' total was about 1½ times that of Oregon.

Most of the mercury was from the Terlingua district, Brewster County, but some also came from Presidio County.

Leading producer to the end of 1957, by a substantial margin, was the Chisos mine, Brewster County. This mine started to produce about 1902 and, according to the best information available, produced nearly 60 percent of the total. This mine operated uninterruptedly until 1945, and has not produced since then. Next in importance in total production was the Mariposa mine in the western part of the Terlingua district, which was the first mine to produce a substantial quantity and whose early production coincided with the first recorded output for the State, 1899.

The Mariposa mine produced without interruption for 11 years and accounted for nearly 20 percent of the State total from 1899 to 1910. Estimates (*19*) place the Mariposa production between 17,000 and 30,000 flasks during this period. It produced thereafter only in 1916 to 1918, inclusive, and then in small quantities only. Next in total production was the Big Bend mine at Study Butte, Brewster County, which produced from 1916 to 1920, and almost continuously from 1928 through 1944. Inactive from 1945 to 1954, inclusive, the mine resumed production in 1955. The Rainbow mine just west of the Chisos mine, ranked next to the Big Bend in total output. It produced in 1919 and again continuously from 1929 through 1942. Together the Big Bend and the Rainbow produced nearly 15 percent of the Texas total. The Fresno mine, Presidio County, ranked fifth in Texas in total output and produced in 1940 to 1944, inclusive, and again in 1955. A number of smaller mines also produced from time to time through the years.

Utah

Utah produced mercury from 1903 through 1907, and again in 1933, 1936, and 1940 to 1942, inclusive. Virtually all of the early production, which represents 97 percent of the total thus far for the State, came from the Sacramento gold mine at Mercur, Tooele County, and from the sulphoselenide ores near Marysvale, Piute County. Later small and sporadic production came from the Sacramento mine and from two small properties near Ibapah, also in Tooele County.

Washington

All of the mercury production in Washington came from near Morton, Lewis County. Output began in 1916, when 74 flasks were produced by the Morton mine. There was no production in the State from 1917 to 1925, inclusive. The most productive period began in 1926 and continued, except for 1939, through 1942. Peak annual output was nearly 1,400 flasks in 1929. No production occurred from 1942 until 1957, when a small quantity was reported. Principal producers to date have been the Morton (Fisher) and Barnum-McDonnell mines, which accounted for 97 percent of the total output from the beginning of operations through 1957.

Secondary Mercury

Few researchers have cared to reclaim mercury from scrap, chiefly because mercury scrap has not been available in large enough quantities to have much commercial value. Reclamation processes are known, however, and scrap has been reclaimed on a relatively small scale for many years. The quantities of scrap or dirty mercury available for treatment are increasing, and in recent years accounted for a significant part of the domestic supply. Virtually all metal can be reclaimed from mercury cells, mercury boilers, electrical apparatus, and control instruments, when the plant or equipment is dismantled or scrapped.

Prior to 1954 data on secondary mercury excluded metal reclaimed from scrapped and dismantled plants and other scrap if such metal could be identified and excluded also from consumption data. Beginning in 1954 all secondary mercury data were included in Bureau of Mines statistics.

Secondary mercury production for 1946–53, inclusive, (table 10), was reclaimed from battery scrap, dental amalgams, and sludges from electrolytic processes that use mercury as a catalyst. In subsequent years the data included mercury recovered from dismantled plants and equipment. Secondary production in each of the three years (1954–56, inclusive) was greater than the output from any individual United States mine and represented 19 to 35 percent of total domestic production.

TABLE 10.—*Production of secondary mercury*[1] *in the United States, 1946–57, in 76-pound flasks*

Year	Flasks	Year	Flasks
1946	4,000	1952	2,50
1947	3,500	1953	2,80
1948	2,170	1954	6,10
1949	1,385	1955	10,03
1950	2,000	1956	5,85
1951	2,000	1957	5,80

[1] Until 1954 covers only that metal produced from scrap that could n be excluded because its identity as such was lost following sale.

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CANADA

Except for small quantities produced from a deposit near Kamloops Lake, British Columbia, in 1895–97 and again in 1926, and for even smaller quantities from a Bridge River deposit in 1938 and 1939, Canada was not a source of mercury until 1940. Development of a mine at Pinchi Lake, British Columbia, resulted in important production beginning in 1940. Another mine, on Silver Creek east of Takla Lake, also in British Columbia, began to produce in November 1943. During part of World War II both properties were operated under contracts with the United States Metals Reserve Co. Canada's output rose from 6 flasks in 1939 to 2,000 flasks in 1940, and continued to rise sharply until the annual peak of over 22,000 flasks was established in 1943. Production fell to less than 10,000 flasks in 1944, when both mines closed, owing to termination of Metals Reserve Co. contracts and reduced demand and prices. During much of the war the Pinchi Lake mine was the leading mercury-producing mine in the Western Hemisphere. Total Canadian production from 1940 to 1944, inclusive, was 54,600 flasks. No metal was produced after 1944, and the alltime total probably does not exceed 55,000 flasks.

MEXICO

From 1896 to 1920 inclusive, Mexico produced 125,000 flasks of mercury, or an average of 5,000 flasks a year. The largest annual output in the period was 10,000 flasks in 1898, and the smallest was 1,000 flasks in 1917. From 1920 to 1926, output averaged 1,225 flasks annually and was largely from dumps of the old metallurgical works of Patio, Pachuca, Hidalgo, Fresnillo, Zacatecas, and Guanajuato.

From 1921 to 1957, inclusive, production totaled 363,000 flasks, and averaged 9,800 flasks annually by 1940. Output ranged from nearly 12,000 to over 31,000 in 1940–46 and was influenced by high demand and prices during World War II; it dropped to a low of 3,800 flasks in 1950, when prices for mercury moved against the trend of prices in general and returned to prewar levels. In the period of high prices in 1955, mercury output returned to 30,000 flasks.

The major mercury districts in Mexico (*40*) are Huitzuco and Huahuaxtla, Guerrero; Nuevo Mercurio, Sain Alto, and Canoas, Zacatecas; and Cuarenta, Durango.

The Huitzuco district was discovered in 1869 and yielded about 72,000 flasks of mercury and a large quantity of antimony before closing in 1944.

The Nuevo Mercurio district, discovered in 1940, was the most productive mercury district in Mexico, and one of the most productive in the Western Hemisphere, with a monthly production that averaged 600 flasks or more and at times exceeded 1,000 flasks. At Nuevo Mercurio there were 16 principal mines, about 50 smaller mines, and about 200 prospects. At one time over 900 retort tubes were in operation, but these were replaced during late 1942 and early 1943 by four 40-ton Herreshoff furnaces. Shortly thereafter a 100-ton Herreshoff furnace and a half dozen units of a newly developed furnace, called the Manfrino furnace, were added.

The Cuarenta district, discovered in 1932, reached a peak monthly output of about 300 flasks from 1940 to 1943. The district had produced about 15,000 flasks by August 1943. The Sain Alto district produced about 200 flasks a month in the forties.

Cinnabar was discovered in the Huahuaxtla district about 1923 (*49*); about 8,700 flasks were produced through 1939, and almost half as much (3,700 flasks) from 1940 to 1944, inclusive. The Canoas deposits were discovered about 1878 and thereafter produced about 30,000 flasks to the spring of 1944 (*70*).

CENTRAL AMERICA AND WEST INDIES

Small quantities of mercury were produced in 1945 and 1951 at Talanga, about 30 miles from Tegucigalpa, Honduras. Occurrences of mercury have been reported in Guatemala, Panama, the Dominican Republic, and Haiti.

SOUTH AMERICA

In South America, mercury deposits are known in Argentina, Bolivia, Brazil, British Guiana, Chile, Colombia, Ecuador, Peru, Venezuela, Dutch Guiana, Paraguay, and Uruguay. Production, however, has come almost entirely from Peru and Chile.

CHILE

Quicksilver has been mined intermittently in Chile (*59*) since the end of the 18th century, but only in small quantities for local use until recently, when the large mine at Punitaqui started producing an average of 2,000 flasks annually for export. The exploitation of mercury at that mine depended on profitable extraction of gold and copper. The high mercury prices of World War II revived interest in mercury mining, and production rose from 100 flasks in 1940 to nearly 2,600 flasks in 1943; it dropped thereafter to 100 flasks in 1953, or to the lowest point in the postwar period. In 1955 over 500 flasks were produced.

TABLE 11.—*World production of mercury, by countries,*[1] *1925–57, in 76-pound flasks*

Year	North America			South America			Europe						Asia				Africa		World total
	Canada	Mexico	United States	Bolivia (exports)	Chile	Peru	Czechoslovakia	Germany	Italy [2]	Spain	U.S.S.R.	Yugoslavia [2]	China	Japan	Philippines	Turkey	Algeria	Union of South Africa	
1925	----	1,123	9,053	----	----	----	2,129	----	53,189	37,052	287	----	[3] 95	----	----	98	55	----	103,000
1926	6	1,317	7,541	----	----	----	2,387	----	54,274	46,244	3,678	----	[3] 58	----	----	160	75	----	116,000
1927	----	2,353	11,128	----	----	----	1,601	----	57,900	72,316	2,147	----	2,147	----	----	----	29	----	150,000
1928	----	2,535	17,870	46	----	----	2,086	----	57,677	63,675	2,950	----	1,973	14	----	124	----	----	149,000
1929	----	2,396	23,682	49	----	----	1,897	----	57,966	71,832	3,771	----	580	41	----	235	122	----	163,000
1930	----	4,946	21,553	----	----	----	2,060	----	56,069	19,221	3,278	----	725	121	----	537	325	----	109,000
1931	----	7,292	24,947	1,021	20	----	2,222	----	37,652	19,786	[4] 3,500	----	[3] 638	101	----	235	1,073	----	99,000
1932	----	7,330	12,622	505	8	----	1,305	----	29,480	23,656	[4] 5,000	8	[3] 580	69	----	----	1,184	----	82,000
1933	----	4,478	9,669	817	----	----	194	----	17,605	19,626	6,700	----	[3] 370	234	----	23	----	----	60,000
1934	----	4,580	15,445	557	----	----	763	----	12,804	31,799	7,750	----	[3] 2,950	196	----	41	----	----	77,000
1935	----	6,277	17,518	250	----	----	2,004	116	28,191	35,559	8,700	----	[3] 1,313	148	----	25	----	----	100,000
1936	----	5,307	16,569	224	----	----	1,876	1,093	42,732	[3] 43,424	8,700	----	[3] 2,460	429	----	815	102	----	124,000
1937	----	4,936	16,508	16	----	----	2,750	[4] 1,775	66,963	[3] 28,357	8,700	----	[3] 1,736	580	----	483	140	----	133,000
1938	10	8,519	17,991	----	44	----	2,900	1,392	66,752	41,409	8,700	----	560	592	----	597	191	----	150,000
1939	6	7,376	18,633	7	(5)	----	2,669	1,218	67,154	35,912	(5)	----	4,931	(5)	----	359	(5)	----	145,000
1940	2,024	11,653	37,777	----	100	----	2,582	957	91,230	52,214	8,700	----	3,403	3,394	----	500	791	42	216,000
1941	7,057	23,137	44,921	----	1,305	----	2,611	899	94,161	86,473	5,800	----	2,756	4,323	----	354	147	204	275,000
1942	13,630	32,443	50,846	----	2,256	145	2,205	493	75,921	72,288	1,500	----	4,293	5,197	----	271	121	579	262,000
1943	22,240	28,321	51,929	51	2,563	326	1,973	[4] 3,480	58,004	47,756	2,900	----	3,133	6,706	----	186	146	1,189	231,000
1944	9,682	26,063	37,688	2	1,181	152	1,248	[4] 3,480	28,705	34,349	2,900	----	3,510	7,096	----	97	165	1,192	158,000
1945	----	16,443	30,763	3	862	209	435	----	25,410	40,694	7,300	----	1,828	3,139	----	158	326	852	133,000
1946	----	11,661	25,348	----	827	5	841	----	50,822	41,801	8,700	8,876	1,189	1,372	----	----	340	764	153,000
1947	----	9,700	23,244	----	445	----	768	----	53,984	55,608	11,600	9,457	290	1,622	----	98	346	----	167,000
1948	----	4,786	14,388	1	467	----	800	----	38,233	22,684	11,600	10,936	[4] 290	1,689	----	27	381	----	106,000
1949	----	5,250	9,930	----	754	----	[4] 800	----	44,527	32,289	[4] 11,600	12,764	[4] 290	2,461	----	----	115	----	121,000
1950	----	3,757	4,535	----	314	----	[4] 725	----	53,346	51,808	[4] 11,600	14,368	[4] 1,450	1,312	----	----	----	----	143,000
1951	----	8,064	7,293	19	114	----	[4] 725	----	53,839	44,480	[4] 11,600	14,649	[4] 4,000	1,847	----	----	----	----	147,000
1952	----	8,732	12,547	----	173	----	[4] 725	----	55,869	39,135	[4] 11,600	14,620	[4] 4,000	3,083	----	----	----	----	151,000
1953	----	11,643	14,337	----	100	----	[4] 725	----	51,373	43,541	[4] 12,300	14,272	[4] 5,000	6,406	----	----	----	----	160,000
1954	----	14,755	18,543	----	243	77	[4] 725	----	54,477	43,135	[4] 12,300	14,446	[4] 10,000	10,264	----	261	----	----	180,000
1955	----	29,881	18,955	----	526	148	[4] 725	----	53,520	36,231	[4] 12,300	14,591	[4] 11,500	4,990	635	841	----	----	185,000
1956	----	19,530	24,177	----	575	335	[4] 725	----	61,932	48,269	(5)	13,228	(5)	8,334	3,015	1,079	----	----	220,090
1957	----	21,068	34,625	----	678	411	[4] 725	----	63,237	54,750	(5)	12,328	(5)	11,872	3,363	720	----	----	245,000

[1] Small quantities of mercury produced in about 10 other countries are included in the totals; estimates are used where data are not available.
[2] Beginning 1946 output of Idria mine shown under Yugoslavia.
[3] Exports.
[4] Estimate.
[5] Data not available; estimate included in the total.

In the 25-year period 1933–57, Chile produced 13,500 flasks of mercury, 9,000 of which were produced in the 6-year period 1941–46.

PERU

As stated in the History section, the fourth largest mercury-producing mine in the world in total production is the Santa Bárbara mine, Department of Huancavelica. However, in the 25-year period 1933–57, only about 1,800 flasks were produced, chiefly in World War II; production was resumed in 1954 after 7 years of idleness. The Chonta mine, in the Province of Dos de Mayo, Department of Huanuco, was productive in the war period, and output also came from several small properties in Huancavelica.

OTHER COUNTRIES

From time to time small quantities of mercury have been produced in Bolivia. In the past 25 years, 1933–57, production (as measured by exports) totaled about 2,500 flasks. The period of greatest activity was 1931–36, when output averaged 560 flasks annually. A total of less than 100 flasks was reported in 1940–57. Brazil, Colombia, and Ecuador at one time produced a little mercury which was used largely in the precious metal industry (*30*). A deposit of cinnabar (the San Jacinto) in the State of Lara, Venezuela, which was reported (*43*) to have been mined by the Spaniards in early Colonial days, was operated briefly in 1941–42 and produced some mercury.

EUROPE

CZECHOSLOVAKIA

Production averaged 1,300 flasks of mercury in the 25-year period 1933 to 1957, inclusive. Heaviest period of activity was from 1935 to 1944, when the annual average was nearly 2,300 flasks. The period of highest output coincided with the time of Europe's preparation for World War II and the actual war period.

GERMANY

All of Germany's mercury output for 1933 to 1957, inclusive, was produced in 1935 to 1944, inclusive, and amounted to about 15,000 flasks, or an average annual output of 1,500 flasks for the active period.

ITALY

In recent years Italy has been the world's leading mercury source. With the Idria mine, Italy led in world production in the three decades beginning in 1920; without Idria it led in more than half of the years since 1914 and in each of the past 10 years. The Idria mine was ceded to Yugoslavia after World War II.

During 1932 Italy threatened to withdraw from the Spanish-Italian cartel (formed in 1928), and mercury producers requested permission of the Italian Government to close down mines. Output, which had dropped sharply in 1931, continued downward through 1934 when a low of 12,800 flasks was produced. By 1935 only the Idria mine, subsidized by the Government, was worked at near capacity. Production in 1935, while much below level of years prior to 1933, was more than double that of 1934.

The Italian mercury industry produced at record rates during World War II; the production peak of 94,000 flasks for 1941 surpassed the prewar peak level of 67,000 flasks in 1937–39 by more than 40 percent. Italy's output in 1941 was the largest for any country in any year.

Except for 1947 and despite the loss of the Idria mine, Italy was the world's leading mercury-producing country after the war. Most of the production came from the Monte Amiata district, where the grade of ore ranges from 0.6 to 3 percent. Production, however, comes from ore averaging 1 percent or less mercury.

Four rotary furnaces of 150 tons daily capacity each were installed at the Monte Amiata mine in 1955 and 1957.

SPAIN

Commonly credited with the largest and richest mercury ores in the world, Spain in recent years lost first place in production to Italy. Production of the Government-owned Almaden mine, one of the great mines in the world, virtually represents the Spanish total. Some mercury, however, is produced in the Oviedo Province. In the 20th century, thus far, Spain has produced in excess of 2 million flasks and would have led all other countries in output if the Idria mine had not been controlled by Italy between World War I and the end of World War II; thereby Italy rose to first place in total output for the period. Spain led Italy without interruption from 1900 to 1913, inclusive, but fell below the latter country in over two-thirds of the period thereafter. In each of the past 10 years Spain produced less than Italy and averaged little more than three-fourths of the Italian output, even though the Idria mine in that period was under Yugoslavian rule.

Spanish output in the 1930's averaged 30,000 flasks annually, compared with 43,000 in 1920–29 and 49,000 in 1940–49. The low rate of the thirties was influenced by several factors. In 1928 Spanish and Italian producers organized a cartel aimed at distribution of sales, control production, and stabilization of prices (see section on Mercury Cartel). Prices were stabilized at high levels, and production was stimulated in other countries. Moreover, the world depression, beginning in 1929, caused a reduction in world consumption with a consequent sharp rise in world stocks. Production was curtailed in both Spain and Italy in the early and middle thirties. Italy invaded Ethiopia and was subjected to economic sanctions that ended in 1936; Spain became embroiled in civil war. The latter events made operation of the cartel virtually impossible. When the Spanish war ended, the cartel resumed active operation in early 1939—the year World War II began in Europe. Output in Spain rose rapidly and reached an alltime high of 86,000 flasks in 1941. During World War II the cartel again found it virtually impossible to operate. The cartel, however, was revived in 1945 after the war ended and was abandoned again on January 1, 1950.

Following the end of World War II Spanish production ranged from a low of 23,000 flasks in 1948, during the period of depressed post-war prices, to a high of 52,000 flasks in 1950. Prices were trending sharply upward when the Korean War began that year.

Two modern furnaces, each having a capacity of 100 tons, were installed at the Almaden mine in 1952–53 under a modernization program. The completion of a new hoisting shaft in 1956 increased hoisting capacity to 315 tons daily. The average grade of ore mined ranged from 6.1 percent in 1940 to 5.8 percent in 1944, but in recent years, this grade has been lower. Ore treated in 1957 averaged about 2.5 percent mercury.

U.S.S.R.

Until World War II the principal producing area in the U.S.S.R. had been the mines at Nikitovka in the Donets Basin. When the Germans overran that area, the output was temporarily lost to the U.S.S.R. Widespread exploratory work was undertaken from the Donets Basin to Eastern Siberia. In addition to the Nikitovka mines in the Ukraine, which up to World War II had been operated for half a century, mercury was mined at Osh and Frunze; in Kirghizia and other places in that region; at the Chagan-Uzun mines in the Mining Altai; and at Norilsk in Siberia. Mercury has also been reported in Georgia.

During World War II, with the principal deposit in German hands and doubtless also because of increased needs for mercury, the U.S.S.R. purchased over 22,000 flasks from the United States under lend-lease arrangements.

Production data for the U.S.S.R. are far from satisfactory. From the best estimates available, total output in the 25-year period 1933–57 was about 240,000 flasks, or about 9,600 flasks annually. If these estimates are correct, this nation ranked fourth to sixth in world production in recent years.

YUGOSLAVIA

The Idria mine, Province of Slovenia (near Trieste in the Julian Alps, Province of Gorizia when under Italian control), was ceded to Yugoslavia after World War II; its output virtually represents the total for the country.

There are small mines at Sveta Ana, Knapovze, Litija, and Marija Reka in Slovenia; at Maraska and Cemernca in Bosnia-Herzegovina; at Avala and Donja Tresnjica in Serbia; and at Sutomor in Montenegro.

From the beginning of the 20th century until 1911, Idria produced at a rate of 14,000–17,000 flasks annually; from 1911 to 1915, inclusive, production exceeded 20,000 flasks, was nearly 26,000 flasks in 1914, and dropped to less than half that quantity in 1916. Since 1917 the output has never exceeded 15,000 flasks and declined to a very low level in 1944. In 1950 to 1955, inclusive, production consistently ranged from 14,300 to 14,600 flasks annually, but it dropped to 13,200 flasks in 1956 and to 12,300 in 1957.

In the 25-year period 1933–57, the Idria mine produced about 270,000 flasks, or an annual average of nearly 11,000 flasks. The average grade of ore has declined in recent years and is currently about 0.35 percent mercury.

OTHER COUNTRIES

Mercury also has been produced in Austria (not including the Idria mine when controlled by Austria-Hungary), France, Hungary, Portugal, Rumania, and Sweden, and is reported to occur in Albania and Corsica.

ASIA

CHINA

A source of mercury since 300 or 200 B.C. (*18*), China currently vies with Japan as the principal mercury-producing country in Asia.

The Kweichow Province has been the largest producer and probably has the greatest reserves. The mines are small, and the mercury content of the ore averages about 1 percent. The next largest producer is the Kwangsi Province. Deposits in Hunan and Szechuan Provinces, extensions of the belt in northeastern Kweichow, and two groups of mines in western Yunnan Province likewise have been productive.

In the 25-year period 1933–57, China produced about 80,000 flasks, or an average of about 3,200 flasks annually. Recent estimates place current production near the highest levels of the 25-year period.

JAPAN

From 1925 to 1945, 20 mines in Japan (*46*) produced a total of 33,900 flasks, of which 70 percent came from the Itomuka mine in Hokkaido. This mine operated from 1939 to 1945 and produced 23,700 flasks; its peak was 5,700 flasks in 1944. From 1939 to 1953 the Itomuka mine (*76*) produced over 41,000 flasks of mercury from ore averaging 0.48 percent mercury.

In the 25 years, 1933–57, Japan produced 88,000 flasks of mercury and reached its highest levels (an average of 5,000 flasks annually) in 1940 to 1945 during World War II. In the most recent 5 years, Japan averaged over 8,000 flasks annually.

PHILIPPINES

The first mercury mine in the Philippines produced 530 flasks in the final quarter of 1955. An 80-ton-per-day plant operated at the mine near Tagburos Barrio, about 8 miles north of Puerto Princesa, Palawan Island. In mid-1956 a second 80-ton-per-day rotary furnace was installed, which raised output about 50 percent to 300 flasks a month. The entire production in 1955–57 was exported to Japan. Ore reserves averaged about 4 pounds of mercury per ton.

TURKEY

In the 25-year period 1933–57, Turkey produced a total of about 6,200 flasks of mercury. Most of the metal came from mines near Izmir on the Karaburun Peninsula. In this period output reached its highest level (over 800 flasks) in 1936, and in 1955. In 1949–53, inclusive, there was no production at all. In 1954–57 output averaged 540 flasks annually.

OTHER COUNTRIES

Mercury was produced in Sarawak, Borneo, East Indies, many years ago and amounted to about 1,700 flasks in 1872. No production in recent years is known. Mercury occurs also in Java and Sumatra; a shipment of 20 tons of ore went from Java to the United States for treatment in 1947, and 65 flasks was recovered.

AFRICA

ALGERIA

Algeria produced about 3,300 flasks of mercury in the 25-year period 1933–57. Highest annual total was nearly 1,200 flasks in 1932; the mines were unproductive in 1933–35 and from 1950 to date. The most important deposit is the Ras-el-Ma in the Department of Constantine, about 15 miles from Philippeville.

UNION OF SOUTH AFRICA

In the 25-year period 1933–57, the Union of South Africa produced 4,800 flasks of mercury only during 1940–46, inclusive. Anticipated difficulty in obtaining supplies of metal gave impetus to mercury mining. All production came from the Monarch Kop mine in the Murchison Range, North Transvaal. Production averaged nearly 1,200 flasks annually in 1943–44 and met domestic requirements in those years.

OTHER COUNTRIES

Mercury was produced in Tunisia from 1935 to 1943, inclusive, in the 25-year period ending in 1957; the total was less than 700 flasks.

OCEANIA

No mercury has been produced since 1945. In the 25-year period beginning 1933, Australia produced less than 300 flasks, and New Zealand produced about 600 flasks. Australia's output was from near Kilkivan, Queensland, and New Zealand's came from near Puhipuhi, North Island.

WORLD CONSUMPTION

Data on mercury consumption by uses throughout the world are not available. However, a fair guide to the rate of world consumption over a period of years is world mercury production. In the 20 years prior to the 20th century, world output averaged 115,000 flasks annually; subsequently, it averaged 107,000 flasks a year until World War II, 182,000 flasks each year during the 1940–49 period, and 177,000 flasks each year from 1950 to 1957, inclusive.

Before the 20th century, much of the metal was consumed in the recovery of gold and silver by amalgamation. Up to 1890, 10,000 flasks annually were probably used in the United States for that purpose. In addition, each year about 8,000 flasks were used to make vermilion, 2,500 flasks to manufacture fulminate and pharmaceuticals, and 1,000 flasks to make felt, thermometers, barometers, and various laboratory products.

Subsequently, the use pattern changed drastically. Today, recovery of gold and silver requires less than 500 flasks a year, the latest published figure for vermilion was 200 flasks

2, and use of mercury in felt manufac-
has been abandoned. In pharmaceuti-
on the other hand, demand for mercury
sharply, particularly in World War II,
is now well below peak levels. The use
ercury continues to expand for electrical
ratus, agricultural purposes, industrial
control instruments, and for new chlorine
caustic soda plant installations that use
rcury cells.

UNITED STATES

Except for occasional periods, no data on
nsumption of mercury by end uses were
ailable until the beginning of World War
. By then the most important early uses
d dropped to insignificance or had been
scontinued. Entirely different items now
ke the major part of the mercury consumed.

The average annual consumption in the
nited States in the most recent 25-year pe-
iod—1933–57—by 5-year periods, follows:

	Flasks
1933–37	29, 900
1938–42	32, 400
1943–47	45, 400
1948–52	46, 900
1953–57	51, 900

Data for 1928, shown in table 12, are an indication of industrial distribution by uses in the earliest part of the 25-year period. Statistics for recent years were compiled on a different basis from the earlier information, and make direct comparisons difficult for many uses.

The years 1933 to 1936, and part of the next 5-year period in the United States, were years of depression, and in Europe they were ones of depression followed by years of large-scale preparation for war.

During most of 1941–45 the United States and much of Europe were engaged in World War II. In the United States, this period witnessed the alltime peak (62,400 flasks in 1945) in mercury consumption. In 1948–52 consumption in the United States rose 3 percent over the preceding 5-year period and continued well above the level of prewar periods. In 1953–57 consumption virtually returned to the World War II rate of 51,900 flasks annually.

Although uses for mercury during war periods are largely the same as those in peace time, the proportions are different. In the World War II period (1941–45), mercury consumed for pharmaceuticals, drugs, and chemicals averaged 11,700 flasks annually, dropped to 4,100 flasks in the next 5-year period, and in recent years averaged 1,700 flasks annually. The use of mercury in fulminate

TABLE 12.—*Mercury consumed in the United States in 1928, by uses*

Use	76-pound flasks
Drugs and chemicals:	
Pharmaceuticals	5, 421
Dental preparations	357
Chemical preparations	7, 388
Seed disinfectants	360
Total	13, 526
Fulminate	6, 500
Vermilion	2, 418
Felt manufacture	1, 697
Amalgamation	447
Electrical apparatus:	
Lamps	1, 184
Rectifiers and oscillators	227
Primary and storage batteries, battery zincs, and standard cells	899
Rectifier bulbs and power-control switches	212
Total	2, 522
Industrial and control instruments:	
Heat-control devices	201
Compensating clock pendulums	32
Gas pressure and other tank gages	558
Gas-analysis apparatus	61
Flow meters	280
Thermometers, barometers, and miscellaneous scientific instruments	144
Industrial-control apparatus not definitely specified	1, 567
Vacuum pumps	114
Total	2, 957
General laboratory use	620
Manufacture of caustic soda and glacial acetic acid	987
Various uses: Emmet boiler, boiler compound, fireworks, wood preservative, antifouling paint, and other miscellaneous uses	2, 808
Grand total	34, 482

for munitions and blasting caps (including calomel for tracers, as munitions other than fulminate) decreased from an annual average of 4,400 flasks in the war period to an average of 420 flasks in the postwar period. In the most recent 5-year period, this use took less than 50 flasks annually.

Mercury acts as a catalyst in numerous chemical reactions, and for most of 1943 the principal quantities consumed were as catalysts in the manufacture of materials for chemical warfare. This use is included under "Other" in table 13.

In 1944 production began on the dry cell battery for war uses. The demand for the battery caused mercury consumption to reach new record levels in 1945, and the total consumption of 62,400 flasks exceeded the previous record in 1943 by 15 percent. The war-battery contracts were cancelled in mid-1945, and consumption of mercury in electrical apparatus, which included the mercury cell, fell from 24,500 flasks in 1945 to 3,900 flasks in 1946.

In 1950, when the Korean war began, mercury was used principally in electrical apparatus, which accounted for nearly 25 percent of the total mercury consumed in that year.

TABLE 13.—*Mercury consumed*[1] *in the United States, 1941–57, in 76-pound flasks*

Use	1941	1942	1943	1944	1945	1946	1947	1948	1949
Pharmaceuticals	16,237	8,088	14,563	8,358	11,166	4,095	3,047	3,382	3,443
Dental preparations[2]	609	1,198	556	442	537	1,133	785	994	963
Fulminate for munitions and blasting caps	[3] 6,599	[3] 7,830	[3] 4,428	1,890	1,115	682	523	441	149
Agriculture (includes insecticides, fungicides, and bactericides for industrial purposes)	1,968	1,533	1,993	3,930	2,862	3,134	5,617	7,048	4,667
Antifouling paint	680	1,220	2,702	2,439	1,661	994	760	996	1,683
Electrolytic preparation of chlorine and caustic soda	155	549	691	657	597	550	693	806	755
Catalysts	2,027	3,253	4,432	4,764	3,650	3,310	5,078	3,262	2,520
Electrical apparatus[2]	4,696	4,550	3,284	7,092	24,468	3,889	6,763	6,471	7,323
Industrial and control instruments[2]	3,631	3,529	3,674	3,249	3,776	4,609	5,394	5,653	5,016
Amalgamation	160	180	24	29	205	99	138	143	165
General laboratory	175	294	360	265	337	269	333	442	345
Redistilled[2]	2,163	6,175	5,384	6,613	9,712	5,574	4,689	6,499	6,642
Other	4,248	9,338	[4] 11,065	2,236	2,343	3,214	1,761	10,116	6,186
Total	[5] 44,800	[5] 49,700	[5] 54,500	[5] 42,900	62,429	31,552	35,581	46,253	39,857

Use	1950	1951	1952	1953	1954	1955	1956	1957
Pharmaceuticals	5,996	2,761	1,395	1,858	1,846	1,578	1,600	1,751
Dental preparations[2]	1,458	803	1,027	1,117	1,409	1,177	1,328	1,371
Fulminate for munitions and blasting caps	289	494	337	39	106	90	11	------
Agriculture (includes insecticides, fungicides, and bactericides for industrial purposes)	4,504	7,737	5,886	6,936	7,651	7,399	9,930	6,337
Antifouling paint	3,133	2,500	1,178	655	512	724	511	568
Electrolytic preparation of chlorine and caustic soda	1,309	1,543	2,507	2,380	2,137	3,108	3,351	4,025
Catalysts	2,743	2,635	1,048	826	594	729	871	859
Electrical apparatus[2]	12,049	10,250	8,018	9,630	10,833	9,268	9,764	9,151
Industrial and control instruments[2]	5,385	6,158	6,412	5,546	5,185	5,628	6,114	6,028
Amalgamation	192	154	151	200	203	217	239	244
General laboratory	646	524	629	1,241	1,129	976	984	894
Redistilled[2]	7,600	8,776	7,547	7,784	9,281	9,583	9,483	9,703
Other	3,911	12,513	6,421	14,047	1,910	16,708	9,957	11,958
Total	49,215	56,848	42,556	52,259	42,796	57,185	54,143	52,889

[1] Until 1954 included only such small quantities of secondary metal as were not separately identifiable; data by uses not available prior to 1941.
[2] A breakdown of the "redistilled" classification showed ranges of 53 to 28 percent for instruments, 22 to 5 percent for dental preparations, 53 to 10 percent for electrical apparatus, and 21 to 9 percent for miscellaneous uses in the period 1945–57; data for 1941–44 not available.
[3] Includes metal for munitions other than fulminate as follows: 1941, 4,059; 1942, 3,684; 1943, 1,286.
[4] A large part of the total was for chemical-warfare purposes.
[5] The items, which were on a partial coverage basis, do not add to the total.

In recent years, the relighting of many streets with mercury lamps, the production of hearing-aid batteries and other uses in electrical equipment, required an annual average of 9,700 flasks.

Mercury also is used in mercury boilers for the generation of power and in the electrolytic preparation of chlorine and caustic soda. Such installations require large quantities of mercury for initial installation, but subsequent usage is small. The withdrawal of metal from supplies for these plants is shown under "Other" in table 13.

During 1936, three mercury boilers were operating in the eastern United States at Schenectady, N.Y., Hartford, Conn., and Kearny, N.J. Three new mercury-boiler plants were installed in 1949. A Pittsfield, Mass., plant used mercury reclaimed from the closed Schenectady plant, and a new Hartford, Conn., plant that replaced the original installation, used mercury reclaimed from the old, smaller unit. The new plant was at Portsmouth, N.H. The installations in 1949 represented consumption only insofar as new metal was used to supplement that reclaimed from other boilers. No new boilers have been placed in operation since 1949.

Mercury cells to produce chlorine and caustic soda have received considerable publicity since World War II, and a number of such plants have been installed in the United States. In 1948, two chlorine and caustic soda plants—Syracuse, N.Y., and Wyandotte, Mich.—were placed in operation. In the following years, except for 1949–50 and 1954, several new chlorine and caustic soda plants were installed as well as expansions made to existing facilities. The new plants were at Saltville, Va., 1951; McIntosh, Ala., and Plymouth, N.C., 1952; Anniston, Ala., Calvert City, Ky., and Moundsville, W. Va., 1953; Muscle Shoals, Ala., 1955; and Linden, N.J., Brunswick, Ga., and Longview, Wash., 1956. In 1953 the Jersey City, N.J., plant was closed.

In table 13, the redistilled classification covers use of virgin metal in the preparation of redistilled mercury, which is used for many of the same purposes that consume prime virgin metal. Following redistillation, mercury is usually bottled in smaller containers. Redistilled mercury is used in instruments or uses that require a higher degree of purity. A breakdown of quantities shown under "redistilled" in the table would add substantially to the items indicated by footnote 2.

FOREIGN COUNTRIES

GERMANY

Full data on mercury consumption in Germany are not available. In the 5-year period 1929–33, an average of 9,400 flasks of mercury was imported annually (net imports after deducting exports); 24,200 flasks entered Germany each year in the next 5-year period, 1934–38.

In 1935 a campaign was started to reopen mines that had been idle for many years in an effort to develop domestic resources and to curtail imports. The plan failed to reduce imports, and in 1937 Germany was the largest mercury-importing country in the world (25,730 flasks). The annual average receipts of mercury more than doubled in the next 5 years (55,700 flasks in 1939–43) and were 23,500 flasks in 1944. Imports of mercury in 1951 and 1952 were approximately 5,000 flasks in each year, and rose to 21,800 flasks in 1954.

Germany's increased consumption went largely into new or expanded plants where mercury was used as a catalyst or in the electrolytic production of chlorine and caustic soda.

American occupation forces were reported to have found 51,500 flasks of mercury stored in the Mansfield mine near Eisleben.

JAPAN

For many years Japan depended on imports of mercury to meet its domestic needs. From 1925–45 production totaled 33,800 flasks and imports were 240,000 flasks. Exports in this period were small and averaged 685 flasks a year. Table 14 shows consumption by uses for 1952–54.

TABLE 14.—*Estimated consumption of mercury, in Japan, by uses, 1952–54, in 76-pound flasks*[1]

Use	1952	1953	1954
Fulminate	1,015	1,073	696
Antifouling paint	1,015	1,073	1,044
Chlorine and caustic soda:			
For new plant	1,305	754	2,828
For consumption	580	986	1,828
Organic synthetic industry	870	1,610	1,886
Inorganic chemicals	830	870	1,740
Industrial and control instruments	870	1,132	1,740
Pharmaceuticals and dental preparations	58	203	464
Agriculture	290	406	1,480
Other	102	87	348
Total	6,935	8,194	14,054

[1] Source: Nomura Mining Co., Ltd.

UNITED KINGDOM

The United Kingdom is one of the world's largest mercury-consuming countries. A rough guide to consumption is obtained by subtracting reexports from imports, but this calculation makes no allowance for industry and Government stocks, data on which are not available (table 15).

TABLE 15.—*Imports, reexports, and apparent consumption of mercury in the United Kingdom, 1946–57, in 76-pound flasks*

Year	Imports	Reexports	Apparent consumption
1946	2,020	330	1,690
1947	25,670	2,280	23,390
1948	30,630	7,150	23,480
1949	18,800	3,900	14,900
1950	54,200	14,300	39,900
1951	18,800	6,100	12,700
1952	9,200	3,600	5,600
1953	21,300	2,500	18,800
1954	29,500	6,600	22,900
1955	12,900	3,300	9,600
1956	19,600	4,000	15,600
1957	18,200	15,300	2,900

OTHER COUNTRIES

In table 16, apparent consumption of mercury, calculated by the conventional method of production plus imports minus exports, is shown for several other mercury-consuming countries. In addition, large quantities of mercury entered Brazil and Colombia for consumption in recent years.

WORLD TRADE

The United States usually depends on foreign sources for a major part of its mercury requirements. Domestic mines have contributed enough mercury to fill United States demand in only 7 years since 1909. In most of the years covered by table 17, supplies were obtained mainly from overseas sources, an adverse factor in wartime. Spain and Italy supplied 35 and 31 percent, respectively, of total receipts in the 24 years, 1934–57; Mexico was third with 21 percent, and Yugoslavia and Canada supplied 5 and 3 percent, respectively.

Exports and reexports are usually negligible, and for most years, each represented less than 5 percent of the total imports. From 1925 to 1957, the United Kingdom ranked first as an export destination; Canada, Japan, Brazil, Australia, Germany, Colombia, and Hong Kong were next in order of importance, and the remainder went to a few other countries in lots of less than 1,000 flasks each. Data on reexports by country of destination are available only from the year 1942. Except for large shipments to the U.S.S.R. in 1942 and 1943, most of the reexports went to Canada, followed by Japan, United Kingdom,

TABLE 16.—*Production, imports, exports, and apparent consumption of mercury for selected foreign countries, 1948–57, in 76-pound flasks*

	Production	Imports [1]	Exports [1]	Apparent consumption
1948				
Canada	----	10,580	2	10,578
France	----	12,400	330	12,070
Germany	----	5,700	----	5,700
Japan	1,690	(2)	10,300	(2)
United Kingdom	----	30,630	7,150	23,480
1949				
Canada	----	3,660	(3)	3,660
France	----	3,500	60	3,440
Germany	----	3,300	20	3,280
Japan	2,460	(2)	10,090	(2)
United Kingdom	----	18,800	3,900	14,900
1950				
Canada	----	8,080	110	7,970
France	----	8,000	40	7,960
Germany	----	9,500	520	8,980
Japan	1,310	----	30	1,280
United Kingdom	----	54,200	14,300	39,900
1951				
Canada	----	4,060	770	3,290
France	----	11,300	80	11,220
Germany	----	5,800	50	5,750
Japan	1,850	5,500	1	7,349
United Kingdom	----	18,800	6,100	12,700
1952				
Canada	----	1,900	20	1,880
France	----	6,100	180	5,920
Germany	----	4,400	30	4,370
Japan	3,080	730	1	3,809
United Kingdom	----	9,200	3,600	5,600
1953				
Canada	----	2,580	90	2,490
France	----	7,600	80	7,520
Germany	----	8,500	150	8,350
Japan	6,410	4,820	20	11,210
United Kingdom	----	21,300	2,500	18,800
1954				
Canada	----	3,220	80	3,140
France	----	9,500	210	9,290
Germany	----	21,800	140	21,660
Japan	10,260	900	80	11,080
United Kingdom	----	29,500	6,600	22,900
1955				
Canada	----	7,310	50	7,260
France	----	13,000	190	12,810
Germany	----	20,700	100	20,600
Japan	4,990	5,340	(3)	10,330
United Kingdom	----	12,900	3,300	9,600
1956				
Canada	----	5,920	80	5,840
France	----	11,400	50	11,350
Germany	----	15,500	550	14,950
Japan	8,330	13,780	5	22,105
United Kingdom	----	19,600	4,000	15,600
1957				
Canada	----	5,300	20	5,280
France	----	10,100	10	10,090
Germany	----	15,000	530	14,470
Japan	11,900	13,400	15	25,285
United Kingdom	----	18,200	15,300	2,900

1 Mainly from Imperial Institute.
2 Not available.
3 Less than 1 flask.

Sweden, and Brazil. The remainder was shipped to 39 other countries in lots of less than 500 flasks each.

UNITED STATES

IMPORTS

The longtime record of imports covers imports for consumption, which include those for immediate consumption plus withdrawals from warehouse for consumption.

General imports—those for immediate consumption plus entries into bonded warehouses—afford a better measure than imports for consumption of material actually entering the country during a calendar year. Imports for immediate consumption are included in both general imports and imports for consumption; therefore, general imports will differ from imports for consumption, for a particular period, to the extent that entries into warehouses are more or less than withdrawals for consumption. In 1946 and 1948, the difference between the two types of imports amounted to nearly 10,000 flasks; in other years of the past decade, the differences have ranged from a few flasks to more than 6,000 flasks.

After the beginning of domestic mercury production more than 100 years ago, mercury imports exceeded exports in only 1 or 2 years until 1911. Thereafter, with the exception of 1916, 1917, 1931, and 1940, imports were greater.

For the 5-year period 1921–25, imports for consumption constituted more than two-thirds of the apparent domestic supply. In 1928 and 1929, however, they were less than domestic production. Imports in 1931 were the lowest since 1910, and virtually all of them represented deliveries under old contracts. Almost one-half of the imports constituted withdrawals from bonded warehouses of metal shipped in previous years.

With the outbreak of civil war in Spain, fears arose that supplies would be difficult to obtain, and imports in 1936 and 1937 were more than double the 1935 receipts. Importations virtually ceased in the late months of 1937, and in 1938 were only 12 percent of the previous 2 years. During most of 1940, prices for mercury abroad were substantially in excess of the domestic price, and imports for consumption were the lowest since 1910.

After the start of World War II, production in the United States rose sharply; output in 1940 and 1941 represented successive peaks in the annual production recorded since 1883. Supplies from domestic mines, however, were just enough to satisfy domestic needs in 1941 and 1942. The movement of mercury from normal sources had been cut off in 1940, and in July 1941 an agreement was reached with the Mexican Government which assured retention of Mexican production in the Western Hemisphere (see section on Legislation and Government Programs). This agreement, together with the Metals Reserve Co. purchase agreements, resulted in large importations in 1942 and 1943. These data, however, included large quantities subsequently redesignated as reexports, owing chiefly to the fact that they consisted mainly of imported metal that was reshipped without changing its form.

TABLE 17.—*Mercury imported for consumption into the United States, by countries, 1934–57, in 76-pound flasks*

[U.S. Department of Commerce]

Year	North America		South America		Europe						Asia	Other[1]	Total
	Canada	Mexico	Chile	Peru	Italy	Netherlands	Spain	Sweden	United Kingdom	Yugoslavia	Japan		
1934	------	2,480	------	------	649	------	7,053	10	------	------	------	------	10,192
1935	------	55	------	------	904	------	6,856	------	------	------	------	------	7,815
1936	------	347	------	------	6,470	------	10,195	1,076	------	------	------	------	18,088
1937	------	1,533	------	------	9,832	------	7,042	------	510	------	------	------	18,917
1938	------	------	------	------	1,111	------	1,251	------	------	------	------	------	2,362
1939	------	562	------	------	336	------	2,601	------	------	------	------	------	3,499
1940	------	128	------	------	3	------	40	------	------	------	------	------	171
1941	785	6,851	------	------	------	------	104	------	------	------	------	------	7,740
1942	7,400	30,112	1,409	------	------	------	------	------	------	------	------	20	[2] 38,941
1943	15,581	29,457	2,660	107	------	------	------	------	------	------	------	------	[2] 47,805
1944	1,564	16,955	982	52	------	------	------	------	------	------	------	------	19,553
1945	1,720	10,853	477	153	------	------	55,391	------	------	------	------	23	68,617
1946	(3)	5,360	369	------	5,038	------	3,127	------	------	------	------	------	13,894
1947	50	1,783	270	------	2,899	------	3,498	------	------	1,400	3,108	------	13,008
1948	(3)	3,489	------	------	3,947	------	19,384	------	------	1,256	3,675	200	31,951
1949	7	3,091	------	------	84,894	------	9,264	------	------	3,176	2,709	------	103,141
1950	107	3,480	------	------	14,974	575	28,462	1,061	800	5,528	793	300	56,080
1951	660	5,109	------	------	21,868	350	11,954	680	47	6,459	250	483	47,860
1952	20	7,941	------	------	26,276	100	27,102	------	1	10,365	------	50	71,855
1953	171	13,298	------	6	36,120	50	28,049	------	(3)	5,649	25	25	83,393
1954	115	8,887	------	------	22,180	------	29,884	------	------	3,891	------	------	64,957
1955	114	10,250	------	95	629	------	5,458	------	1	3,807	------	------	20,354
1956	80	11,536	25	372	16,810	20	15,713	------	350	2,350	------	60	47,316
1957	66	5,280	------	244	8,056	------	25,276	------	2,500	568	------	15	42,005

[1] Includes Colombia, Honduras, Nicaragua, Bolivia, Czechoslovakia, Denmark, Germany, Switzerland, India, Turkey, and French Morocco. (Data by countries not available prior to 1934.)
[2] Includes the following quantities reexported and not separately classified by countries: 1942, 7,461 flasks; 1943, 14,852 flasks.
[3] Less than 1 flask.

TABLE 18.—*Mercury imported for consumption in the United States, 1926–57*

[U.S. Department of Commerce]

Year	76-pound flasks	Value	Year	76-pound flasks	Value
1926	25,634	$1,784,250	1942	[1] 38,941	$6,730,471
1927	19,941	1,780,134	1943	[1] 47,805	8,545,953
1928	14,562	1,437,153	1944	19,553	2,511,756
1929	14,917	1,513,197	1945	68,617	9,009,930
1930	3,725	361,810	1946	13,894	933,276
1931	549	48,540	1947	13,008	828,703
1932	3,886	107,528	1948	31,951	1,566,859
1933	20,315	689,563	1949	103,141	6,761,933
1934	10,192	481,488	1950	56,080	2,694,272
1935	7,815	381,516	1951	47,860	6,586,589
1936	18,088	1,017,817	1952	71,855	12,546,687
1937	18,917	1,227,991	1953	83,393	13,568,576
1938	2,362	132,610	1954	64,957	10,783,657
1939	3,499	336,744	1955	20,354	5,148,996
1940	171	17,961	1956	47,316	11,009,945
1941	7,740	1,308,593	1957	42,005	9,332,724

[1] Includes the following quantities reexported and not separately classified by countries: 1942, 7,461 flasks; 1943, 14,852 flasks.

all of this metal went to the U.S.S.R. The German occupation of the Donets Basin, the principal source of mercury in the U.S.S.R., cut off most of their supply and brought large orders from the U.S.S.R. to the United States.

The anticipated expansion in consumption of mercury for the new type of battery at the beginning of 1945 caused consumers to look to Spain for large, rapidly increased supplies to augment domestic production. Imports for consumption in 1945 rose to 68,600 flasks, 44 percent above the previous peak of 1943. Spain supplied 55,400 flasks of the total receipts. More mercury was imported in 1949 than ever before; the total was three times as large as that of 1948 and 50 percent greater than the previous record of 1945. Most of the mercury was for the National Stockpile and was purchased by the Economic Cooperation Administration with counterpart funds in Italy.

Imports in 1950 dropped 46 percent, but they continued high in relation to most earlier years due to anticipated defense requirements after the outbreak of hostilities in Korea in June. Speculation was also a factor in the large importations. Increased demand for chlorine for defense purposes accounted in part for the large imports in 1951 and 1952. Receipts of mercury in 1953 rose to 83,400 flasks, only 19 percent less than the alltime record in 1949, and second only to that record. Government barter contracts involving surplus commodities contributed substantially to the large receipts of mercury from abroad in 1953.

Data on United States imports, insofar as they are available, are given in tables 17, 18, and 19.

TABLE 19.—*Mercury imported (general imports) into the United States, by countries, 1925–57, in 76-pound flasks*

[U.S. Department of Commerce]

Year	North America		South America		Europe								Asia		Other [1]	Total
	Canada	Mexico	Chile	Peru	Belgium	Germany	Italy	Netherlands	Spain	Sweden	United Kingdom	Yugoslavia	Japan	Turkey		
1925	296	979	---	---	148	(2)	11,097	---	9,626	---	335	---	---	---	---	22,481
1926	175	1,058	---	---	---	22	11,613	---	13,931	---	494	---	---	166	779	28,238
1927	---	1,819	4	---	---	---	8,969	50	13,484	---	---	---	---	---	---	24,326
1928	(2)	1,792	---	---	902	538	5,642	---	6,108	---	396	---	---	---	---	15,378
1929	493	1,209	---	13	1,249	701	892	---	9,412	---	---	---	---	---	323	14,292
1930	(2)	141	---	---	---	---	---	---	2,802	---	---	---	---	---	---	2,943
1931	---	6	---	---	---	---	---	---	350	---	---	---	---	---	---	356
1932	---	3	---	---	100	---	3,447	---	4,554	---	10	---	---	---	---	8,114
1933	(2)	2,054	---	---	---	---	3,212	---	17,007	---	282	---	---	---	---	22,555
1934–37 [3]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1938	---	69	---	---	---	---	100	---	250	---	---	---	---	---	---	419
1939	---	1,109	---	---	---	---	1,001	---	4,875	---	---	---	---	---	---	6,985
1940	---	1,471	---	---	---	---	390	---	---	---	---	---	---	---	---	1,861
1941	785	6,693	---	---	---	---	---	---	---	---	---	---	---	---	---	7,478
1942	7,400	30,122	1,409	---	---	---	---	---	---	---	---	---	---	---	20	38,951
1943	15,582	29,487	2,660	107	---	---	---	---	---	---	---	---	---	---	---	47,836
1944	1,564	17,221	982	52	---	---	---	---	---	---	---	---	---	---	---	19,819
1945	1,720	13,082	751	185	---	---	---	---	55,747	---	---	---	---	---	23	71,508
1946	(2)	6,669	550	---	---	---	10,284	---	5,559	---	---	---	---	---	---	23,062
1947	50	1,824	120	---	---	---	1,516	---	2,161	---	---	1,500	3,107	---	---	10,278
1948	(2)	4,063	---	---	---	---	4,994	---	27,114	75	49	1,691	3,746	---	---	41,732
1949	29	3,506	---	---	---	---	84,628	---	2,225	---	---	3,753	2,777	---	---	96,918
1950	107	3,986	---	---	---	---	18,073	825	29,439	1,061	---	5,980	793	---	300	60,564
1951	660	4,989	---	---	---	250	17,633	---	13,707	680	(2)	6,525	250	---	233	44,927
1952	20	7,971	---	---	---	---	26,025	100	24,333	---	1	10,186	---	---	50	68,686
1953	171	13,637	---	6	---	---	37,827	50	28,303	---	(2)	5,765	25	---	---	85,784
1954	115	9,374	---	---	---	---	21,858	---	29,859	---	---	4,057	---	54	---	65,317
1955	114	10,310	---	95	---	---	579	---	5,524	---	1	4,325	---	---	---	20,948
1956	80	12,502	125	372	---	---	17,592	20	18,104	---	564	2,590	---	60	---	52,009
1957	66	5,991	---	244	---	---	9,208	---	25,993	---	2,500	1,432	---	---	15	45,449

[1] Includes Colombia, Honduras, Nicaragua, Bolivia, Denmark, France, Portugal, Switzerland, and French Morocco.
[2] Less than 1 flask.
[3] Not available.

EXPORTS

Prior to 1910 the United States exported about one-half of its mercury production. This condition changed in 1911 when exports decreased and amounted to only 5 percent of total imports. In the war years, 1916 and 1917, exports again exceeded imports, and after a period of being virtually nonexistent from 1921–30, they rose in 1931 to 5,000 flasks and again exceeded imports. This situation resulted from the cartel-held high prices which made it advantageous for domestic producers to sell their mercury abroad. Thereafter, exports were negligible until 1939.

Late in 1939, following declaration of war by the United Kingdom on September 5, the supply situation abroad became acute, and the European market favored exportation of mercury. In 1940 cartel-supported prices again favored disposition of mercury abroad. Disruption of ocean transportation and blockades caused by the war brought demands for United States mercury from markets normally supplied by the cartel. In 1940 exports totaled 9,600 flasks, the largest since 1917. Shipments of domestic metal had risen to nearly 2,300 flasks in May 1940, considerably more than the normal average monthly production of domestic mines. Although exports dropped to 1,400 flasks in June, domestic consumption plus exports exceeded the increased supplies from domestic mines. On July 2 the President signed a measure that placed certain strategic materials, including mercury, under export control. The effects of the measure were evident immediately. Shipments to Japan in May and June totaled 1,300 flasks and in July less than 300 flasks; for the remainder of the year they were nonexistent. On the other hand, following the Government policy of all-out aid to the British Empire, exports to the United Kingdom were 2,500 flasks in the first half of the year, and 2,700 flasks in the latter half. In subsequent years, exports were less than 5 percent of total imports in all years, except for 1946 and 1947 when imports were the lowest since 1941.

The shortage of mercury for sale in quantity lots during most of 1954 and the resulting high prices caused the Bureau of Foreign Commerce to place export restrictions on mercury effective June 5. Exports to all destinations except Canada required licenses. As a result; exports in 1955 were less than one-half the 1954 quantity. In the last quarter of 1955 restrictions were relaxed, and exports were no longer subject to quantity control.

Reexports represent metal, previously imported, which is exported without change in form. Except for 1 or 2 years, reexports have been negligible. In 1942 and 1943 large quantities were shipped to the U.S.S.R. after German occupation of the Donets Basin, the U.S.S.R.'s main source of mercury supplies.

Exports and reexports are shown in tables 20, 21, 22, and 23.

INTERNATIONAL TRADE

The principal mercury-exporting countries are Italy, Spain, Mexico, and Yugoslavia. The United Kingdom is not a mercury-producing nation, but it reships metal which originates elsewhere. In the most recent 10-year period, the four major exporting countries, in order of importance, were Spain, Italy, Mexico, and Yugoslavia.

SPAIN

In all but 4 of the last 10 years, Spain shipped most of its mercury to the United States. Other destinations of Spanish metal were the United Kingdom, France, and Germany, in that order. Exports by country of destination for 1948–57 are shown in table 24.

ITALY

Italy ranked first as an exporter of mercury in 3 of the 10 years under review. The large purchase by the United States in 1949 with counterpart funds is not shown as an export in the Italian foreign-trade statistics. The United States, the United Kingdom, and Germany were the chief destinations of Italian mercury from 1948 to 1957, inclusive. Table 25 shows exports by country of destination for this period.

MEXICO

Virtually all of Mexico's mercury output is exported. The United States received most of the Mexican metal. Exports by country of destination for 1948–57 are given in table 26.

YUGOSLAVIA

Yugoslavia did not become a leading exporting country until 1952. Control of the Idria mine, Province of Slovenia (formerly Gorizia, Italy) since the end of World War II has made Yugoslavia an important producer and exporter of mercury. Shipments went chiefly to the United States, with important quantities shipped to Germany, Switzerland, the United Kingdom, and Austria. Table 27 shows exports by country of destination for 1948–57.

UNITED KINGDOM

Reexports from the United Kingdom for 1948–57 are shown in table 28.

TABLE 20.—*Mercury exported from the United States, by countries,[1] 1925–57,[2] in 76-pound flasks*

[U.S. Department of Commerce]

	1925	1926	1931	1932	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
North America:																										
Canada	58	22	810	59	44	53	23	304	775	144	41	15	25	26	124	92	230	64	215	40	28	210	100	106	100	102
Other	50	22			49	66	101	89	145	135	63	45	82	54	39	69	33	56	55	44	62	25	20	53	54	62
South America:																										
Brazil	1	11			3	12	7	29	108	70	64	89	227	62	258	53	28	32	28	14	77	147	651	30	16	24
Colombia	39	11	17	30	47	86	71	72	165	108	13	6	28	29	86	31	31	25	70	22	35	35	6	54	47	25
Other	31	12			94	112	82	75	137	100	50	34	40	47	57	86	98	30	53	84	81	32	82	80	79	71
Europe:																										
Belgium-Luxembourg			324			15		29	52						23	12	3	8	6	13	6	6	3	2	3	7
Czechoslovakia														4	21	140										
Denmark								8										175			10					4
Germany			1,344																							
Netherlands			116				1		1					13	48	3	5	2		3						
Sweden	1					27		20	34					600	56	6			3		2					
United Kingdom	(3)		708		3	60	405	206	5,178	598			1	14		2										776
Other							3	22	9	1	2	67	107	44	82	103	2	1	1	2		2				
Asia:																										
Hong Kong			1,092						(3)	60					25	(3)										
India			15				3	2	21	135		21	1	2	6	1	(3)		1	1		2				
Indonesia					1			11	65	288	18			16	1	73	13	12				11				
Japan	1		387		4	13	3	177	1,598													41		66	400	798
Korea																	15	167						[4] 29	[4] 86	[4] 29
Nansei & Nanpo Is.																									150	
Philippines	6	31	24	15	18	4	8	46	67	111				2	7	17	1	2	6	7	6	4		13	8	9
Taiwan																		3		9				17	134	
Other		5				3	4	13	28	35	18	58	76	83	35	72	30		5	1	7	19	4	1	3	12
Africa:																										
Union of South Africa						3			398	247	20	16	10	23	36	119	4				21	11	24			
Other							2	29	121	75	48	14	36	17	3	(3)	32		4	1	65	1				
Oceania:																										
Australia	14		3	32				75	666	476		2	110	1												
Other								1	49	7	8	18	7	1		5	1									
Grand total	201	114	[5] 4,984	[5] 214	263	454	713	1,208	9,617	2,590	345	385	750	1,038	907	884	526	577	447	241	400	546	890	451	1,080	1,919

[1] Countries to which 100 flasks or more were shipped in any year of the period, 1925–57.
[2] Data are not available for the years 1927–30 and 1933–35.
[3] Less than one flask.
[4] Republic of Korea.
[5] Data do not add to the total; additional breakdown by countries not available.

TABLE 21.—*Mercury exported from the United States, 1925–57, in 76-pound flasks*

[U.S. Department of Commerce]

Year	Flasks	Value	Year	Flasks	Value
1925	201	$15,930	1944	750	$123,481
1926	114	10,319	1945	1,038	121,713
1927–30	(1)	(1)	1946	907	113,817
1931	[2] 4,984	433,596	1947	884	90,659
1932	[2] 214	13,121	1948	526	42,620
1933–35	(1)	(1)	1949	577	54,413
1936	263	19,456	1950	447	37,985
1937	454	37,165	1951	241	57,502
1938	713	50,184	1952	400	85,974
1939	1,208	137,427	1953	546	105,975
1940	9,617	1,743,149	1954	890	183,417
1941	2,590	470,903	1955	451	155,433
1942	345	76,448	1956	1,080	284,418
1943	385	88,842	1957	1,919	483,892

[1] Not separately classified.
[2] From a special compilation by the Custom Statistics Section, Bureau of Foreign and Domestic Commerce.

PRICES

In the 1920's cooperative action by European mercury producers was a factor in sustaining prices, and before 1930 the New York price was virtually the European price plus the cost of importation. Following formation of Mercurio Europeo in 1938 (see Mercury Cartel), the mercury price in the United States, as well as elsewhere, was regulated by the policy of the cartel, which established the price at £21 15s., about $105.85 f.o.b. Spanish or Italian port. The cartel held to within £1 of this figure until June 1, 1931, when it was reduced to £16 15s., equivalent to $81.50 with sterling at par. The price was reduced to $80 in London when the United Kingdom suspended the gold standard, and New York representatives of the cartel began quoting $78.30 to $80 for delivery in the United States in bond.

During most of 1931 quotations on imported metal were well above the prices at which domestic metal was being sold. Much of the time the New York price was approximately the same as the European price despite the duty of $19 a flask; the European price was sometimes higher, and occasionally domestic firms could sell mercury to better advantage in Europe than in the United States. The cartel price cut in June 1931 resulted in a return to a more normal United States foreign relationship.

Reports in the middle of 1932 that the Italian producers were dissatisfied with the price situation and were about to withdraw from the cartel caused loss of price control by the cartel, and prices dropped abruptly. However, in 1933 it was announced that agreement had been reached to renew the cartel until the

TABLE 22.—*Mercury reexported from the United States, by countries, 1942–57, in 76-pound flasks* [1]

[U.S. Department of Commerce]

Country	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
North America:																
Canada	—	—	100	75	502	1,405	416	535	578	215	190	285	1,057	256	1,164	697
Netherlands Antilles	—	—	20	18	29	22	45	27	12	1	—	—	—	—	—	—
Other [2]	—	—	1	4	17	23	17	7	3	1	15	18	5	—	10	17
South America:																
Argentina	—	—	—	73	193	50	—	—	—	—	—	—	—	—	10	—
Brazil	—	—	3	172	493	71	349	108	221	37	21	29	115	—	—	—
Colombia	—	—	1	11	22	31	27	73	46	17	25	50	—	—	—	—
Venezuela	—	—	—	19	38	8	5	19	5	2	1	4	8	11	18	7
Other [2]	—	—	—	—	1	5	5	6	3	2	7	—	—	—	—	4
Europe:																
Belgium-Luxembourg	—	—	—	75	105	51	33	30	—	—	—	—	—	—	—	—
Germany	—	—	—	—	—	—	—	—	—	—	—	70	—	—	—	—
Netherlands	—	—	—	—	—	—	—	—	—	—	—	127	—	—	—	—
Sweden	—	—	—	1,211	367	85	—	—	—	—	—	—	—	—	—	—
Switzerland	—	—	—	—	353	29	—	—	—	—	—	—	—	—	—	—
U.S.S.R.	7,461	14,852	—	—	—	—	—	—	—	—	—	—	—	—	—	—
United Kingdom	—	—	—	—		1,202	—	—	—	—	—	—	10	—	—	499
Other [2]	—	—	—	20	—	6	—	—	—	—	—	—	—	—	—	—
Asia:																
China	—	—	—	1	120	—	—	—	—	—	—	—	—	—	—	—
Hong Kong	—	—	—	—	50	72	—	7	—	—	—	—	—	—	—	—
Japan	—	—	—	—	—	—	—	—	—	400	—	307	96	—	823	1,855
Korea	—	—	—	—	—	—	—	—	—	—	—	[3] 26	[3] 145	—	—	[3] 23
Other [2]	—	—	—	1	17	35	24	16	18	—	—	—	—	—	—	153
Africa:																
Liberia	—	—	1	13	—	—	—	—	—	—	—	—	—	—	—	—
Other [2]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20
Oceania:																
New Guinea	—	—	—	—	50	—	—	—	—	—	—	—	—	—	—	—
New Zealand	—	—	—	—	(4)	—	—	—	—	—	—	—	—	—	—	—
Total	7,461	14,852	126	1,693	2,357	3,095	921	828	886	675	259	916	1,436	267	2,025	3,275

[1] Data by countries not available prior to 1942.
[2] Other in North America includes Costa Rica, Cuba, Dominican Republic, El Salvador, French West Indies, Guatemala, Haiti, Honduras, Nicaragua, and Panama; South America—British Guiana, Chile, Ecuador, Peru, Surinam, and Uruguay; Europe—Ireland, France, and Norway; Asia—India and Dependencies, Israel and Palestine, Kuwait, Philippines, Saudi Arabia, and Taiwan; Africa—Rhodesia and Nyasaland.
[3] Republic of Korea.
[4] Less than 1 flask.

TABLE 23.—*Mercury reexported*[1] *from the United States, 1938–57, in 76-pound flasks*

[U.S. Department of Commerce]

Year	Flasks	Value	Year	Flasks	Value
1938	1,790	$118,040	1948	921	$52,849
1939	929	(2)	1949	828	53,057
1940	3,899	(2)	1950	886	63,839
1941	786	(2)	1951	675	111,274
1942	7,461	(2)	1952	259	46,721
1943	14,852	2,829,778	1953	916	157,880
1944	126	9,599	1954	1,436	257,342
1945	1,693	155,067	1955	267	77,664
1946	2,357	192,899	1956	2,025	475,667
1947	3,095	200,218	1957	3,275	763,303

[1] Data not available prior to 1938.
[2] Not available.

end of 1934, at which time it was extended for another 2 years. Mercury prices in the United States moved upward from March 1933 until April 1934, when the monthly average was $75.93. Prices in London, on the other hand, dropped rapidly in the early part of 1933, rose sharply in October, and ranged from $48.45 to $58.67 during 1934. The differential between New York and London prices in both years was the highest since 1923.

The disturbed political situation in Europe in 1935, which included war between Italy and Ethiopia, economic sanctions against Italy, and internal disorders in Spain, brought fears of possible difficulty in obtaining supplies of mercury and increased demand for the metal in the latter part of the year. The price of mercury in Europe rose as a result of the political developments and the uncertainty as to the availability of mercury supplies. The average quoted price in London rose $4.59 over that

TABLE 24.—*Exports of mercury from Spain, by countries, 1948–57, in 76-pound flasks*[1]

Country	1948	1949	1950	1951	1952
Argentina	2,564	774	1,410	-------	-------
Australia	-------	-------	-------	827	50
Belgium-Luxembourg	604	177	592	116	6
Brazil	-------	-------	-------	148	20
Canada	7,116	-------	-------	-------	-------
Denmark	165	479	302	134	-------
Finland	-------	302	-------	104	-------
France	3,002	2,936	2,036	6,411	3,765
Germany	4,873	5,479	2,350	4,554	1,804
India	1,149	-------	2,007	-------	-------
Japan	-------	-------	-------	1,076	377
Netherlands	664	1,642	1,256	986	1,308
Norway	-------	487	261	551	200
Portugal	70	186	35	162	801
Sweden	2,863	400	2,712	2,176	203
Switzerland	464	-------	5,155	5,416	3,878
United Kingdom	21,518	11,258	46,636	15,516	4,566
United States	29,783	3,516	34,528	9,857	27,160
Venezuela	20	9	9	-------	-------
Other countries	102	-------	220	509	115
Total	74,957	27,645	99,509	48,543	44,253

Country	1953	1954	1955	1956	1957
Argentina	-------	-------	-------	-------	-------
Australia	105	1,392	195	220	-------
Belgium-Luxembourg	38	-------	123	195	856
Brazil	367	777	1,437	2,352	1,836
Canada	-------	-------	1,501	601	651
Denmark	-------	-------	-------	450	4
Finland	-------	1,001	297	317	1,340
France	3,415	4,226	7,629	3,991	5,140
Germany	2,606	1,460	4,214	2,434	4,450
India	-------	-------	-------	1,689	550
Japan	1,761	901	927	1,787	1,178
Netherlands	441	1,016	896	1,964	3,749
Norway	290	145	150	145	300
Portugal	96	345	159	96	341
Sweden	320	640	1,236	2,599	1,256
Switzerland	2,451	751	1,159	153	618
United Kingdom	6,701	6,315	4,203	3,859	6,482
United States	24,972	24,217	7,835	16,586	17,258
Venezuela	-------	-------	-------	1,287	-------
Other countries	105	348	284	10	488
Total	43,668	43,534	32,245	40,735	46,497

[1] Source: Estadistica del Comercio Exterior de España.

TABLE 25.—*Exports of mercury from Italy, by countries, 1948–57, in 76-pound flasks*[1]

Country	1948	1949	1950	1951	1952
Argentina	611	140	110	-------	-------
Australia	25	-------	234	25	128
Austria	103	-------	120	105	70
Belgium-Luxembourg	400	-------	325	50	-------
Brazil	841	82	1,053	250	-------
Canada	-------	-------	1,701	-------	-------
Colombia	-------	-------	-------	-------	-------
Czechoslovakia	601	-------	1,457	-------	173
Finland	-------	-------	-------	-------	-------
France	9,228	-------	4,731	2,228	325
Germany	1,455	270	7,759	432	156
Hungary	-------	100	490	-------	-------
India and Pakistan	2,979	882	[2] 30,231	[3] 2,402	-------
Indonesia	-------	-------	-------	-------	15
Japan	-------	-------	-------	-------	-------
Netherlands	29	-------	3,102	200	341
Norway	-------	-------	-------	-------	10
Poland	-------	-------	1,665	2,177	581
Rumania	-------	-------	-------	300	341
Sweden	-------	-------	405	35	-------
Switzerland	941	145	770	299	-------
Union of South Africa	-------	390	232	-------	92
U.S.S.R.	-------	2,176	-------	-------	-------
United Kingdom	7,706	921	8,111	2,909	3,703
United States	6,455	[4] 3,002	19,170	16,073	27,762
Other countries	284	350	638	23	54
Total	31,658	[4] 8,458	82,304	27,508	33,751

Country	1953	1954	1955	1956	1957
Argentina	-------	-------	-------	470	-------
Australia	76	98	165	215	197
Austria	43	471	368	629	1,010
Belgium-Luxembourg	400	288	299	690	264
Brazil	11	141	310	-------	4,052
Canada	-------	400	473	1,125	99
Colombia	9	-------	-------	2,100	-------
Czechoslovakia	1,389	177	1,433	1,848	812
Finland	599	512	232	232	-------
France	3,351	5,629	3,014	6,846	4,363
Germany	3,881	15,234	12,473	9,796	5,924
Hungary	583	-------	270	335	-------
India and Pakistan	-------	[3] 3	-------	[3] 2,260	[3] 487
Indonesia	-------	-------	339	-------	-------
Japan	-------	-------	641	6,353	2,680
Netherlands	496	820	595	316	99
Norway	466	145	-------	-------	-------
Poland	2,817	751	1,738	2,039	818
Rumania	-------	-------	325	-------	-------
Sweden	-------	304	177	806	78
Switzerland	100	250	67	339	78
Union of South Africa	181	-------	-------	299	148
U.S.S.R.	-------	-------	-------	-------	-------
United Kingdom	8,506	16,210	3,951	13,735	3,252
United States	32,025	20,230	-------	24,242	4,151
Other countries	235	257	1,053	328	276
Total	55,168	61,920	27,923	75,003	28,788

[1] Source: Comercio con L' Estero.
[2] Mostly India.
[3] India only.
[4] Does not include large purchase by United States with counterpart funds. United States import statistics show 84,894 flasks from Italy in 1949.

TABLE 26.—*Exports of mercury from Mexico, by countries, 1948–57, in 76-pound flasks* [1]

Country	1948	1949	1950	1951	1952
Argentina	25	------	------	------	------
Belgium	89	89	55	59	479
Brazil	28	------	65	303	96
Canada	------	------	------	------	22
China	------	------	------	113	------
Finland	112	------	------	------	------
France	------	------	------	------	------
Germany	------	------	------	------	------
Italy	------	810	------	------	------
Japan	------	------	------	335	------
Netherlands	28	156	------	236	151
Netherlands Antilles	------	------	------	------	------
Sweden	------	------	------	------	------
Switzerland	167	------	100	145	66
United Kingdom	------	1,002	------	------	------
United States	4,322	4,427	4,718	6,500	8,653
Venezuela	------	------	------	6	------
Other countries	7	7	11	8	35
Total	4,778	6,491	4,949	7,705	9,502

Country	1953	1954	1955	1956	1957
Argentina	------	------	------	271	------
Belgium	------	60	53	------	------
Brazil	------	24	24	------	------
Canada	100	193	2,066	978	889
China	------	------	54	------	------
Finland	------	------	------	------	------
France	213	438	------	109	------
Germany	110	294	465	711	1,108
Italy	------	------	------	------	------
Japan	236	605	1,587	1,626	5,340
Netherlands	50	517	340	11	------
Netherlands Antilles	------	------	------	------	------
Sweden	------	60	------	54	11
Switzerland	------	------	86	------	------
United Kingdom	------	4,790	5,283	1,388	2,973
United States	15,629	11,469	14,251	17,821	10,637
Venezuela	------	------	11	------	------
Other countries	21	14	17	108	7
Total	16,359	18,464	24,237	23,077	20,965

[1] Source: Anuario Estadistico del Comercio Exterior.

TABLE 27.—*Exports of mercury from Yugoslavia, by countries, 1948–57, in 76-pound flasks* [1]

Country	1948	1949	1950	1951	1952
Austria	1	3	4	4	356
Belgium-Luxembourg	1	4	11	5	791
Brazil	------	------	------	------	------
Canada	------	------	------	------	------
France	------	2	4	16	731
Germany [2]	16	------	12	13	971
Netherlands	3	15	13	11	450
Sweden	4	11	7	1	485
Switzerland	1	------	3	8	565
United Kingdom	------	13	------	12	697
United States	3	36	82	60	8,906
Other countries	66	18	3	------	11
Total	95	102	139	130	13,963

Country	1953	1954	1955	1956	1957
Austria	360	366	577	1,829	953
Belgium-Luxembourg	347	330	90	------	------
Brazil	------	95	------	------	------
Canada	------	------	200	------	------
France	300	585	510	612	410
Germany	2,289	3,874	1,662	816	2,742
Netherlands	300	------	236	379	------
Sweden	336	260	40	165	60
Switzerland	195	977	4,967	2,405	1,010
United Kingdom	2,666	1,001	175	474	125
United States	5,972	4,353	4,753	1,821	1,201
Other countries	51	------	------	100	355
Total	12,816	11,841	13,210	8,601	6,856

[1] Source: Statistics of Foreign Trade of Yugoslavia.
[2] West Germany, except for 1948.

TABLE 28.—*Reexports of mercury from the United Kingdom, by countries, 1948–57, in 76-pound flasks* [1]

Country	1948	1949	1950	1951	1952
Australia	1,077	572	617	526	156
Belgium	------	------	911	238	70
Brazil	56	203	426	------	------
Canada	------	------	------	------	------
Czechoslovakia	------	------	1,495	1,838	1,256
Denmark	------	------	------	------	------
Finland	------	25	357	158	122
France	------	------	1,233	892	------
Germany	------	------	------	------	200
Hong Kong	643	974	512	------	------
Hungary	------	------	------	------	------
India	3,069	1,228	4,436	------	------
Indonesia	------	------	------	------	------
Japan	------	------	------	------	------
Netherlands	654	2	121	160	253
Norway	31	17	627	663	------
Poland	------	------	------	------	197
Rhodesia and Nyasaland, Federation of	------	------	------	------	[2] 42
Sweden	------	7	673	423	------
Union of South Africa	755	273	719	103	909
United States	------	------	513	------	------
Other countries	861	603	1,677	1,125	402
Total	7,146	3,904	14,317	6,126	3,607

Country	1953	1954	1955	1956	1957
Australia	260	364	214	422	389
Belgium	278	465	89	140	259
Brazil	------	(3)	------	------	------
Canada	------	------	775	------	1,129
Czechoslovakia	199	------	------	------	------
Denmark	78	215	150	364	265
Finland	------	622	193	255	553
France	------	------	------	------	------
Germany	------	224	------	------	821
Hong Kong	75	------	30	200	275
Hungary	753	415	------	------	------
India	------	------	2	573	341
Indonesia	------	15	354	81	------
Japan	------	------	------	159	------
Netherlands	------	115	22	------	218
Norway	47	842	12	------	------
Poland	------	1,973	350	------	------
Rhodesia and Nyasaland, Federation of	[2] 79	104	133	72	103
Sweden	71	118	516	334	592
Union of South Africa	161	285	86	83	298
United States	------	------	------	810	9,308
Other countries	502	816	333	528	759
Total	2,503	6,573	3,259	4,021	15,310

[1] Source: Foreign service dispatches.
[2] Southern Rhodesia.
[3] Less than 1 flask.

in 1934, whereas the New York price decreased $1.88 per flask. The price differential in favor of New York, caused by the domestic tariff on mercury, declined sharply.

The United States in an attempt to provide against cutting off supplies from Spain, for years the largest source of imports, imported more than 18,000 flasks of metal in the 6 months from October 1936 through March 1937, 41 percent more than the annual average importation for the 20 years prior to 1937. By the middle of the year it was apparent that only unusual consumption could absorb the large quantity of mercury made available by the heavy importations and large domestic production. Increased demands for mercury failed to materialize; industrial activity declined as the year progressed; and prices declined steadily from June 1937 into the early months of 1938. Demand abroad was greater than in the United States, and the New York and London price differential was lower in 1938 than at any time since 1931, when the United States had an excess of production and exported relatively large quantities of metal. The London price fell only 4 percent compared with a 16-percent decrease in New York.

World events in 1939 caused sharp fluctuations in mercury prices. In the early months of the year the price was strengthened by fears of war abroad and uncertainty over the sales policy of Spanish and Italian producers after Franco's victory in the Spanish Civil War. In May Mercurio Europeo resumed selling Spanish and Italian mercury, and the price eased instead of rising (the average monthly price for May was $86.77 compared with $90.80 for April).

Following declaration of war by the United Kingdom on September 5, 1939, the price jumped $20 a flask to $110 and continued up sharply until it reached $165 on September 18. The low rate of imports into the United States since late 1937 (in 8 of the 10 years preceding 1938, imports represented 24 to 68 percent of the new supply available for consumption) and the failure of domestic production to rise to meet the drop in imports caused consumers to draw on stocks to meet their requirements. In addition, consumers feared that competition for mercury among the countries at war or preparing for war would threaten supplies. Despite these conditions, prices dropped to $132 late in November. Prices advanced in the first half of 1940, interrupted only by a slight decrease in April, and the monthly average of $197.36 in June for a 76-pound flask had been exceeded only on two previous occasions—January and February 1916—when the quoted averages were $231.50 and $283.50, respectively, for 75-pound flasks. Production in 1940 reached the highest level since 1883; export controls were placed on mercury in July, and prices trended downward throughout the second half of the year.

Monthly prices for mercury rose steadily throughout 1941 and into January 1942. Further gains in prices were discouraged by warnings issued twice during 1941 by the Office of Price Administration, and ceiling prices were established in February 1942. Ceiling prices ranged from $191 to $193 a flask depending on point of shipment (see section on Legislation and Government Programs).

Under maximum price limitations, monthly quoted prices fell from $202.52 in January 1942 to $194.28 in June, remained at $194.43 for 3 months, and then advanced to $196 in November and December. The price remained at this level until late in September 1943. Increased production and high record imports resulted in abundant supplies, and prices fell sharply. By the end of 1943 prices were quoted at a range of $190 to $193.

Much of the production at that time and during January 1944 was being purchased by the Metals Reserve Co., but such purchases ceased at the end of January. The downtrend in prices continued until a monthly average of $101 was established in July 1944. The anticipation of new record rates of consumption with the development of the new dry-cell battery, of which mercuric oxide is an important component, caused the price to turn upward late in 1944 and to jump to $165.55 in February 1945. Record-breaking receipts of mercury from Spain assured an ample supply for the expanded consumption, and the price movement was reversed. The end of World War II accelerated the price decline to below $100 in September. The market strengthened in the final quarter of 1945 when it became known that surplus mercury from contract cancellations would become part of the Government stockpile. Ceiling price restrictions were removed in August 1945.

In the postwar period the prices for mercury generally trended downward from May 1945 until a gradual strengthening took place in the latter part of 1948. In late December 1948 the Spanish-Italian cartel (which had been inactive during the war and had been revived at the end of 1945) raised its price $14 a flask, and the New York quotation rose similarly. The downtrend was resumed almost immediately and continued to fall virtually without interruption through the second quarter of 1950. In June 1950 the price was at the lowest level since September 1935, in contrast to the general wholesale-price index of the Bureau of Labor Statistics which had more than doubled.

An upsurge in prices followed the outbreak of hostilities in Korea in June 1950, and prices virtually trebled in the 7-month period that followed. Further advances were halted by the General Ceiling Price Regulation, issued on January 26, 1951, and lasting to August 10, 1951, when an amendment freed mercury from price control. A downward trend was in progress when large purchases for Government and others caused a shortage in spot supplies, and mercury prices rose to an all-time peak of $325–$330 a flask in November 1954. Quotations dropped gradually thereafter until mid-August 1955. Prices strengthened in November, and the annual average of $290.35 in 1955 established a new peak. Mercury quotations trended downward from January 1956 until early July, when they ranged from $255–$257 a flask; the annual average was 10 percent less than the 1955 peak. Except for a slight drop in October 1956, prices continued at the July 1956 level through the third week of July 1957. Thereafter, the price declined gradually to $225–$230 by mid-November and ended 1957 at that range.

With the outbreak of World War II, the London price followed the trend in the United States but did not exceed the New York price until January 1940. Except for May and June the London price was consistently higher than the domestic one, despite a tariff of $19 a flask on imported metal. In May 1941 a price-control order was issued in the United Kingdom. The order was revoked in August 1946, but the price was not reduced until November 15, when import controls were abolished (see Legislation and Government Controls for foreign countries). By the end of 1946 the quoted price was £20 15s. ($83.68), and in December the London price was below the New York price for the first month since May 1942. A New York excess is normal, however, because of the United States tariff on mercury, and this relationship has continued, on an annual basis, since the end of 1946 (see table 29).

The London quotation was £16 ($64.46) from late August 1947 through the third week of May 1948, when it dropped to £15 ($60.47). In the last days of December mercury was quoted at £18 5s. ($73.57); it rose to £18 10s. ($74.58) in February 1949 and remained at that level until the pound was devalued in mid-September. Thereafter it was £26 5s. ($96.79).

The mercury price in London rose gradually following the outbreak of war in Korea until December 1950, when it reached the equivalent of $100.89 a flask. In late January 1951 it rose to £73 10s. ($204.54) and re-

TABLE 29.—*Average prices per flask (76 pounds) of mercury at New York and London and excess of New York price over London price, 1925–57*

Year	New York [1]	London [2]	Excess of New York over London
1925	$84.24	$67.79	$16.45
1926	93.13	77.16	15.97
1927	118.16	104.01	14.15
1928	123.51	108.54	14.97
1929	122.15	108.11	14.04
1930	115.01	105.91	9.10
1931	87.35	89.76	[3] 2.41
1932	57.93	48.24	9.69
1933	59.23	41.64	17.59
1934	73.87	56.15	17.72
1935	71.99	60.74	11.25
1936	79.92	64.33	15.59
1937	90.18	69.65	20.53
1938	75.47	66.92	8.55
1939	103.94	88.26	15.68
1940	176.87	201.10	[3] 24.23
1941	185.02	194.20	[3] 9.18
1942	196.35	227.87	[3] 31.52
1943	195.21	281.44	[3] 86.23
1944	118.36	281.44	[3] 163.08
1945	134.89	242.45	[3] 107.56
1946	98.24	120.39	[3] 22.15
1947	83.74	73.02	10.72
1948	76.49	62.35	14.14
1949	79.46	73.28	6.18
1950	81.26	61.94	19.32
1951	210.13	203.37	6.76
1952	199.10	194.89	4.21
1953	193.03	192.49	.54
1954	264.39	255.33	9.06
1955	290.35	280.22	10.13
1956	259.92	238.68	21.24
1957	246.98	232.36	14.62

[1] Engineering and Mining Journal, New York.
[2] Mining Journal (London) prices in terms of pounds sterling are converted to American dollars by using average rates of exchange recorded by Federal Reserve Board.
[3] London excess.

mained at that approximate level for the remainder of the year. Prices fluctuated throughout 1952 and 1953 and reached a monthly peak of $307.74 in November 1954. The price declined during 1955 but from June through August ranged from $18.03 to $35.85 above the New York quotation. The annual average price in 1955 established a new peacetime peak; it was only slightly under the 1943 and 1944 averages when prices were controlled. The downward trend in mercury quotations continued in 1956 and reached £83 10s. ($233.80) by the third week in August. This price held until mid-December when the quoted price ranged from £84 to £84 10s. ($235.20–$236.60). In early 1957 the price advanced to

£84 10s.–£85 ($236.60–$238.00), and slight increases thereafter resulted in a quotation of £91 10s. ($256.20) by the end of May. In late June prices began to drop, and at the end of the year mercury was quoted at £69 ($193.20).

STOCKS

Inventories in the hands of consumers and dealers from 1940 to 1957 ranged from 33,700 flasks to 9,100 flasks (table 30). The fluctuation in year-end stocks during this period was due to accumulations and subsequent withdrawals of metal for mercury boiler and mercury-cell chlorine and caustic soda plant installations. Producers held only a small part of the total industry stocks.

Mercury acquired by the Procurement Division of the Treasury Department from 1940 through 1943 and thereafter by the Metals Reserve Co. was transferred to the strategic stockpile in 1947. Data on quantities of mercury in the stockpile may not be disclosed.

Data are not available on stocks outside the United States.

TABLE 30.—*Stocks of mercury in the United States, 1940–57, in 76-pound flasks* [1]

End of year	Consumers and dealers	Producers	Office of Metals Reserve [2]	Total
1940	14, 100	607	550	15, 257
1941	12, 400	439	7, 458	20, 297
1942	10, 700	1, 377	27, 410	39, 487
1943	13, 200	3, 457	69, 852	86, 509
1944	10, 400	2, 714	67, 812	80, 926
1945	17, 000	3, 243	63, 638	83, 881
1946	16, 400	2, 599	20, 884	39, 883
1947	16, 200	3, 084	----------	19, 284
1948	25, 000	5, 165	----------	30, 165
1949	15, 600	5, 354	----------	20, 954
1950	32, 900	2, 719	----------	35, 619
1951	29, 100	1, 072	----------	30, 172
1952	33, 700	685	----------	34, 385
1953	25, 900	1, 121	----------	27, 021
1954	22, 300	186	----------	22, 486
1955	9, 100	928	----------	10, 028
1956	21, 100	1, 210	----------	22, 310
1957	17, 000	3, 749	----------	20, 749

[1] Data on stocks held by consumers and producers not available prior to 1940.
[2] Includes metal held by Procurement Division of the Treasury Department in 1940-43, inclusive.

CHAPTER 6. STRUCTURE OF THE INDUSTRY

MARKETING

The product of mercury mines is prime virgin metal containing in most cases 99.9 percent mercury and is acceptable for most uses of the metal. Market quotations cover prime virgin metal only, and there are no overall market specifications for the metal.

Prime virgin mercury has been sold on the basis of flasks containing 76 pounds since June 1927. From June 1904 to June 1927 the flasks contained 75 pounds, and prior to June 1904 the basis was 76½ pounds to a flask.

In establishing the flask at the 76-pound basis (*74*), Spanish standards were used because that country has been the world's leading mercury producer for centuries. The Spanish apothecaries quintal of 100 apothecaries pounds was in use when Spain adopted the metric system. One Spanish quintal of 100 apothecaries pounds would equal 76.07 U.S. avoirdupois pounds, and the present Spanish metric weight of 34½ kilos equals 76.06 pounds. The accepted standard of 76 pounds and 1 ounce per flask would equal 76.063 U.S. avoirdupois pounds; the extra ounce was dropped and the even 76-pound unit was adopted.

Flasks for prime virgin are made of wrought iron and spun steel. There are wide differences in diameter, height, and weight. They range in diameter from 4 to 7 inches—usually in the upper part of this range—average in height about 12 inches, weigh from 7 to 15 pounds, and average about 8 pounds. They are regular articles of commerce and can be purchased from concerns that deal in mercury. If carefully treated and not permitted to rust, flasks usually continue in use for many years. Because most of the world's mercury is produced in Europe, most flasks are of European manufacture. Flasks are owned by the purchaser and may be resold to the producer. Depending on the market, used flasks sell for 50 cents to $1.50 each (fig. 19).

Mercury producers market prime virgin metal through dealers or brokers and also sell directly under contract to consumers. Some concerns act as both dealers and brokers. Dealers purchase and own the mercury handled, and the profit realized depends on their ability to purchase metal below market prices. Dealers, however, may fail to make any profit at all if prices drop materially between purchases and sales. Brokers' rates are officially 1 percent, but there is claimed to be little brokerage activity.

During World War II the Office of Price Administration established maximum prices for prime virgin mercury and ruled that all other kinds and grades of mecrcury were to be sold at their normal differentials from such maximum prices. Brokers' charges for handling mercury were limited to 1 percent. Dealers were allowed a 2-percent premium which they were permitted to split with another dealer or broker but not with a producer if by such an allowance the producer would receive more than the applicable maximum price.

New York is the primary market in the United States for prime virgin mercury, although San Francisco was the leading market for many years. Most of the metal imported comes through New York. Metal produced in the United States is shipped to consumers, brokers, and dealers by rail, truck, and boat.

Prime virgin metal in small lots is usually sold at $5 to $10 per flask above the lowest Engineering and Mining Journal quotations; small-lot prices usually are changed immediately upon any change in the EMJ quotations.

Freight rates in 1957 for shipping mercury by rail from San Francisco, Calif., Grants Pass, Oreg., Phoenix, Ariz., and Battle Mountain, Nev., to New York were $5.88 per hundred pounds in carlots minimum 40,000 pounds and $9.36 per hundred pounds for less than carlots. These prices approximated $5 and $8 a flask. From Alpine, Tex., the rate for 30,000-pound-minimum carlots was $2.78 per hundred pounds and for less than carlots, $4.87. These costs approximated $2.40 and $4.25, respectively, per flask, depending on weight of containers.

Ocean freight rates from San Francisco and Portland to New York were $3.53 per hundred pounds and from Galveston and Houston were $1.46 per hundred pounds with a minimum of 30,000 pounds. With no minimum, costs for Galveston and Houston were $2.58 per hundred. No minimum applied to San Francisco and Portland. The foregoing costs approximated $3, $1.25, and $2.25 per flask, respectively, depending on container weight.

FIGURE 19.—Mercury Flasks. (Country of Origin—Left to Right): Peru, Italy, U.S.A., Spain, Mexico, U.S.A., U.S.A., Yugoslavia.

(Courtesy, F. W. Berk & Co., Inc.)

The Engineering and Mining Journal, Metal and Mineral Markets, publishes weekly quotations on mercury, wholesale lots, f.o.b. New York, and the American Metal Market gives daily quotations for wholesale quantities, New York, spot or nearby delivery. Other journals that quote prices on mercury include the following:

- Chemical Engineering and Mining Review (Melbourne) (monthly)
- Journal of Commerce (New York) (weekly)
- The Metal Bulletin (London) (monthly quotations)
- Metal Industry (London) (weekly)
- Metals (Daily Metal Reporter Monthly Supplement) (monthly)
- The Mining Journal (London) (weekly)
- The Mining Magazine (London) (monthly)
- New York Times (New York) (daily)
- Oil, Paint & Drug Reporter (New York) (bimonthly)
- Wall St. Journal (New York) (daily)

Since early 1958 Italian mercury has been marketed through a sales organization, Mercurio Italiano, Via Piemonte 38, Rome, Italy, which represents the Monte Amiata S.M.p.A., Stabilimento Minerario del Siele, Mineraria Argus S.p.A., and S.I.A.M. Societa Italiana Anonima Mercurio mines. In the United States, the Leghorn Trading Co., 141 East 44th Street, New York, N.Y., is the sole agent for the concern, and in Great Britain and all countries of the sterling area, the agent is Roura & Forgas, Ltd., Colquhoun House, 27–37 Broadwick St., London, W. 1, England.

Charges on mercury shipped to the United States from Italy amount to about \$3 a flask for freight plus insurance costs of one-half to 1 percent of the insured value. The Italian Government imposed a tax on mercury production of 32,000 lire a flask (equivalent in late 1956 to about \$51), which the producing companies pay.

Spanish mercury is marketed through selling agencies located in different parts of the world. In the United States the Interchange Commercial Corp., 46 W. 55th Street, New York, N.Y., represents the Almaden mine and thus is the agent for all Spanish metal imported. Representatives of the Almaden mine in other parts of the world are as follows:

Name and address of agent	*Area represented*
Elder Smith & Co., Ltd., 3 St. Helen's Place, London E.C. 3	England.
Patvag A. G., Talaker 16, Zurich__	Switzerland, Austria, West Germany.
Skandinavijka Malm—Och Metallaktie—Bolaget, Regeringsq 26—Stockholm.	Denmark, Sweden, Norway, Finland.
Continental Metal & Erts Maatchppig, Herengracht 554 A., Amsterdam.	Netherlands.
Impex S. A., 28 Avenue de L'Opera, Paris.	France.
Eduardo Bueso Ferreri, Rua Nova de Santa Cruz, Braoi.	Portugal.
Metalegesellshaft, Reuterweg 14, Frankfurt/Main.	Germany.
M. Van Arenberg, 50 Avenue Messidor—Uccle—Broxelie.	Belgium.
Brasilerira de Comercio e Representacoes (Bracorep), Rua Barao de Itapetininga 140, Bandar, Sao Paulo.	Brazil.

Charges on mercury shipped to the United States from Spain amount to about $2 a flask for freight plus insurance costs of about 30 cents per $100 of the insured value.

GRADES AND SPECIFICATIONS

REDISTILLED MERCURY

Grades of mercury other than prime virgin are produced by concerns that reduce the impurities in virgin mercury by redistilling, triple distilling, or other means.

USP mercury conforms to United States Pharmacopoeia specifications. Technical mercury is a grade generally used for industrial purposes. Triple distilled mercury conforms to American Dental Association and National Formulary requirements, and Reagent conforms to American Chemical Society specifications. These and other forms of mercury produced from prime virgin or scrap metal are usually packaged in small containers—from 10 pounds down to 4 ounces in size—of earthenware, glass, or plastic.

The foregoing grades command substantial premiums over prime virgin, and the premiums within grades vary inversely with sizes of containers.

Scrap or dirty mercury shipped to processors for cleaning and converting to distilled grades is subject to charges ranging from 80 cents to $1 a pound, depending on the quantity. Cleaning charges for virgin mercury are approximately $15 a flask, and for dirty mercury about $21 a flask, depending on quantity.

SPECIFICATIONS

General Services Administration, Emergency Procurement Service, Material Purchase Specification P-31-R, dated June 3, 1953, superseded by P-31-R1 of May 27, 1958, for purchases for the national stockpile, called for prime virgin mercury, averaging not less than 99.9 percent mercury and stated that the mercury "shall be bright and clean."

Military specifications MIL-M-191-B and amendment 1, dated April 12, 1952, and December 17, 1954, respectively, called for two grades, (I) for mercury fulminate and (II) for instrument, chemical, and laboratory uses. For both grades the mercury must have a bright mirrorlike surface, and be free from film or scum. In grade I, gold and silver contents must be nil, and the mercury should contain no more than 0.05 percent heavy metal impurities. In grade II, mercury should contain no more than 0.005 percent of nonvolatile residue.

MERCURY CARTEL

Mercurio Europeo, a cartel of Spanish and Italian producers but called an International Cartel, was formed October 1, 1928, when world stocks were excessive. Headquarters was at Lucerne, Switzerland. Aims of the organization were distribution of sales, control of production, and stabilization of prices. Spanish and Italian producers controlled over 80 percent of world production at the time; sales were to be allocated 55 percent to Spain and 45 percent to Italy. Meetings were held annually, and world quotas and markets were allocated.

In the early days of the cartel the policy was principally to sustain prices; less rigid control was exercised over production, and the stocks on hand when the cartel was formed rose. World stocks at the end of 1930 were equivalent to fully 1 year's supply (150,000 flasks or more) most of which was produced but not sold by the members of the cartel. Moreover, the maintenance of high prices stimulated production in other countries and closed or restricted markets formerly supplied by Spanish and Italian producers. By far the largest gain in production was at U.S. mines, which in 1931 produced enough metal to supply U.S. requirements for the first time in 14 years and in addition had a surplus available for export. The 1931 annual quoted price of mercury in London averaged $2.41 a flask more than the price in New York despite the U.S. tariff of $19 a flask. The cartel price cut in June 1931 caused a return to a more normal United States-foreign relationship.

Price reduction by the cartel failed to stimulate buying, but in 1932 U.S. production was cut in half.

Mercurio Europeo made an effort to increase consumption. In 1929 it offered £5,000 for any discovery that by 1935 would lead to consumption of 5,000 flasks of mercury for a new use. Unfortunately for the mercury producing industry, payment was never required.

In February 1932 the cartel transferred some of its sales activities to the London firm of Roura & Forgas, and London once again became the major market instead of Lucerne, headquarters of the cartel. Evidently in return for being made "sole importing buyers" for the world, Roura & Forgas, which formerly represented the cartel in the British Empire, guaranteed to take 30,000 flasks a year for a 3-year period at a specified price.

Over the next few years there were many rumors that Italy or Spain was discontented with the cartel, but not until 1936, during the Spanish Civil War, was the cartel denounced by Spain, owing, it was said at the time, to alleged Italian deliveries of arms to the insurgents. Thereafter Italian sales were to be made through Amalgamated Merchants, Ltd. which shared combined London offices with Roura & Forgas, selling agents for the Almaden mine. Following the end of the Spanish Civil War, combined selling of Italian and Spanish metal under Mercurio Europeo, with sales headquarters in London, was resumed in 1939.

The outbreak of war between Germany and the United Kingdom and France in September 1939 brought a new problem of disposing of mercury in neutral territory; the contract to sell in London was not renewed. A plan to sell in Belgium proved impractical, so London continued to market metal during the first weeks of 1940, after which Mercurio Europeo began to sell directly to consumers. Operation of the cartel was virtually impossible in World War II, and mercury was sold directly from producing areas. In 1945 the cartel was revived; Idria, which had been ceded to Yugsoslavia at the end of World War II, was not, however, a party to the revived cartel. Agencies were appointed to represent the cartel all over the world, as follows:

- Elder, Smith & Co., Ltd., 3, St. Helen's Place, London E.C. 3, England (British Empire, China, Japan, Palestine, Iraq, Iran, Trans-Jordan, Saudi Arabia, and Egypt).
- Belgameric, Rue Montoyer 4, Brussels, Belg. (Belgium, Netherlands, Luxembourg, and respective colonies).
- Scandinaviska Malm-Och Metallaktiebolaget, Postbox 16130, Stockholm 16, Sweden (Sweden, Norway, Denmark, and Finland).
- Société Impex 9, Rue Boissy-d'Anglas, Paris 8, (France and colonies).
- "Patvag," Bahnhofstrasse, 12-Zürich, Switzerland (Switzerland, Austria, Poland, Czechoslovakia, Hungary, Balkan countries, and Turkey).
- "Tecnar," San Martin 195, Buenos Aires, Argentina (South and Central America).
- Chematar, Inc., 40 Exchange Place, New York 5, N.Y. (Russia).

Spain withdrew from Mercurio Europeo, and the cartel was dissolved January 1, 1950, following a large purchase of Italian mercury by the U.S. Government with counterpart funds. Reports in the press from time to time that the cartel was to be reconstituted have been denied by the principals.

DIRECTORY OF SELECTED PRODUCERS, CONSUMERS, AND DEALERS

LARGE U.S. PRODUCERS

Alaska:
- DeCoursey Mountain Mining Co., P.O. Box 442, Anchorage.

California:
- Harold Biaggini, Atascadero.
- COG Minerals Corp., Denver Club B, Denver, Colo.
- New Idria Mining & Chemical Co., P.O. Box 87, Idria.
- Sonoma Quicksilver Mines, Inc., Guerneville.

Idaho:
- Holly Minerals Corp., 340 Third Street, N.W., Albuquerque, N. Mex.
- Rare Metals Corp. of America, 10th Floor, First Security Bldg., Salt Lake City, Utah.

Nevada:
- Cordero Mining Co., 131 University Ave., Palo Alto, Calif.

Oregon:
- Arentz-Comstock Mining Venture, 870 First Security Bldg., Salt Lake City, Utah.
- Bonanza Oil & Mine Corp., Sutherlin.

FOREIGN PRODUCERS

Italy:
- Societá Anonima Mineraria Monte Amiata (Monte Amiata S.M.p.A.), Via Barberini 47, Rome.
- Societá Anonima Stabilimento Mineraria del Siele, Via G. d'Arezzo 32, Rome.
- Societá Italiana Anonima Mercurio (S.I.A.M.), (subsidiary of Siele), Via G. d'Arezzo 32, Rome.
- Societá Anonima Mineraria Argus, Via Barberini 47, Rome.

Mexico:
- Minas Asociadas del Sur, S.A., Avenida Juárez 76–401, Mexico, D. F.
- Cia. Mercurio Norteño, Alberto Towns R., Av. Matamores 124 Pte., Torreon, Coahuila.
- Cia. Minera "La Marina," Huitzuco district, Guerrero.
- José Menendez, Huitzuco district, Guerrero.
- José Jimenez Jaidar, Las Pailas district, Guerrero.
- Cía. Minera de Huahuaxtla, Huahuaxtla district, Guerrero.
- International Hermes S.A. and Enrique Paredes, Huahuaxtla district, Guerrero.

Lic. Agustin Domingues, Huahuaxtla district, Guerrero.
Mr. Otto Fyre, Coacoyul de Alvarez district, Guerrero.
Nicolás Valdez E., Avenida Matamoras No. 51, Ote., Torreon, Coahuila.
Sonora Graphite Co., Apartado 88, Guaymas, Sonora.
Almada Zacatecano, Sain Alto, Zacatecas.
Cía. Explotadora de Mercurio S.A., Sain Alto, Zacatecas.
Cía. Minera de Mercurio en Sain Alto, S.A., Moreles 18, Sain Alto, Zacatecas.
Guillermo Vallejo Leal, Palma 24, Desp. 30, Mexico, D.F.
Cía. Minera Picacho de Lobena, S.A., Real de Angeles, Zacatecas.
Cía. Minera Nomar S.A., Tlapehuala, Guerrero.
Juan Pons, Pozos station, Guanajuato.
Cía. Minera Ranas, S.A., E. Doctor district, Queretaro.
Mercurios, S.A., San Juaquin district, Queretaro.
Mercurio Mexicano S.A., Edificio America, Desp. 307, Apdo. 195, Torreon, Coahuila.
Walter A. Edeles, Sombrerete district, Zacatecas.
Lauro Rayas, Munic. of Fresnillo, Zacatecas.
Metalúrgica S.A., Pedernales, Chihuahua.

Peru:
Sociedad Minera "El Brocal," S.A., Avenida Tacna 338, Lima.

Republic of the Philippines:
Palawan Quicksilver Mines, Inc., Puerto Princesa, Palawan.

Spain:
Consejo de la Administración de las Minas de Almadén, y Arrayanes, Alcalá 45, Madrid.

Turkey:
Mr. Mehmet Demirkirişcı Vakif Iş Hani No. 1, Konya.
Mr. Osman Tascioğlu, Karaköy Palas Kat. 6 No. 15, Galata, Istanbul.
Mr. Fehim Kiremitçiler ve Ort, Karaburun, Kara Reis, Izmir.

Yugoslavia:
Rudnik Zivega Sreba, Idrija, Idrija.

LARGE U.S. CONSUMERS

The Adams & Westlake Co., Elkhart, Ind.
Allied Chemical Corp., National Aniline Div., 40 Rector Street, New York 6, N.Y.
Allied Chemical Corp., Solvay Process Div., P.O. Box 271, Syracuse, N.Y.
American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N.Y.
American Meter Co., Erie, Pa.
American Meter Co., 1300 Industrial Blvd., Dallas, Tex.
B I F Industries, Inc., P.O. Box 1342, Providence, R.I.
Bailey Meter Co., 1052 Ivanhoe Road, Cleveland 10, Ohio.
J. T. Baker Chemical Co., Phillipsburg, N.J.
F. W. Berk & Co., Inc., Park Place East, Wood Ridge, N.J.
Buckman Laboratories, Inc., Memphis 8, Tenn.
Carbide & Carbon Chemicals Co., A Div. of Union Carbide & Carbon Co., 300 Madison Ave., New York 17, N.Y.
Carbide & Carbon Chemicals Co., A Div. of Union Carbide & Carbon Co., Niagara Falls, N.Y.
L. D. Caulk Co., Milford, Del.
Cooper-Hewitt Electric Co., 410 8th St., Hoboken, N.J.
E. I. duPont de Nemours & Co., Inc., 1007 Market St., Wilmington 98, Del.
Eastern Smelting & Refining Co., 107–109 W. Brookline St., Boston 18, Mass.
Thomas A. Edison, Inc., Primary Battery Div., Bloomfield, N.J.
Foxboro Co., Foxboro, Mass.
General Aniline & Film Corp., Dyestuff & Chem. Div., P.O. Box 12, Linden, N.J.
General Color Co., Inc., 24 Avenue B, Newark 5, N.J.
General Electric Co., Purchasing Dept., 1 River Road, Schenectady 5, N.Y.
Gulf Oil Corp., Gulf Bldg., Pittsburgh 30, Pa.
Homestake Mining Co., Lead, S. Dak.
Mallinckrodt Chemical Works, Jersey City 5, N.J.
Mathieson Chemical Corp., Mathieson Bldg., Baltimore 3, Md.
The Mercoid Corp., 4201 Belmont Avenue, Chicago 41, Ill.
Metalsalts Corp., 200 Wagaraw Road, Hawthorne, N.J.
Minneapolis-Honeywell Regulator Co., Micro Switch Div., Freeport, Ill.
Minneapolis-Honeywell Regulator Co., 2753 - 4th Avenue S., Minneapolis 8, Minn.
Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Purchasing Dept., 4331 Wayne Ave., Philadelphia 44, Pa.
Monsanto Chemical Co., 918 16th St., N.W., Washington, D.C.
Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia, Pa.
Public Service Co. of New Hampshire, 1087 Elm St., Manchester, N.H.
Public Service Electric & Gas Co., 80 Park Place, Newark, N.J.
Quicksilver Products, Inc., 407 Sansome St., San Francisco 11, Calif.
Standard Oil Co. of Indiana, 910 S. Michigan Ave., Chicago 80, Ill.
Taylor Instrument Companies, P.O. Box 110, Rochester 1, N.Y.
Westinghouse Electric Corp., 306 4th Ave., Pittsburgh 30, Pa.
Wyandotte Chemical Corp., Wyandotte, Mich.

LARGE U.S. DEALERS

Associated Metals & Minerals Corp., 75 West St., New York 6, N. Y.
Ayrton Metal & Ore Corp., 30 Rockefeller Plaza, New York 20, N.Y.
Bache & Co., 36 Wall St., New York 5, N.Y.
Barada & Page, Inc., Guinotte & Michigan Aves., Kansas City, Mo.
Barth Metals Co., Inc., 99–129 Chapel St., Newark 5, N.J.
F. W. Berk & Co., Inc., Park Place East, Wood Ridge, N.J.
Braun Corp., 1363 S. Bonnie Beach Place, Los Angeles 54, Calif.
Chemical Mfg. Co., Inc., of Calif., 714 W. Olympic Blvd., Los Angeles 15, Calif.
Derby & Company, Inc., 10 Cedar St., New York 15, N.Y.
Stanley Doggett, Inc., 99 Hudson St., New York 13, N.Y.
Fleischman Burd & Co., 22 W. 48th St., New York, N.Y.
Geotrade Industrial Corp., 141 E. 44th St., New York 17, N.Y.
Goldsmith Bros. Smelting & Refining Co., 1300 W. 59th St., Chicago 36, Ill.
Gordon I. Gould & Co., 58 Sutter St., San Francisco 4, Calif.
W. R. Grace & Co., P.O. Box 286, Church St. Annex, New York 8, N.Y.

Haesler Metal & Ore Corp., 11 West 42d St., New York 36, N.Y.
Chas. P. Hull Co., Inc., 50 Church St., New York 7, N.Y.
Interchange Commercial Corp., 46 W. 55th St., New York 19, N.Y.
International Bartering Co., 52 Broadway, New York, N.Y.
International Minerals & Metals Corp., 11 Broadway, New York 4, N.Y.
International Selling Corp., 122 E. 42d St., New York 17, N.Y.
L. H. Keller Co., 50 E. 42d St., New York, N.Y.
Leghorn Trading Co., Inc., 141 East 44th St., New York, N.Y.
Lentex Metal & Chemical Co., 500 Fifth Ave., New York 36, N.Y.
Fred H. Lenway & Co., Inc., 112 Market St., San Francisco, Calif.
Mefford Chemical Co., Sub. McKesson & Robbins, Inc., 5353 Jillson Street, Los Angeles 22, Calif.
Mercantile Metal & Ore Corp., 595 Madison Ave., New York 22, N.Y.
Mercer Chemical Corp., 11 Mercer St., New York 13, N.Y.
Merchants Chemical Co., Inc., 60 East 42d St., New York 17, N.Y.
Metal Traders, Inc., 26 Broadway, New York 4, N.Y.
Metallurg, Inc., 99 Park Ave., New York, N.Y.
Metalsalts Corp., 200 Wagaraw Rd., Hawthorne, N.J.
Pacific Vegetable Oil Co., 62 Townsend St., San Francisco 17, Calif.
Philipp Bros., Inc., 70 Pine St., New York 5, N.Y.
C. L. Pratt, Jr., 10210 Second Blvd., Detroit 2, Mich.
Quicksilver Products, Inc., 407 Sansome St., San Francisco 11, Calif.
Frank Samuel & Co., 2200 Lincoln-Liberty Bldg., Philadelphia 7, Pa.
The Schmitz-Schoenewaldt-Turner Co., 20 Vesey St., New York 7, N.Y.
Seaforth Mineral & Ore Co., 3537 Lee Rd., Cleveland 20, Ohio
William M. Stieh & Co., Inc., 721 River Road, Teaneck, N.J.
Swiss Bank Corp., N.Y. Agency, 15 Nassau St., New York 5, N.Y.

CHAPTER 7. RESEARCH AND DEVELOPMENT

Research in the mercury industry is sponsored by the Government, universities, and industry. Government research consists of that work done in Government laboratories and that done under contract with universities and with industrial research organizations.

Most of the mercury research in Government laboratories is related to mercury production and is performed by the Federal Bureau of Mines and Geological Survey. The activities include studies of domestic mercury resources, mining and processing methods and costs at representative mercury mines, and beneficiation, roasting, and leaching of mercury-bearing materials.

Other Government sponsored research is concerned principally with properties and specific uses for mercury.

Mercury research at universities—in addition to that supported by the Government—deals mainly with basic mineralogical and metallurgical studies of mercury ore and concentrates.

Virtually all of industry's efforts are directed at the development of new and improved mercury chemicals for agricultural, industrial, and pharmaceutical purposes and more efficient utilization of mercury in products and equipment.

Outstanding developments by industrial research include the mercury dry cell batteries, larger and more efficient mercury electrolytic cells for the preparation of chlorine and caustic soda, the various types of mercury lamps, and the numerous mercury compounds for agriculture, industry, and medicinal purposes.

The Bureau's Secondary Nonferrous Metals Research Program on recovery of metals from waste by amalgam metallurgy involves potential new uses for mercury. Experiments on the recovery of zinc from skimmings, ashes, and dross and of tin from "hardhead" by amalgam techniques have been successful. Similar bench scale tests on cadmium refining have been only partly successful, but the results are encouraging. After completion of amalgam-electrolytic investigations, it is proposed to study the relatively new techniques of amalgam-solution phase exchange.

CHAPTER 8. LEGISLATION AND GOVERNMENT PROGRAMS

UNITED STATES

TARIFF

The history of tariff protection granted to the domestic mercury producers is shown in table 31.

TABLE 31.—*Rates of duty on imported mercury*

Act of—	Paragraph	Rates of duty, specific and ad valorem
1883	211	10 percent ad valorem.
1890	207	10 cents per pound.
1894	170½	7 cents per pound.
1897	189	Do.
1909	189	Do.
1913	159	10 percent ad valorem.
1922	386	25 cents per pound.
1930	386	25 cents per pound.

The tariff of 25 cents a pound is equivalent to $19 a flask of 76 pounds. No trade agreement concessions have been granted on mercury. The flasks in which mercury (quicksilver) is imported are currently dutiable at 12½ percent ad valorem (paragraph 328, Tariff Act of 1930). This was reduced from 25 percent by concessions granted at the General Agreements Tariffs and Trade (GATT); depending on the value of the flask, the duty varies from about 15 cents to 30 cents a flask.

Mercury ore is on the free list of the Tariff Act of 1930 and, if imported, would enter under paragraph 1719, which provides for "Minerals, crude, or not advanced in value or condition by refining or grinding, or by other process of manufacture, not specially provided for." No trade agreement concessions have been granted on mercury ore.

New York and London prices from 1925 to 1957, inclusive, are shown in table 29. It will be noted that usually the tariff was not fully effective; the differential in favor of selling in the New York market rarely equalled the tariff. Moreover, the cost of shipping to the United States market would reduce the differential shown. The large excess of London prices (dollar equivalents) over New York prices in World War II years was caused by the abnormal marketing conditions that prevailed during those years. Prices on both markets were subject to Government controls for most if not all of that war period.

WORLD WAR I

The outbreak of war in Europe and subsequent large consumption of mercury in the manufacture of war supplies resulted in a soaring market throughout 1915 and until March 1916. Prices became so high ($300 a 75-pound flask in February 1916) that contractors in the United States were unable to fill foreign orders for the Allies. The contractors induced the British Government to lift the embargo on exports and permit shipments of mercury to the United States. As a result the price dropped sharply until it reached $75 a flask in August 1916. With the high demand for mercury for war uses, prices advanced in 1917 to between three and four times the prewar averages, and this level was maintained into 1918.

Early in 1918 the War Industries Board took action toward stabilizing the price. Contracts were made with producers for requirements, so far as they were known, at a price of $105 a flask, f.o.b. San Francisco, Calif., or of $105.75 New York, effective at the beginning of April. About 40 percent of the output of the principal mines was requisitioned at this price, and producers also agreed not to allow the outside market price to advance beyond $125 per flask. Importers were ordered to reserve 40 percent of all imports for Government purchase at the price agreed upon with producers.

WORLD WAR II

DOMESTIC SUPPLY CONTROLS

The history of controls in the United States during World War II is given in "History of the War Production Board and Predecessor Agencies, 1940–45, Industrial Mobilization for War, 1947," by the former Civilian Production Administration, and in the Federal Records of World War II, 1950, by the General Services Administration. Control orders during World War II were issued by the Economic Stabilization Agency, the Office of Price Administration, the Office of Production Management, and the War Production Board. Since the close of World War II, control orders have been issued by the National Production Authority and the Office of International Trade and its successor agency, the Bureau of Foreign Commerce.

The Strategic Materials Act, Public Law 117, (53 Stat. 811) of June 7, 1939, provided for the investigation of domestic sources of strategic materials (*60*). As a result of this act, the Strategic Minerals Development Program was inaugurated by the Department of the Interior through the Federal Bureau of Mines and the Geological Survey. Mercury was one of the seven original metals designated as strategic, and the search for these minerals was begun on July 1, 1939, and extended through World War II.

The Procurement Division of the Treasury Department operating under Public Law 117 entered into contracts with producers for the delivery of certain quantities of mercury, and metal produced in the United States was added to the stockpile during 1941. In May 1940 with the fall of France, the war in Europe took a serious turn, and it became apparent that accelerated and expanded stockpiling activities were necessary. Accordingly, on June 25, 1940, the Reconstruction Finance Corporation Act of 1933 was amended to permit the establishment of subsidiary corporations with power to produce, procure, and store strategic and critical materials, and to permit loans for such purposes.

During July 1941 an agreement was reached with the Mexican Government whereby the United States was to obtain surplus production of certain materials, including mercury, for 18 months. Under the terms of the agreement, the United States was obliged to acquire all metal not sold through ordinary commercial channels in countries in the Western Hemisphere that had export restrictions similar to those that had recently been put into effect in Mexico; the obligation applied to quantities up to 125 percent of total exports of mercury from Mexico during the 18 months that ended July 1, 1941. Purchases were made for the United States by the Metals Reserve Company. The agreement provided for changing prices based upon quotations in the United States regarded by the U.S. Government as technically authoritative.

In April 1942 consumption lagged behind supplies available from domestic mines, and Metals Reserve arranged to purchase surplus spot mercury from current domestic production at $192 per flask, f.o.b. New York. The program was enlarged in July to permit disposal of metal at purchase depots established at many points throughout the United States and was also extended conditionally through December 31, 1943. Later it was extended to December 31, 1944, when it was specified that "qualified producers" (those who produced not more than 90 flasks of mercury in April 1942) must "contract in writing with Metals Reserve Company to aid in supplying the increased requirements for war by producing maximum capacity until December 31, 1944." Metals Reserve was to purchase all or any part of the production of such producers, provided the total for any one did not exceed 300 flasks in 1944, except by special arrangement. Their production, however, could go partly or entirely to others than Metals Reserve. Provision was made for terminating the program within 30 days of notice of the intention to do so on or after December 31, 1943. The supply situation improved considerably and on December 8, Metals Reserve served notice that December 31 was the last date on which producers could apply for confirmation as "qualified" producers, and the buying program was halted January 31, 1944. The company selected the termination penalty to "Settle in cash for such producer's 'total unfilled production' of mercury on the basis of $20 per flask." Such total unfilled production was the amount of mercury equivalent to the producer's average monthly production for the 6 calendar months preceding the effective date of the termination multiplied by the number of months from the effective date of termination to December 31, 1944, or the average production for August 1943 to January 1944, inclusive, multiplied by 11.

The Metals Reserve contract with the larger Canadian producer, Consolidated Mining and Smelting Co. of Canada, Ltd., was cancelled September 1943, and that with Bralorne Mines, Ltd., was cancelled September 1944. Shipments against Mexican contracts, scheduled to be completed in July 1944, were permitted to be made subsequent to July with the total quantity involved unchanged. The contract with Chile ran to January 31, 1945.

The demand for mercury for the manufacture of the new dry cell batteries became evident in August 1944, and a critical supply situation developed. To improve the domestic mercury supply the War Production Board announced, on December 1, that the Metals Reserve Company, upon its recommendation, would release mercury from the stockpile for current war and essential civilian needs. The metal was released at $2 a flask above the quotation in Metal and Mineral Markets on the Thursday subsequent to the execution of the contract. At the end of 1947 no mercury was held by the Office of Metals Reserve; the remaining metal had been transferred to the Government strategic stockpile.

DOMESTIC USE CONTROLS

Conservation Order M–78, issued January 3, 1942, by the Office of Production Man-gement, restricted the use of mercury for car-oting hat fur, for marine antifouling paint, hermometers (except industrial and scien-ific), treatment of green lumber (except Sitka spruce), turf fungicides, vermilion, wall witches for nonindustrial use, and wood reservatives from January 15 to March 31, 942, to 50 percent of such use in a selected ase period, described below. Effective April ., 1942, all use for the above purposes was to e discontinued, unless otherwise specifically uthorized by the Director of Priorities. Con-umers of mercury for the following purposes vere ordered to restrict their use to the fol-owing percentages: Fluorescent lamps, 100 ercent; health supplies, 100; mercuric ful-ninate for commercial blasting caps, 125; nercuric fulminate for ammunition, 100; and hermometers (industrial and scientific), 100 ercent. Other consumers were restricted to 30 percent. "Base period" meant, at the op-ion of the manufacturer, either (1) the cor-responding quarterly period in 1940 or (2) the first calendar quarter of 1941, provided that he same option be used throughout the calen-lar year. Exceptions from the order prima-rily covered materials for delivery under war and lend-lease contracts. In August 1942 the order was amended to add fireworks and prep-arations for film developing to the list of dis-continued uses. The use of mercury for cos-metics or any preparation designed for bleach-ing the skin or removing freckles was cut to 30 percent. An amendment on September 9, 1943, permitted the use of mercury for pur-poses, formerly banned, as follows: Marine antifouling paint, 100 percent of base period; preparations for film developing, 100; ther-mometers (except industrial and scientific), 80; treatment of green lumber, 100; vermilion, 80; wall switches for nonindustrial use, 100; and wood preservation, 100. The revision to the order increased the amounts of mercury permitted for use in mercuric fulminate for commercial blasting caps to 200 percent of the base period; the allotment for industrial and scientific thermometers was raised to 200 per-cent; and all limitations on health and agri-cultural uses were removed. The order was revoked February 2, 1944.

EXPORT CONTROLS

In 1940 cartel supported prices favored the disposal of mercury in the international mar-ket despite the record-breaking annual price in the United States, protected by a tariff of $19 a flask. Disruption of ocean transportation and blockades caused by the war brought de-mands for U.S. metal in markets ordinarily supplied by the international cartel. In May shipments of domestic metal advanced to nearly 2,300 flasks, considerably more than the normal average monthly output of domestic mines. The May rate of exportation defeated the beneficial effects of increased domestic pro-duction, and consumers were forced to draw on stocks to fill requirements. Exports dropped to 1,400 flasks in June but domestic consump-tion plus exports continued above the in-creased supplies from domestic mines. On July 2, 1940, the President signed a measure placing certain strategic materials, including mercury, under export control, and thereafter shipments to foreign countries decreased; those to certain other countries, ceased.

IMPORT CONTROLS

General Import Order M–63, effective De-cember 28, 1941, provided that unless other-wise authorized by the Office of Production Management all future contracts for imports of 13 strategic materials, including mercury, would be handled by the Metals Reserve Co. An amendment issued in 1942 added mercury-bearing ores and concentrates to the commodi-ties covered by the order. In July 1944 mer-cury was removed from the list of products under import control.

PRICE CONTROLS

Price Schedule 93, issued February 4, 1942, by the Office of Price Administration, pro-vided a maximum base price for mercury for California, Oregon, Washington, Idaho, Utah, Nevada, and Arizona of $191 per 76-pound flask, f.o.b. point of shipment; for Texas and Arkansas it was $193 f.o.b. point of ship-ment; for mercury produced outside the con-tinental United States and Mexico and enter-ing the United States through Pacific coast ports of entry, it was $191; and for Mexico it was $193 f.o.b. freight station in the United States at or nearest the point on the bound-ary at which the shipment entered the United States (duty, if any, included). All other kinds and grades were sold at their normal differentials from the maximum prices estab-lished. Amendment 1 provided that, effective February 10 and until March 2, 1942, the schedule was not applicable to dealers who had mercury on hand or in transit on Febru-ary 4 to meet contracts made before February 4. Press Release PM 2731, issued March 19, 1942, explained that the 2-percent premium allowed to dealers under the regulation could be split with another dealer or broker but not with a producer if this would result in the producer obtaining more than the applicable maximum price. Amendment 1 to Revised Price Schedule 93 defined "mercury" as prime virgin mercury, redistilled mercury, reclaimed mercury, and all other kinds and grades of mercury. The amended schedule provided that, effective July 7, all kinds and grades of mercury sold in containers of 25 pounds or less should be sold and bought for not more than the normal differentials prevailing between October 1 and 15, 1941. Mercury ceiling-price restrictions were suspended late in August 1945.

KOREAN WAR

The General Ceiling Price Regulation, issued by the Economic Stabilization Agency on January 26, 1951, provided that prices of mercury, among many other commodities, be held not to exceed the highest level prevailing from December 19, 1950 to January 25, 1951, inclusive. The regulation established ceilings on an individual company basis; and most producers were caught without a ceiling price, as no sales had been made during the specified period. The problem thus created could be solved only by the Office of Price Stabilization setting individual ceilings. General Overriding Regulation 9, Amendment 4, issued August 10, 1951, exempted mercury from price control.

DEFENSE PRODUCTION ACT

Under the Defense Production Act of 1950 (later, as amended) mercury was found to be ineligible for Defense Materials Procurement Agency (successor to Defense Minerals Administration) production expansion assistance. The Defense Minerals Exploration Administration, however, granted exploration loans to properties that fulfilled established specifications. This assistance was granted on a matching-funds principle, the Government meeting 75 percent and the operator 25 percent of costs. On May 15, 1953, mercury was removed from the list of minerals eligible for exploration assistance, but it was reinstated March 23, 1954. Through June 30, 1958, the DMEA had entered into 46 contracts for exploration of such deposits. As of December 31, 1958, the total estimated cost was $2,885,655 of which the Government's share was $2,130,246. Mercury reserves have been developed in several areas as a result of this program.

Effective October 22, 1957, DMEA Order 1, Revised, lowered Government participation on applications on or after October 22 to 50 percent.

Contracts for mercury exploration from the beginning of the DMEA program, April 6, 1951, until June 30, 1958, when DMEA became the Office of Minerals Exploration (OME), are shown in table 32. Under OME mercury continued to be eligible for exploration assistance.

TABLE 32.—*DMEA contracts involving mercury, by States, 1951–58*

State and contractor	County	Total value [1]
ALASKA		
Clarence Wren, Frank Waskey & Chas. Wolfe.	Bristol Bay district	$25,614
Moneta Porcupine Mines, Ltd	do	118,720
DeCoursey Mountain Mining Co	Georgetown	287,920
Do	Otter	81,000
ARIZONA		
Ord Mercury Mines	Gila	28,000
CALIFORNIA		
Jones & Johnson	Contra Costa	73,571
Walabu Mining Co	Kern	26,000
California Quicksilver Mines, Inc	Lake	163,540
Hugh M. Simmons	Napa	17,800
Toyon Mine Co	do	16,120
H. L. M. Mining Co	do	16,520
New Idria Mining & Chemical Co	San Benito	365,126
Do	do	129,331
Do	do	96,980
Frank Vollmer	San Luis Obispo	6,639
Smith & Biaggini	do	11,060
Cordero Mining Co	Santa Clara	200,828
Palo Alto Mining Corp	do	20,020
Sonoma Quicksilver Mines, Inc	Sonoma	77,900
Altoona Quicksilver Mining Co	Trinity	90,452
L. A. Smith & B. C. Austin	do	95,260
Murray A. Schutz, et al	Yolo and Napa	28,540
Trans-Pacific Metals, Inc	Yolo	102,316
IDAHO		
Mac D Mining Corp	Owyhee	6,748
T. R. Baugh	Valley	21,720
NEVADA		
W. F. Dunnigan	Esmeralda	8,925
Aubrey Minney	Humboldt	17,600
C. A. Coppin	Pershing	31,310
Walter L. & Dorothy Low	do	10,544
OREGON		
John McManmon	Crook	9,433
Owen Pigmon	do	20,460
Strickland Butte Mines, DBA	do	5,600
Orion Exploration & Development Co	do	12,100
Bonanza Oil & Mine Corp	Douglas	94,100
Moneta Porcupine Mines, Ltd	do	5,199
Roba & Westfall	Grant	20,140
International Engineering & Mining Co.	Jefferson	10,420
Mercury & Chemicals Corp	Lane	62,340
H. K. Riddle	Malheur	30,500
TEXAS		
Maravillas Minerals Co	Brewster	10,450
Paulsel Mining Co	do	75,900
Southern Geophysical Co., Inc	do	63,240
Amerimex Mining Co	Presidio	80,000
Big Bend Mining Co	do	132,000
Dow Chemical Co	do	59,244
WASHINGTON		
R. A. Whiting, Jr	Yakima	18,425
		2,885,655

[1] Government participation was 75 percent in exploration projects for mercury until Oct. 22, 1957; thereafter, it was 50 percent.

Expansion Goal No. 64, issued April 1, 1952, y the Defense Production Administration, set ie expansion goal for mercury at an annual ipply of 60,500 flasks beginning in 1952. Esti- iates of domestic production and imports from vailable sources indicated that supply would e sufficient to meet future demand, and no nancial assistance would be provided to ex- and production. Revision 1, issued October , 1952, increased the goal to 80,000 flasks in 953 and 1954. On April 25, 1957, the goal vas closed following studies that indicated ufficient capacity either was planned or then xisted to meet presently known mobilization equirements.

Effective June 5, 1954, the Bureau of For- ign Commerce placed export restrictions on nercury; exports to all destinations except Canada would require licenses. Late in 1955 t was annouced that exports would no longer be subject to quantity control but would con- inue to require licenses, and this situation continued throughout 1957.

On July 6, 1954, the General Services Ad- ministration announced a 3-year guaranteed-price program for mercury. The announcement stated that it was designed to "broaden the mobilization base of the metal and increase its supply for defense and industrial purposes." The program provided for the purchase of, at $225 a flask, a maximum of 125,000 flasks of domestic mercury and 75,000 flasks of Mexican metal but was scheduled to end on December 31, 1957, even if such quantities had not been obtained. The $225 price for Mexican metal included the tariff of $19. Also, the program provided for possible contracts with foreign producers, particularly those in Canada. From the inception of the program in 1954 until November 1957 the open market price consistently exceeded $225, and only 5 flasks were purchased. In March 1957 the Office of Defense Mobilization authorized GSA to extend the program through 1958. The extension provided for the purchase of up to 30,000 flasks of domestic mercury, including Alaska, and 20,000 flasks from Mexico at $225 a flask. Revision 1 to the regulations, issued November 8, 1957, extended the program through 1958 and revised packaging specifications.

Producers stated that they were unable to comply with the new packaging specifications to meet the 1957 deadline and on November 22 were notified by GSA that metal available in 1957, except for the packaging requirements, could be delivered by March 31, 1958. Such requests had to be in writing, and the actual availability was to be physically verified. Purchases applicable to the 1957 quota were 9,428 flasks of domestic mercury and 766 flasks of Mexican mercury.

TAXATION

Under the Internal Revenue Act of 1913, an allowance for discovery value was provided on mercury mines. The Internal Revenue Act of 1932 permitted a depletion allowance of 15 percent of gross income for mercury mines, limited to 50 percent of the net income from the property. Under the Internal Revenue Code of 1954 the percentage depletion was raised to 23 percent for domestic mines; the depletion allowance for foreign mines was established at 15 percent; and the 50-percent net income limitation continued in effect.

FOREIGN COUNTRIES

Actions taken by other governments regarding mercury in World War II were the United States-Mexican purchase agreement reached in July 1941 (see World War II Domestic Supply Controls) and the United Kingdom mercury price controls.

In May 1941 the British Ministry of Supply issued a control order that called for maximum prices of £48 15s. ($196.71) a flask for quantities of over 1 and less than 11 flasks, and of £48 ($193.68) for larger quantities, ex-sellers' premises in both cases. Smaller lots (under 1 flask) and redistilled grades were entitled to higher prices. The Ministry of Supply also announced that it was prepared to sell mercury to approved buyers at £47 15s. ($192.67), ex-warehouse in the United Kingdom. In August 1942 the control maximum prices were raised to £69 15s. ($281.44) for small quantities and £69 ($278.42) for larger lots. Control maximum prices remained unchanged until October 1945; prices dropped to less than half and were £30 to £31 5s. ($121.05–$126.09) a flask.

The maximum price order was revoked in August 1946, but the British Ministry of Supply continued as the sole importer and distributor, and the selling price was not reduced. The official price was dropped £5, effective November 15, when control of imports was relinquished.

During 1954 export controls on mercury were issued by several countries; Canada required licenses to all destinations except the United States effective September 1; licenses were required on exports of mercury and mercurial salts from the United Kingdom to all destinations effective October 20; and licenses were required on exports from Mexico effective December 15.

In November 1954 the Italian Government ıposed a manufacturing tax of 32,000 lire ›quivalent to $51.20) per flask; if mercury sold in the form of ore or concentrate, the ,x is 800 lire ($1.28) per kilogram of con- ,ined metal. The tax is paid by the pro- ıcers on all flasks of mercury shipped hether or not for export.

Effective January 1, 1956, the Mexican Con- ress established a new set of taxes covering ›ncessions and production, provision of fis- ıl contracts for the stimulation of mining, ıd a new system of subsidies applicable to nall and medium mining producers. Com- ared with superseded legislation, the new decree lowered the production tax on mercury. The new tax on mercury was:

	Percent
Metallic	3. 13
Concentrates and ores	3. 34

These charges were based upon a New York quotation of US$150 per flask of 76 pounds and were to increase or decrease according to the increase or decrease of the market quotation; the amount of the increase or decrease is calculated by multiplying the difference between the market quotation and the base, expressed in dollars and fractions (U.S.), by the factor 0.0207.

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