UNITED STATES ASSAY OFFICE

AT

NEW YORK

W. S. ROCKWELL COMPANY

FURNACE ENGINEERS AND CONTRACTORS

50 CHURCH STREET NEW YORK

The entire furnace equipment, including furnaces,
blowers, pumps, piping, etc., installed by

W. S. ROCKWELL COMPANY

Furnace Engineers and Contractors

New York, N. Y.

Treatment of Gold and Silver at the United States Assay Office in New York City.

THE United States Assay Office in New York City has always been a source of interest to the public. That a great metal refining plant, carrying on the smelting and refining business, should actually exist on Wall St., the great center of the money market of the Western Hemisphere, has always been a matter of astonishment. The fact remains, however, that such an establishment does exist and has been located there for many years. Next to it is the Sub-Treasury, and across the street is the office of J. P. Morgan & Co. No explanation is necessary to show that this gold and silver refinery is at its logical place.

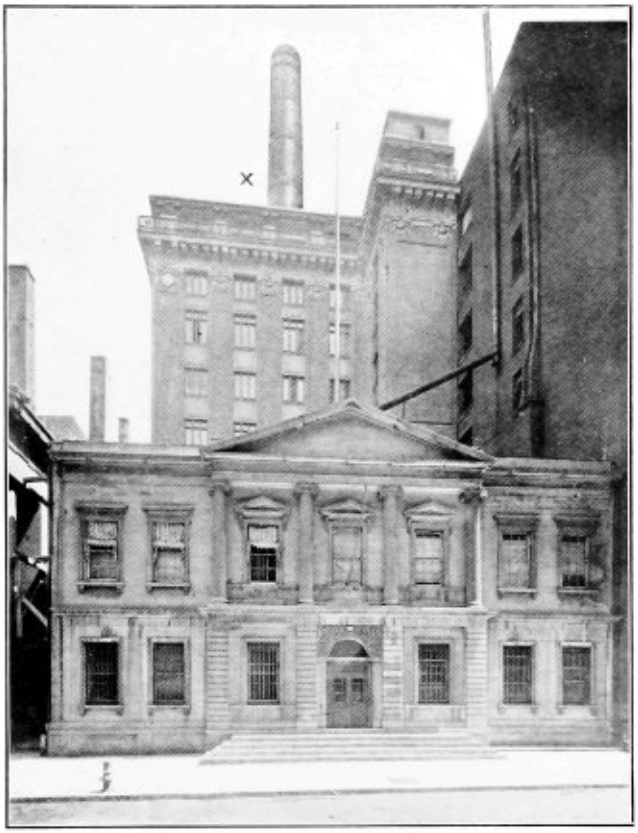

Fig. 1. U. S. Assay Office and Chimney.
Old Assay Office—Nos. 30 and 32 Wall St.—in Foreground.

The building has been in existence for close to a century and is one of the landmarks of New York City. The front of the building is shown in Fig. 1. For many years, indeed up to a comparatively few years ago, all the gold and silver used by the Government in the manufacture of its coins were refined at this establishment, but lately the refining has been split up and a portion of it is carried on at the Mints. A fire damaged the Assay Office a number of years ago and it was then undecided whether to sell the property or rebuild it and continue the business as in the past. It was finally decided to reconstruct the building and equip it with more modern appliances for the refining of gold and silver. In the remodeling, part of the old building at the back was torn away to make room for the new building shown by x in Figs. 1, 2, and 3. Plans now under way provide for the entire removal of the remaining portion of the old building, shown in Fig. 1, with the extension of the new building to Wall St. and the erection of a new entrance. The top of the chimney shown is 256 feet above the street level.

Since the year 1866, the sulphuric acid parting process was used at the Assay Office for parting the gold and silver bullion, but during the reconstruction of the plant this process has been abandoned and the electrolytic process adopted instead. Each process has advantages of its own, but, after an extensive test, carried over several years, the Government experts decided that the electrolytic process was preferable. One of the

chief difficulties with the sulphuric acid process would have been the objectionable nature of the fumes in view of the surrounding office buildings.

The new Assay Office, if it may be called such, is equipped with the most modern appliances for the treatment of gold and silver bullion and separating the individual metals. The photographs herewith shown illustrate the plant as it exists to-day. That this plant has been rebuilt on Wall St. instead of in some other obscure location is explained by the fact that New York is the center of the money market of the United States and it was deemed necessary, by the Government officials, to have a refining plant in close proximity to the business, and this decision has met with the approval of the trade. Miners and smelters can still ship their base bars and bullion to New York, obtain advances on it, and have it refined promptly. Shipping to other cities, where the refining could take place, would not be favorable in the majority of instances, for the reason that the headquarters of the mines or smelters are very frequently in New York City.

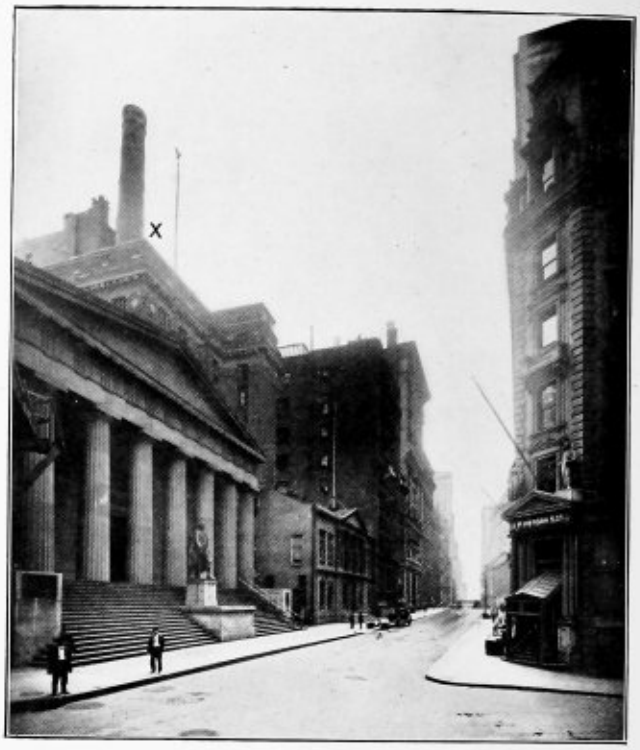

Fig. 2. U. S. Assay Office and Chimney. U. S. Sub-Treasury and Old Assay Office on left, J. P. Morgan & Co. Office on right. View from corner Wall and Broad Sts., looking north-east.

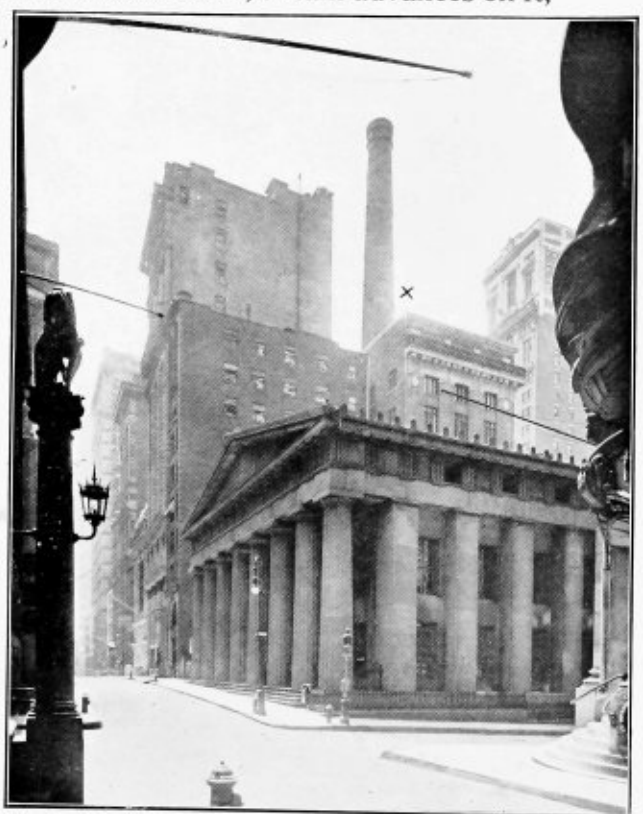

Fig. 3. U. S. Assay Office and Chimney. U. S. Sub-Treasury in Foreground. View from corner Nassau and Wall Sts., looking east.

The Assay Office will receive all gold and silver offered for handling, irrespective of shape, issuing a receipt for the weight of metal received, as the value, of course, has not yet been determined. The Government will purchase all the gold offered and pay $20.68 an ounce for it, or it will refine the gold and charge only a small amount for the work. It may or may not purchase the silver, but in any event it will refine it and return the exact amount offered. Pure gold and silver are seldom offered at the Assay Office, except where it is desired to dispose of some special lot, for there would be no object in refining them. The great majority of that of-

fered (bullion, foreign gold coins, old jewelry, scrap, etc.) contains both gold and silver and may be of various kinds, and it is the business of the Office to separate (part) these metals into their individual condition and remove any foreign metals, such as copper, tin, zinc, lead or iron. The greater part, of course, is a "clean-up" from a mine-smelter, or that from an electrolytic copper refinery. Such material may be in the form of "base-bars" or "bullion" containing gold and silver and other metals. The only requirement imposed upon material offered is that it shall contain not less than 20 per cent. of gold and silver and shall be worth at least $100. These restrictions avoid the handling of small lots which it would not pay to work.

Fig. 4. U. S. Assay Office and Sub-Treasury. Wall St. looking toward Trinity Church. Bankers Trust Bldg. in course of construction.

When deposits are received by the Assay Office, they are melted down individually in the furnaces illustrated by Figs. 5 and 6 and a "dip" sample taken for assay. This method avoids any uncertainty as in boring a cast bar. Melting is necessary in order to mix the ingredients, but taking a sample from a cast bar involves the uncertainty of segregation and liquation. Obtaining a sample while the metal is melted means uniformity. The metal is dipped out with a small ladle and immediately poured into water to granulate and cool it. The shot is used for the assay. The customer receives his return on the result of this assay (the whole operation of melting and assaying is completed in about

Fig. 5. General View—Deposit Melting Room—1st floor.

four days) and does not have to wait for the complete refining of the metal which would, of course, be impossible with small lots. Figs. 7 and 8 illustrate the Assay Department where the value of these "dip" samples is determined.

If the deposit runs less than 900 fine in gold, it is handled in the silver refinery, and if more than 900 fine in gold it is considered a gold proposition and handled in the gold refinery.

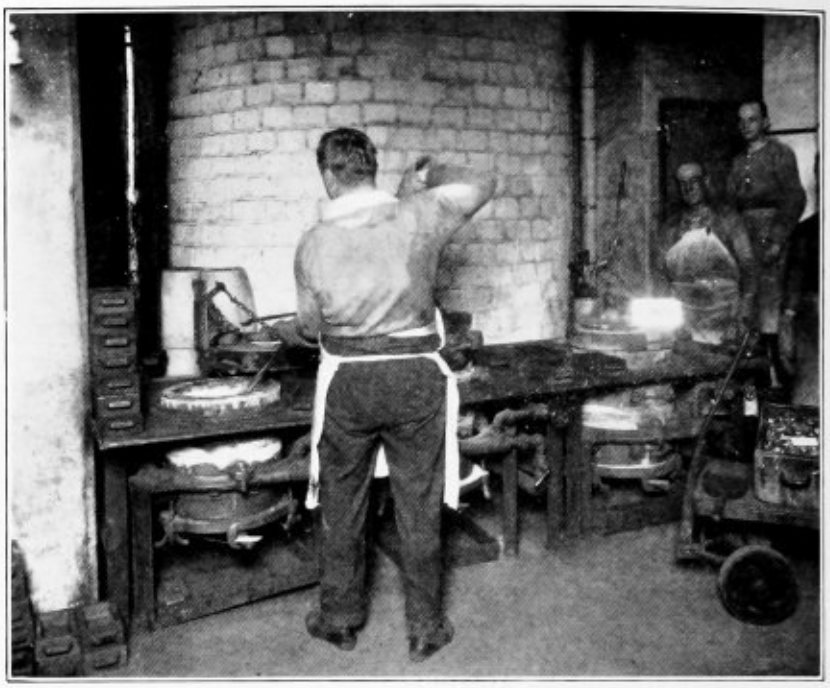

Fig. 6. Stirring a Deposit—Deposit Melting Room—1st floor.

If it has been found that the deposit comes under the head of a silver refining material, then it is remelted in the furnaces shown in Fig. 9. The furnaces are of the stationary type and oil used for fuel. It will be noted that these furnaces are built above the floor, which is a practice always followed in melting precious metals as it allows stirring, nitreing or other operations, involving the mechanical treatment of the metal, with less discomfort to the operator.

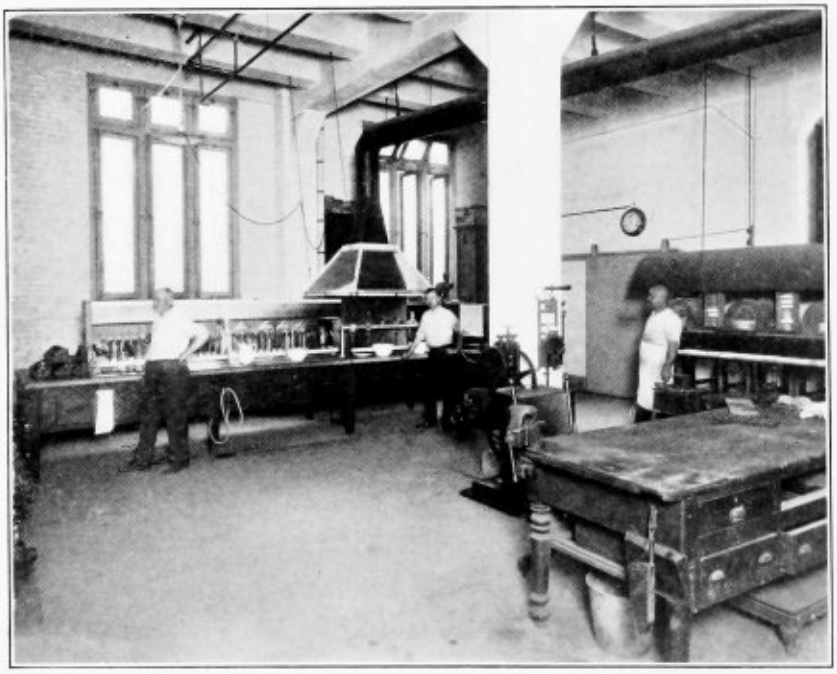

Fig. 7. Assay Laboratory Table and Cupel Furnaces—5th floor.

The material melted in the preceding manner is cast in iron molds, shown in Fig. 9, in the form of a thin plate, 16 inches long, 3 inches wide, and 3/8 inch in thickness. These are used as anodes for the electrolytic refining of the silver. In order to use these anodes for silver refining, however, it is necessary that there be an excess of silver; otherwise it would be impossible to refine the metal in this manner. The

proportions which can be used for this purpose are:

Gold—250 to 400 parts.

Base Metals—150 parts or under.

Silver—Remainder.

Total—1,000 parts.

In melting, the fineness of the silver is raised, if necessary, by the addition of other material carrying this metal. Obtaining the right proportion of metal is an operation requiring much patience and experience, and is done by carefully sorting the lots received and adjusting so as to obtain the proportions as nearly as possible. The base metals, when present in so large an amount as 150 parts, render the electrolytic refining somewhat difficult. It is necessary to surround the anodes with muslin bags to prevent the slime from floating away. Fig. 10 shows the furnace charges being made up in the office of the Melting and Refining Department.

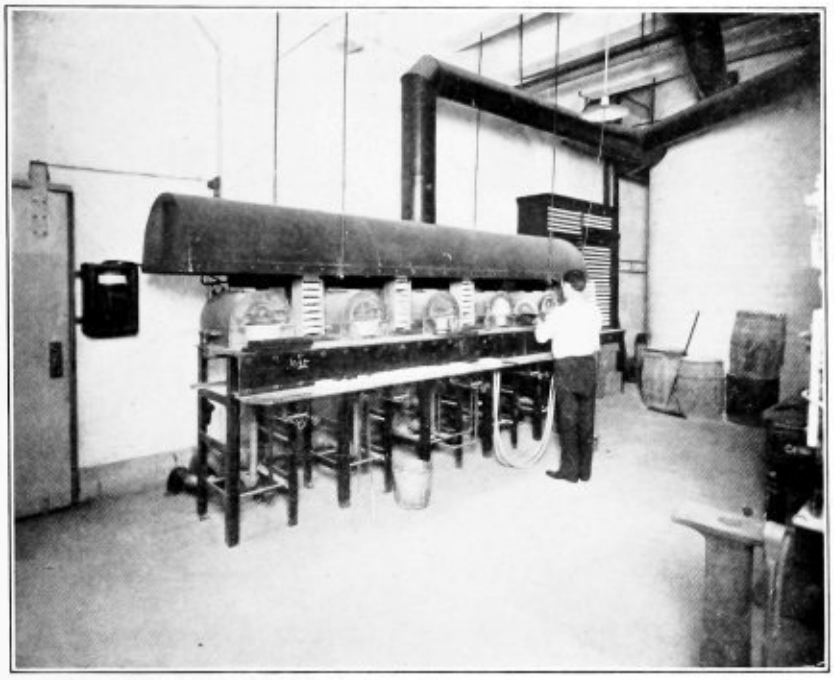

Fig. 8. Cupel Furnaces—Assay Department—5th floor.

Fig. 9. Anode Melting Furnaces—3rd floor.

The silver anodes, containing the gold and silver with the base metals, are suspended in the electrolyte used for the silver refining. This electrolyte is composed of a solution containing 3 per cent. of silver nitrate and 2 per cent. of free nitric acid. This strength must be continuously maintained. The tanks or "cells" used are shown in Fig. 11 and are composed of brown stoneware. The agitation of this solution, while the electrodeposition is going

on, is necessary, and is accomplished by a small glass propeller in each tank operated by a motor.

During the action of the current, the current density being 7 amperes per square foot, the silver only is dissolved and the gold is left in the bag around the anode as a spongy material. The base metal enters the solution and is not deposited with the silver. The electrolyte needs renewing frequently on account of the contamination by these base metals. The silver is removed from the impure electrolyte by means of copper and used over again for refining. The solution is then thrown away after the copper has, in turn, been recovered.

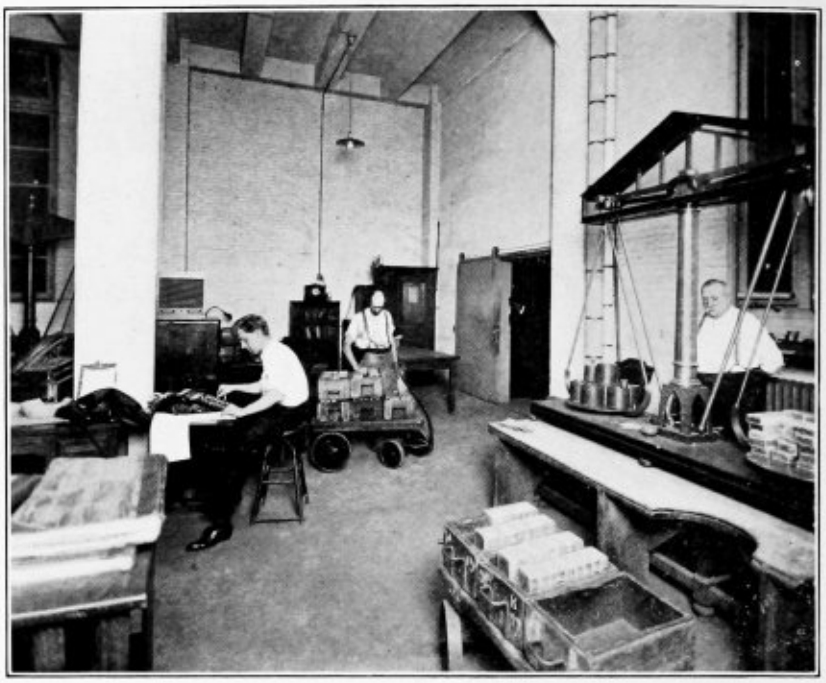

Fig. 10. Office of the Melting and Refining Department and Make-up Room—3rd Floor.

Every eight hours, each cathode is lifted out and the silver deposit scraped off. The silver thus obtained is in a spongy or granular form and is washed free from adhering solution, dried, and then melted into bars. With care it is obtained practically 999.5 fine. A very small quantity of gold finds its way into the silver, although it is watched as carefully as possible, and not permitted to exceed 2 parts in 100,000. It has been found impossible to prevent this, however, and all commercial silver bars thus produced will always contain this minute amount of gold.

Fig. 11. Electrolytic Silver Cells—7th Floor.

The gold is left in the bags, surrounding the silver anodes in the electrolytic silver refining, in the form of sponge or finely divided gold. This is removed, dried, and melted into gold anodes, for further refining, in the furnaces illustrated by Fig. 9. This gold is not pure and contains some silver and base metals. Any original deposit that is sufficiently fine in gold is melted with the gold for making the anodes. The refining of the gold is not carried on in exactly the same manner as the silver, the Wohlwill electrolytic process being used. Royal Berlin porcelain tanks are used, which are 19 inches long, 14 inches wide, and 12 inches deep. The electrolyte is composed of 30 grams of gold chloride per litre with a small amount of free hydrochloric acid. The anode used for this refining is 8 in. long, 3 inches wide and ½ inch thick. The anode is made wedge-shaped to prevent its being unevenly dissolved away near the surface. It is necessary, in the refining of the gold, to keep the silver content of the anodes down to 5 per cent.; if above this amount it forms an insoluble silver chloride which will finally give off chlorine and affect the working of the solution.

Fig. 12. Electrolytic Gold Cells—8th floor.

Fig. 13. Fine Gold Melting Furnaces—3rd floor.

This adherent silver chloride was formerly scraped off by hand, but it is now removed in a very novel manner. An alternating current is used in

connection with the direct current, resulting in a pulsating current through the solution which not only keeps the anode clean, but lessens the quantity of hydrochloric acid used. A current density of 70 amperes per sq. foot is used for the refining of the gold. By this is meant the direct current. The equipment for the electrolytic refining of the gold is shown in Fig. 12.

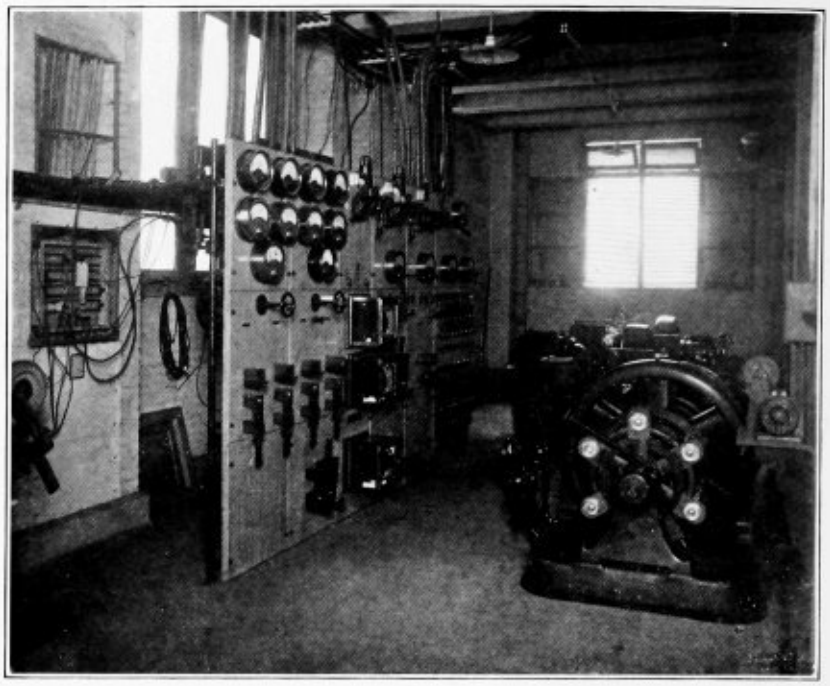

Fig. 14. Electrolytic Switchboard and Low Voltage Dynamo—6th floor.

The spongy gold, which deposits at the cathode in the electrolytic refining of the gold anodes, is washed free from electrolyte and then melted down in crucibles, in the furnaces shown by Fig. 13, and cast into gold bars for the trade. Gold produced in this manner is of high purity and surpasses any obtainable by other refining processes. It is very much purer than the gold obtained by the old sulphuric acid process for the reason that it does not contain so much silver. Gold produced by the electrolytic refining process is almost chemically pure and will run, in many instances, 999.9 fine.

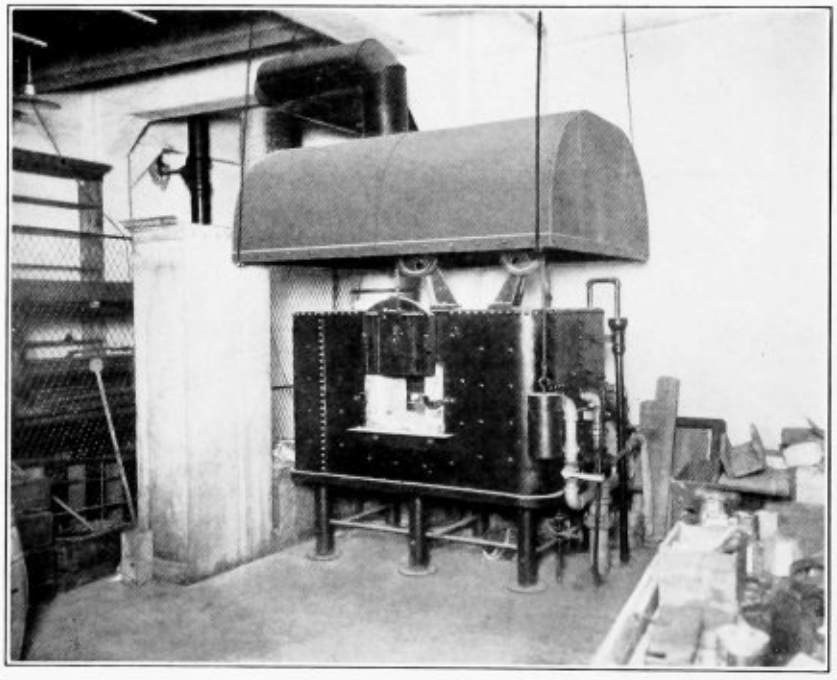

Fig. 15. Reverberatory Melting Furnace—6th floor.

Fig. 14 illustrates the low voltage dynamotors and switchboard supplying current to both the silver and gold electrolytic refining departments.

In the refining of gold by the electrolytic process, any platinum or palladium in the gold goes into the solution and remains there. After a time, when this electrolyte becomes so filled with base metals as to render its further use

impossible, it is syphoned off and treated with ammonium chloride (sal-ammoniac) which precipitates the platinum as ammonium platinic chloride. This is then filtered off and dried. Any palladium is then precipitated in the clear liquid as red palladium ammonium chloride by adding some potassium chlorate and potassium permanganate. This salt is then filtered out and dried. Both these salts are sold, when a sufficient quantity has been accumulated, to the highest bidder. The depositor of the original material, in which these metals may have been present, receives nothing for them. They are usually present in so small an amount that to make any returns on them would be impossible in the ordinary way. The amount of these rare metals obtained, however, has become considerable and from $50,000 to $100,000, it is stated, are now produced annually.

In Fig. 15 is shown a reverberatory furnace that has been installed in the Assay Office and is used for special work, such as cupelling base bullion that contains too great a quantity of base metals to allow refining in the ordinary way. It can also be used for nitreing base bullion which requires such treatment to bring it up to the necessary fineness for electrolytic refining.

In melting operations the Assay Office is what might be termed extravagant in its use of crucibles. A crucible for gold melts is used for three and sometimes four heats. It is then used for silver and may go to eight or ten heats, but no chances are taken that a break will occur with a pot of precious metal in the fire.

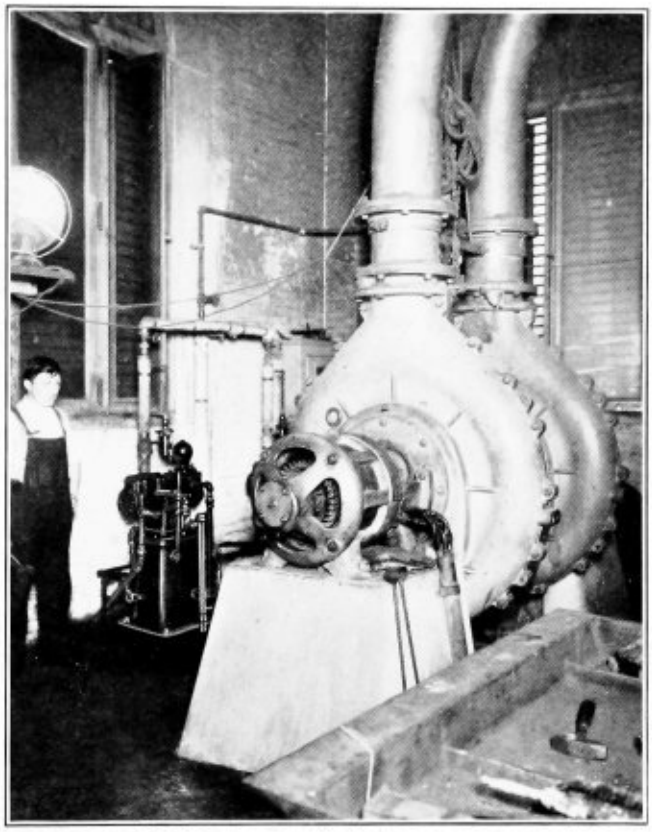

Fig. 16. Centrifugal Air Compressors and Fuel Oil Pumping System—1st floor.

The furnace equipment installed was especially designed to meet the particular requirements of the Assay Office and represents up-to-date practice in every respect. The use of both gas and oil is provided for. Oil is used for the purpose of economy in melting on the larger furnaces requiring high heats, while gas is used for the lighter work of smaller melting furnaces, cupelling furnaces, acid boiling flask burners, etc. Fig. 16 illustrates the pumping system supplying fuel oil to the oil burning furnaces, as well as two of the three centrifugal air compressors furnishing air to both the oil and gas burning furnaces. Fig. 17 gives an idea of the size of the gas meters employed, by comparison with the man standing alongside. Each meter has a capacity of approximately 4,000 cu. ft. of gas per hour.

Methods of recovery of the last particles of value at the Assay Office are very exact and painstaking. Beginning in the melting room, the flues from the melting furnaces lead into fume chambers equipped with a series of baffle walls. These chambers, situated on the lower floors, communicate with similar chambers on the top floor by means of square flues. The gases from the furnaces must pass through these chambers and flues before entering the main chimney. A great deal of valuable material is therefore recovered from these various reservoirs, and these careful methods are richly rewarded by the extent of the annual clean-up.

Fig. 17. Lighting Switchboard and Gas Meters—Basement.

In order to take care of any precious metals which might be carried off in the wash or rinse water from the various operations contingent upon electrolytic refining, a large settling tank has been installed in the basement, and in this tank any mechanically suspended gold or silver will settle and can finally be recovered.

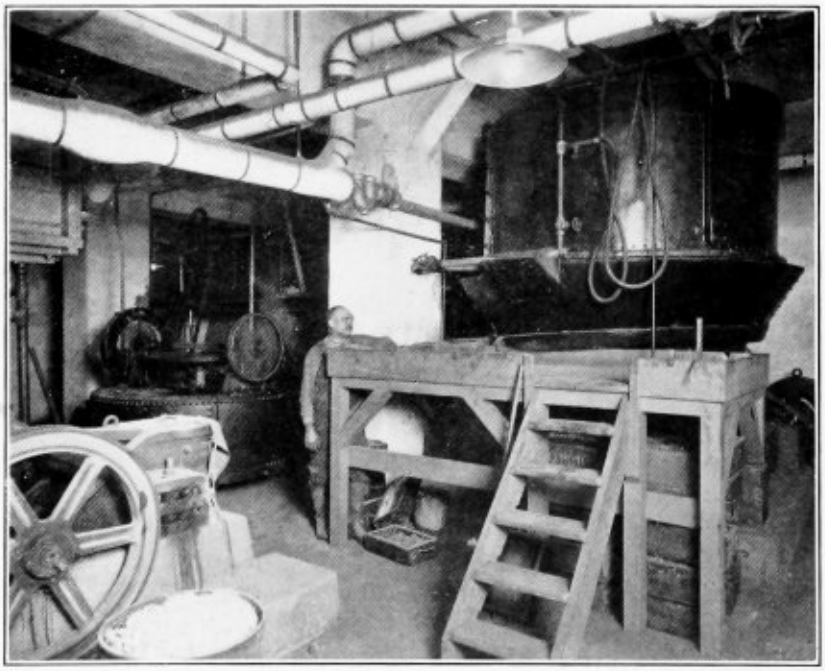

Fig. 18. Sweep Handling Machinery—Basement.

The modernly equipped sweeps department, shown in Fig. 18, has recently been installed in the cellar of the Assay Office to handle the refuse from the melting rooms themselves, such as the dust from sweepings, old crucibles, etc., which represent very valuable items and with which a large loss will take place unless carefully looked after. The sweeps are first crushed in a jaw crusher to a diameter of about half an inch or less.

The next operation is to grind the sweeps, thus crushed, to a 60 mesh fineness. The grinding is carried out wet and the grinder is of the Chilian mill type in which the pan remains stationary and two rolls revolve in it. The ground sweeps are then passed into two settling tanks. The material is next dried and is agitated while drying so that it will not bake on the bottom.

Figs. 19 and 20 show the completely equipped testing laboratory for testing the various solutions, etc.

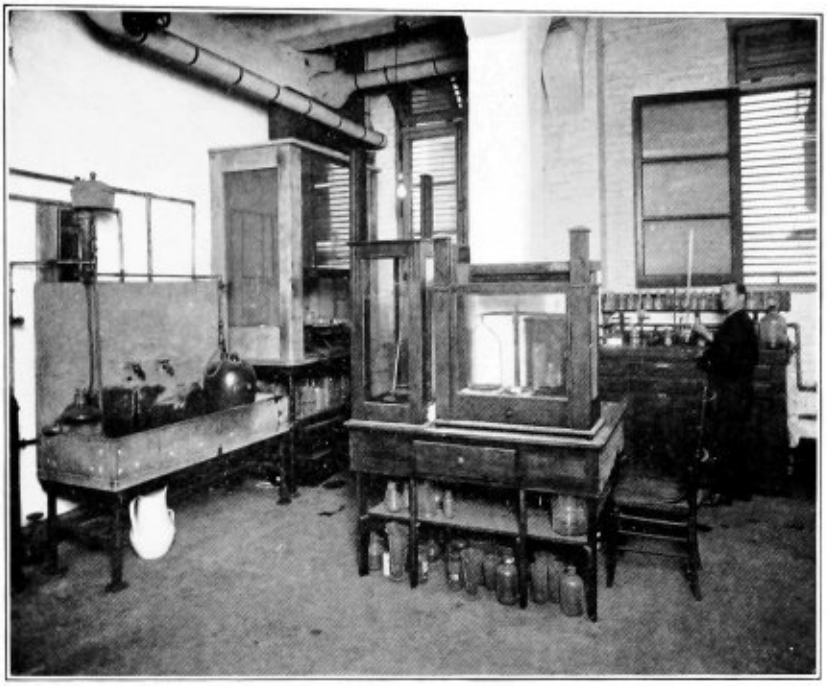

Fig. 19. Testing Laboratory—8th floor.

Fig. 20. Testing Laboratory—8th floor.

The Assay Office has been made completely fireproof and will be free from danger in this respect. The plant is now believed to be the most modern of its kind in existence.

Our grateful thanks are hereby extended to the publishers of the "Brass World", "Metallurgical & Chemical Engineering", and "Metal Industry", to whose articles on the work of the Assay Office we are indebted for much of the material used above.

We make a specialty of industrial furnace equipment to meet individual requirements. The following list of furnaces, all of which have been built for each purpose specified as well as many others not mentioned, illustrate the variety of work we do and our familiarity with furnace and fuel problems.

ANNEALING FURNACES: Rolling mill type for brass, copper, aluminum, steel and German silver bars, sheets, coils, wire, tubes, etc. Also for miscellaneous stamped, punched or drawn parts such as cups, shells, etc.
Stationary type with packing boxes for bright annealing of armature laminations, sheets, coils, wire and other steel products.
Automatic type for brass, copper, steel, iron and aluminum parts of uniform size and in large quantities, such as cartridge shells, eyelets, ferrules, buttons, caps, cups, springs, bolts, nuts, punchings, etc. Furnished with or without quenching tank and automatic conveyor. Automatic charging, heating, conveying, discharging, quenching, draining and delivery.
Semi-automatic type for aluminum, brass, copper or steel parts in small but irregular shapes, such as cups, shells and special drawn, stamped or punched parts; also for German or sterling silver flat ware, spoons, knives, forks, dishes, etc. Continuous annealing with automatic charging and discharging operations.
Car type, with removable hearth, for heavy and irregular shaped castings or forgings.
Car and ball type with pot for bright annealing of wire, coils, sheets, armature laminations and similar steel products.
Removable roof type for steel castings, gun carriage parts, heavy forgings, etc. Also for miscellaneous steel products in pots.
Stoker fired recuperative type for steel, brass and copper rolling mills and miscellaneous work.

BILLET HEATING FURNACES: Stationary and continuous types. For brass, copper and steel billets. Intermittent or continuous operation.

BLOWERS: Positive pressure or turbo types for air, belt or direct motor driven; argand or turbo types for steam.

CASE HARDENING AND CARBONIZING FURNACES: Single or multi-chambers with or without recuperation. Built in a variety of sizes and arrangement of chambers to suit all requirements. For automobile, engine, machine and other parts.

CYANIDE HARDENING FURNACES: Single or twin pot type with pre-heating chamber.

DRYING FURNACES: Rotary type for continuous operation. Stationary type with single or multi-chambers with or without muffles. For metal goods, earths, phosphates, chemical products, etc.

ENAMEL FURNACES: Standard muffle type for oil or gas. Improved down draft, recuperative SEMI-PRODUCER type for bituminous coal. Muffleless type for oil or gas, with automatic control of fire and moving gases. Also for enamel melting.

FORGE FURNACES: Light forging type for short end heats, tool dressing, knife blanks, shear blades, files, pliers, etc. Also for upsetting or heading light bolt or rivet stock, shaping, bending, etc. General smith work and welding operations, chain links, rail bonds, eye-bending, swedging, pointing, tire welding, etc.
Bolt, bar and rod heating types with economizer shields. Heats from 3 inches to 30 feet.
Bulldozer type for small hammer work.
Heavy forge type for billets and large steam hammer work.
Stoker fired recuperative type for rods, billets, miscellaneous forging, etc.

HARDENING FURNACES: Stationary type in small sizes for dies, cutlery, tools, springs, etc. Larger sizes for automobile springs, crank shafts, etc. For circular, band and hand saws. Also for saw teeth.
Automatic type for balls, bolts, nuts, washers and other small steel parts of uniform size in large quantities. Furnished with or without tank and automatic conveyor. Automatic, charging, heating, conveying, discharging, quenching, draining and delivery.
Semi-automatic type for trap parts, pens, springs and large quantities of irregular shaped pieces to be handled on pans. Automatic charging and discharging operations.
Pot type for hardening in lead, cyanide, barium chloride or other salts.

HEAT TREATING FURNACES: Stationary and semi-automatic types. Single or multi-chambers with or without recuperation. Built in a variety of sizes and arrangement of chambers for all classes of light or heavy work.

HEATING FURNACES: Stationary and semi-automatic types. Constant or intermittent heating for copper and steel billets, etc.
Plate and angle heating furnaces. For heating, bending and flanging plates, angles, beams, rods, etc.
Stoker fired recuperative type for miscellaneous heating operations.

LEAD POT FURNACES: Single or twin-pot types. In all sizes and capacities, with or without spout and valve. For melting lead, tin, babbitt, etc. Also for lead hardening and tempering.

MELTING FURNACES: Stationary, tilting, crucible or reverberatory types. For aluminum, brass, bronze, copper, gold, silver, etc.
Melting furnaces for enamel powder and special purposes.

MUFFLE FURNACES: For enameling, rust-proofing, assaying, scorifying and mint work.

NIBBING FURNACES: For spring work, short end heats, etc.

OIL APPLIANCES: Burners—15 types—for oil or gas with steam or air. Burner plates. Oil pumps. Tell tales. Relief valves. Unloading hose. Oil storage tanks. Fire tiles, etc.

PLATE HEATING FURNACES: For heating and flanging operations in connection with ship, railroad and boiler shop work, miscellaneous forming, bending, etc.

REHEATING FURNACES: Stationary, single or multi-chamber types. For billet heating or heat treating operations.

RIVET FORGES: Stationary type with economizer shields.

RIVET ROD FURNACES: Single or double end types. Short or long heats—up to 30 feet.

SPRING FITTING FURNACES: One, two or four fitter types. Nibbing, forging, welding, drawing, etc.

SOFT METAL MELTING FURNACES: Single or twin-pot types. In all sizes and capacities, with or without spout and valve. For melting lead, tin, babbit, etc.

STOKER FIRED RECUPERATIVE FURNACES: For steel, brass and copper rolling mills; for rods, billets and miscellaneous annealing, heating and forging operations.

SCALING FURNACES: For copper and steel sheets and special drawn shapes.

TEMPERING FURNACES: Stationary type for dies, tools, saws, etc. Tool dressing and miscellaneous tempering.
Automatic type for drawing temper on large quantities of small and regular size pieces.
Multi-chamber type for springs, plow shares, automobile parts, etc.
Multi-chamber type with muffles for needles, springs, and light steel parts.
Saw tempering type with removable dies for saws, trowels, etc.

UPSETTING FURNACES: For bolt or rivet stock, special forming operations, etc.

VARNISH BOILING FURNACES: For varnish, oils, gums, greases, etc.

WIRE FURNACES: For annealing, tempering and baking wire.

WRITE FOR CATALOGS

W. S. ROCKWELL COMPANY

50 CHURCH STREET (Hudson Terminal Building) **NEW YORK**

We solicit inquiries for better heating methods and equipment irrespective of purpose or fuel.

"FURNACE AND FUEL TO SUIT THE WORK"—is the rule governing our consideration of a new or the improvement of an old furnace equipment to suit your needs under your plant conditions. Our purpose is to deal with each case on its individual merits and to recommend changes in methods or equipment only when it is apparent that these will be productive of better results.

We do not merely sell furnaces, but rather means for efficient production in industrial heating operations, which involves a great deal more than brick and iron or the burning of fuel.

LET US HANDLE YOUR FURNACE PROBLEMS

We make inspection of plant, devise methods and means of working, prepare plans, furnish complete industrial furnace equipment and guarantee results using either coal, coke, gas or oil, as the best interests of our patrons require.

"FURNACE AND FUEL TO SUIT THE WORK"

COMPLETE INDUSTRIAL FURNACE EQUIPMENT

OIL — GAS — COAL

W. S. ROCKWELL COMPANY

FURNACE ENGINEERS AND CONTRACTORS

50 CHURCH STREET **NEW YORK**

(Hudson Terminal Building)

CABLE ADDRESS
"LEWKCOR" NEW YORK
WESTERN UNION AND LIEBER CODES

APRIL, 1915