line by substituting curved lines for the straight lines with which we are familiar in the typical pin-connected truss-bridge, and the attempt has certainly been successful. The draw-span measures 46 feet from center to center of the trusses, which are 48 feet in depth between the centers of the chords at the deepest part of the truss over the center pier.

A clear roadway of 42 feet is provided, and the effect, as seen in the accompanying photograph, is certainly spacious and imposing. The sidewalks are 9 feet in width. They are carried on cantilever trusses which are riveted to, and extend at right angles from, the bottom chords of the trusses. The floor of the bridge consists of transverse floor beams which extend from truss to truss, with longitudinal stringers riveted between them, the whole being covered over with buckle-plates on which is laid a concrete and asphalt roadway.

The extensive sub-aqueous foundations called for 33,600 cubic yards of concrete and masonry below the water-line, and in the piers and abutments, above water, there are 23,800 cubic yards of masonry. The total cost of the structure was $1,500,000.

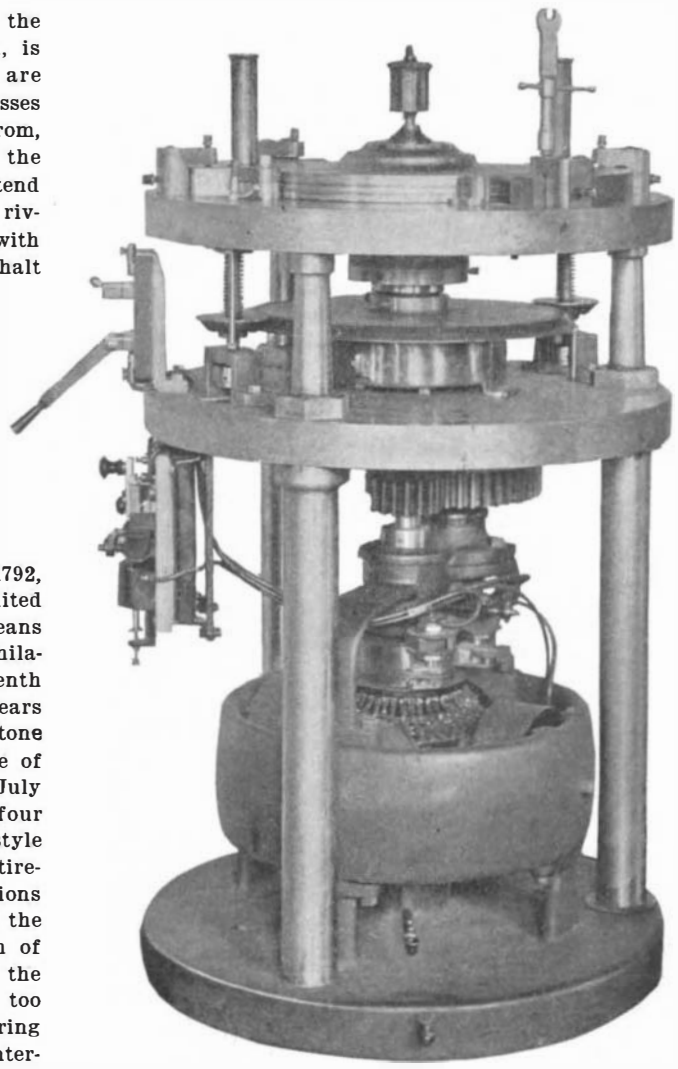
HOW MONEY IS MADE.*

BY MARCUS BENJAMIN, PH.D.

The Mint in Philadelphia was established in 1792, and is the parent institution of its kind in the United States, the other coining mints being in New Orleans and San Francisco. The first mint building in Philadelphia was erected on the east side of Seventh Street above Market Street, but before many years it was found too small for use, and the cornerstone of the second edifice, which is on the north side of Chestnut Street below Broad Street, was laid on July 4, 1829, but it was not ready for occupancy until four years later. It is of marble and in the Grecian style of architecture. In 1854 the building was made entirely fireproof, and since then numerous alterations have been made in the interior to comply with the requirements of the times. But with the growth of the country and the increasing demands upon the mint for coinage, the building has again grown too small, and a new mint has been erected on Spring Garden Street, near Seventeenth Street. Many interesting memories are associated with the old structure, and it would be pleasant to recall the work of the distinguished men who have been connected with it, such as James C. Booth, the melter and refiner, who was succeeded by D. K. Tuttle; Jacob B. Eckfeldt, assayer, and William Barber, engraver, who was succeeded by Charles E. Barber. Of these Messrs. Barber and Tuttle are still in the service. There is only space to mention one among the interesting rules, which required that provision should be made "for the care and feeding of watch-dogs," but it illustrates the primitive methods by which the Mint was cared for in early times.

The process by which the ore from the mine is changed into the new and glittering coin is long and tedious, but a brief summary of the principal steps may be of some interest. The ore as it comes from the ground must first pass through the smelting process, by means of which the metal is extracted and converted into bars of gold or silver, the methods naturally varying, according to the character of the ore and the locality.

Some idea of the enormous amounts that have been handled by the various mints and assay offices is shown by the statement that $2,996,763,252.27 represents the total amount of coinage of the various mints of the United States from the establishment of the Philadelphia Mint to the end of June, 1900. Of this great amount the total gold coinage was $2,167,088,113, the total silver, $796,171,159.55, and the total minor coinage amounted to $33,503,969.72. The bars of gold or silver, known as "bullion," are carefully assayed, either at the Mint or at one of the assay offices in New York city, Helena, Mont., or Denver, Colo.,† and from these the coins are made. The first step consists in preparing an alloy for coinage of the refined gold or silver, which is nearly pure, with copper, and this is accomplished by weighing out quantities of gold and copper, or silver and copper, which are then melted together in a large black-lead crucible; and after the molten metals are thoroughly mixed they are poured into cast-iron molds to produce rectangular bars called "ingots," which vary in size according to the denomination of the coin for which they are intended. Thus,



UPSETTING MACHINE—USUALLY CALLED A "MILLING" MACHINE.

the ingot for the "double eagle" is 12⅝ inches long, ½ inch thick, and 1½ inches wide, and weighs 80 ounces, while the ingot for the silver dollar is 12½ inches long, ½ inch thick, and 1⅝ inches wide. The ingot is then passed between heavy rolls from which it issues in long narrow strips. This operation is called "breaking down," and makes the metal hard and springy, and if continued would cause it to crack and split. In order to prevent this the strips are annealed by being heated in a furnace to about 1,500 deg. F., where they remain for about an hour and a half, according to the heat of the furnace and the size of the strips. They are then cooled in water and each strip wiped dry, after which they are finally passed through the rolls. "Double eagles" and "eagles" pass through the finishing rolls three times, while "half" and "quarter eagles" must go through at least four times. The strips are again annealed, cut in two for convenience in handling, taken to the pointing rolls so that an inch and a half of the end may be pointed or flattened, and greased with tallow to permit their easy passage through the dies of the drawbench. The drawbench consists of two independent sections, each of which has two dies regulated by set-screws, and between these dies the pointed end of the strip is passed, being seized by the jaws of the carriage, drawn by means of an endless chain, which reduces the strip as nearly as possible to standard weight. This is ascertained by weighing sample blanks or planchets that are cut from either end. When the strips are deemed of proper weight they are taken to the cutting shears and the pointed ends cut off, after which they pass to the cutting press, where, by means of a steel punch working into a matrix, the planchets are cut therefrom. These blanks are then taken to the washing-room, where they are cleansed from grease by washing in a lye composed of soap, borax, and water. After rinsing in clean water they are dried in a large copper pan heated by steam. They are then carefully examined on the selecting table and all perfect blanks separated from the imperfect ones, and, in the case of gold coins, must have the following weights: "Double eagle," 516 grains; "eagle," 258 grains; "half eagle," 129 grains; and "quarter eagle," 64.5 grains, although an allowance of half a grain is permitted in the case of the "double eagle" and "eagle," and a quarter grain in the "half" and "quarter eagle." This weight is determined in the adjusting room, where each piece is placed upon the balance, and, if heavier than the limit, is reduced by filing its edge, whereas if lighter it is condemned and returned to the melter. The accepted planchets are then taken to the milling machine where the raised edge, technically called "milling," is put on them.

The machines known as milling machines are simply upsetting devices, and the former designation often misleads one not familiar with minting processes. We illustrate the latest type, which has just been installed. Its duty is to upset the blank after it leaves the cutting press by passing the piece between a segment and a revolving disk, shown at the extreme upper left-hand corner, just below the feed tube. Grooves are cut in the disk and segment by a sharp tool, and the shape of the grooves has been the subject of considerable experiment in order to give as square an edge as possible to the finished coin without producing a fin. It is driven by a 3 horse power compound-wound motor running at 375 revolutions per minute, and transmits a rotary movement to the disk through back-gears. The disk runs at 60 revolutions per minute. The blanks are fed by the operator into the tube and are pushed against the disk by a small feeder, and the friction on the disk carries the blank around the inside of the segment and then it drops into a box. This upsetting machine will upset 575 half-dollars per minute, and the machines for other denominations will turn out a proportional amount. Nine of these machines, excepting the motor, were designed and built at the U. S. Mint, and it is the intention of the authorities to gradually work into the designing and building of several special machines for coining operations.

THE NEW MINT, SPRING GARDEN STREET, PHILADELPHIA.

The advantage of the milling process is that it protects the surface of the coin from abrasion. The milled pieces must be again cleaned and softened, which is accomplished by annealing them at a cherry-red heat, after which they are dipped into a solution of sulphuric acid and water sufficiently strong to clean and brighten them. They are then rinsed in boiling water and shaken in sawdust to dry them, after which they are ready for the stamping press. Before stamping a brief description of the die is necessary. The design being selected, a drawing is made the exact size of the coin required, and from this drawing a tracing is taken for the purpose of transferring the design to the die. This is accomplished by covering the surface of the die, which has previously been made smooth, with a thin coating of transfer-wax; on this wax the tracing is reproduced by rubbing, leaving the design on the steel, and as this is easily obliterated it is best to go over the lines with a sharp-pointed instrument. The next step is to remove the steel in the die by means of chisels and gravers, so that a relief may be had on the coin. From time to time, as the work progresses, proof impressions are taken until the desired result is obtained. The die is then hardened, after which it is ready for use in the press. These dies are then adjusted in the stamping presses and the blanks fed to

*For the information contained in this article the writer is greatly indebted to the courtesy of the Hon. George E. Roberts, Director of the Mint.

†The assaying process is briefly described in an article by the present writer on "The Methods Employed by the Assay Commission" that appeared in the Scientific American for May 19, 1900.

the press through a vertical tube, and as each piece reaches the bottom of the tube steel feeders carry it over between the dies and place it in a steel collar, so that when the dies close upon the planchets it will make the obverse and reverse impressions on the coin. According to a description of the process in the Philadelphia Mint it is said that "double eagles" and "eagles" may be struck at an average rate of 80 a minute, while for the "half" and "quarter eagles" the average rate is 20 per cent greater. The pressure required in the stamping press to produce a sharp, clear impression of the "double eagle" is said to be 175 tons, while only 120 tons are required for the "eagle," 75 tons for the "half eagle," and 40 tons for the "quarter eagle." The silver dollar, half dollar, and quarter dollar are struck at the same average rate as the "double eagle" and "eagle," while the speed for the dimes is equivalent to that of the smaller gold coins. The pressure used in stamping the silver coins is 150 tons for the dollar, 110 tons for the half dollar, 80 tons for the quarter dollar, and 40 tons for the dime. From the stamping press the coins pass to the counting room, where they are put up in proper quantities for distribution. All coins but cents are counted in the usual way, the latter, however, are counted by means of a kind of screen. There are 1,000 depressions in it the exact size of a cent. The coins are brought from the machines in pails and a quantity are thrown upon the counting-screen, which is shaken until each of the depressions is filled. The cents are then tied up in coin sacks. In this very brief summary of the process by which the coin passes from the bullion to the finished money many of the important details have necessarily been omitted, but if there is any one thing more than another that is of conspicuous interest in the mints and assay offices of the government, it is the fact that nothing is lost. Every bit of metal is carefully accounted for, and defective blanks are promptly returned to the melter. Every kind of waste material that is likely to contain gold is preserved. The floor of the melting room is swept each day, and the gatherings are mixed with a suitable flux and thrown into a crucible. "Sweeps" consisting of broken crucibles and dipping cups, all ashes from the fires, burned gloves, aprons, sawdust, and packages in which bullion has been sent to the mint, settlings in catch wells and roof gutters are carefully preserved. It is reported that sales of such "sweeps" at the Philadelphia Mint have yielded a return as high as from $18,000 to $20,000 a year from the melting department alone.

THE WRECK OF THE SANTOS-DUMONT BALLOON.

All those who are interested in aerial navigation must welcome the news that M. Santos-Dumont is constructing a new balloon which will be ready early in September. It will have the same cubical capacity as the one which came to grief on August 8, but instead of being cylindrical, it will be ellipsoidal in shape, and the small interior balloon used for giving a greater or lesser inflation, instead of being at one end, will be placed in the middle. The illustrations which have come to hand of the unfortunate accident to Santos-Dumont's balloon on August 8 are very interesting, and they show how near he came to being seriously injured. On the morning in question he left St. Cloud at 6:12 and reached the Eiffel Tower in nine minutes. When halfway back, about fifteen minutes after he started, he noticed that the front of the balloon was collapsing, which seemed to indicate that gas was escaping. He at once attempted to drive air into the small balloon, or balloonet as it is called, but the motor refused to act. When the gas left the rear of the balloon, the silk hung in flabby folds which threatened to catch the screw. M. Santos-Dumont was afraid of an explosion, which would inevitably be followed by a fall, so he stopped the motor, and the balloon was at the mercy of the wind. It drifted about for a time and finally, after striking the chimney, went down between two sections of the Exposition Trocadero Hotel, where it hung suspended, as shown in our engraving, which is reproduced from l'Illustration.

The balloon lay at an angle of 60 degrees, the screw resting on the roof of one of the lower pavilions of the hotel. M. Santos-Dumont climbed up to the roof by means of a rope which was lowered to him and escaped without injury. When the firemen arrived he helped direct the salvage operations. He first ascertained that the motor had not been damaged. Ropes were then fixed to the framework and the balloon was finally lowered to the yard. The aeronaut at once announced his intention of building another airship to compete for the Deutsch prize, the competition closing for the year on September 15. If the prize is not won within five years, beginning April 15, 1900, the offer of M. Deutsch will become void. Until someone succeeds in gaining the prize M. Deutsch will turn over to the committee of the Aero Club the sum of 4,000 francs each year for distribution among those most deserving of encouragement.

THE WRECK OF THE SANTOS-DUMONT No. 5.

The Ruby.

In trade three classes of rubies are distinguished—rubies of the Orient, rubies of Siam, and spinel rubies.

The different varieties called balass rubies, Brazil rubies, rose rubies, rubace rubies, rock rubies, Siberian rubies, etc., cannot be compared at all with the preceding, of which they have neither the composition nor the constitution. Apart from the balass ruby, which from a scientific view-point does not differ from the spinel ruby, all the others are, properly speaking, only colored quartz or feldspar. The ruby of the Orient is the first of all colored stones in beauty, as in price. Its marvelous hue is that of the human blood, as it jets from an open artery, that of the red ray of the solar spectrum at its maximum intensity.

The ruby is one of the most exquisite products of nature, but it is becoming rare and more rare to find it perfect. It even causes atonishment to find an Oriental ruby as large in size as the topazes and sapphires of the same countries. If it reaches a certain size it is almost always filled with defects.

Rubies of all sizes are put to use. The smallest, down to 20 or 30 to the carat, are employed specially for delicate jewels, for numbers, figures, etc., Many of the smallest are cabochons. When a ruby exceeds the weight of a carat it commands a high price. A ruby may fetch ten or twenty times the price of a diamond of the same weight if it is really of a superior quality.

It may be interesting to give the figures at which rubies were valued fifty years ago. They were much lower than to-day. A perfect ruby of one carat was priced at 240 francs; of two carats, 960 francs; three carats, 3,600 francs; five carats, 14,400 francs; and six carats, 24,000 francs.

In general the cutting as a brilliant is alone suitable for a fine ruby. The ruby is very hard, almost as high as the sapphire. It was but little used for engraving in ancient times, doubtless because of the difficulty of finding those offering a sufficient surface, a reason more plausible than the explanation that the wax adhered to seals made with this substance. The two engraved rubies seen at the Mineralogical Museum of the Garden of Plants prove that successful work of this kind is well nigh impossible.

The carbuncle, to which the ancients attributed fantastic properties, was no other than the ruby. It served, as is said, to give light to certain large serpents or dragons whose sight had been enfeebled by age; they bore them constantly between their teeth, and laid them down only for eating and drinking. It is even claimed that the carbuncle emitted light in darkness, and that the thickest clothing could not stop its rays. Without all the exaggeration of such legends, it was believed for a long time that rubies contained luminous rays. The truth is that they have double refraction and send out the red rays with unequaled brilliancy. Traversed in a vacuum by an electric current they are illuminated with a red fire of extreme intensity. The greatest heat does not change their form or their color.

The most beautiful rubies come from Ceylon, India and China. The mines of Pegu are nearly exhausted, or but little worked to-day. The regions where they are situated are dangerous of approach; besides, in the states of the Grand Mogul the exportation of rubies is forbidden until they have been exhibited to the sovereign, who retains the most beautiful. The stone known under the name of the ruby of Siam is distinguished by its deep red color, somewhat resembling the garnet. But there is no need of being a connoisseur to note the difference between the ruby of Siam and the garnet.

The spinel ruby is much less rich in color, and contrasts visibly in tone with the other kinds. It is of a bright, poppy red. It is much less rare, especially of large sizes, and is not so hard. It is found in the same countries, in the midst of deposits of alluvium in the beds of the torrents. The finest come from Pegu and Cambay. The balass is a very inferior quality of the spinel, of which the color approaches a wine red or clear violet. It is cut with facility, but much skill is required for its polish. It is generally of little value, though large sums are paid for some balass rubies. A beautiful specimen belonging to the treasury of the crown cost 10,000 livres.

The large rubies of the Orient, being excessively rare, are so much the more celebrated. The largest known in Europe is said to be the one that the Russian caravans brought from China with other precious stones in exchange for their peltries, and which forms today one of the rarest ornaments of the Imperial Court of Russia. The one of which Chardin speaks with admiration was a cabochon, was of splendid color, and bore engraved the name of the sheik Lephy. That of the King of Persia, of which Tavernier made a drawing, weighed 175 carats. That of the King of Visapour, a cabochon, fetched in 1653 near 75,000 francs. The one possessed by Gustavus Adolphus was as large as a small egg, and of the most beautiful water. It was presented to the Czarina on the occasion of his visit to St. Petersburg in 1677.

It is seen by the inventory of 1791 that France possessed 81 Oriental rubies, of diverse forms and qualities. One of them remained for a long time in a rough state, in consequence of two or three points which could not be removed without sensibly diminishing the value of the stone; but a diamond artist was able to put these defects to use and transformed the rough stone to a dragon with outstretched wings. This is the most beautiful Oriental ruby known.—Le Diamant.

The Current Supplement.

The current SUPPLEMENT, No. 1340, is begun by a most interesting article upon "The Temples of Nikko," accompanied by six engravings. "Fossils and Their Teachings" is a lecture by Prof. Angelo Heilprin. "St. Paul's" gives a report of the official architect relative to the condition of the celebrated cathedral. "Smyrna Fig Culture in the United States" is by Dr. L. O. Howard, and is accompanied by a number of illustrations. "The Lighthouse Depot of France" describes the interesting museum connected with that institution. "Cements" is by Willett Pierson. The usual "Trade Suggestions from United States Consuls" and "Selected Formulæ" are included in this issue.

Contents.

(Illustrated articles are marked with an asterisk.)

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THE MANUFACTURE OF COINS AS CARRIED ON AT THE UNITED STATES MINT, PHILADELPHIA, PA.—[See page 154.]