horse power per hour, the consumption for average of 16 hours would be 1,140 pounds per hour, and 18,240 pounds, or 9.12 tons, per day.

The Delamater and Corliss works both claim a duty of $2\frac{1}{2}$ pounds of coal per horse power on the engines constructed by them, but in this estimate 3 pounds have been allowed, and manufacturers have proposed to furnish engines and compressors capable of charging one car per minute, for \$20,000. The present motor runs 10 mile, but with the increased reservoir capacity of motors not carrying passengers, the run should be increased to 13 miles, and one station in the middle should run the road.

To remove all questions, however, as to the sufficiency of the estimate now submitted, two stations will be allowed instead of one, each costing \$20,000, and the coal consumption will be increased to 12 tons. The estimate will then stand, as compared with horse power:

Interest and repairs on 167 cars, costing \$92,000, at 20 per cent. per annum.	\$19,400
Interest and repairs on compressor plant, costing \$40,000, at 20 per cent.	8,000
Interest on building for compressors.....	5,000
84 drivers and conductors, \$1,000 per car	84,000
4 engineers at \$3.00 per day,	
4 assistants at 2.00 "	
8 firemen at 2.00 "	
12 tons coal at 41'00 " } per year,	27,010

Total motor expenses.....	\$143,410
Cost per passenger for running expenses,	0.89 ct.
Other expenses as before, including a six per cent. dividend, \$730,046—\$462,414.....	\$267,632
Total expenses, including dividends.....	\$411,042
Cost per passenger on 16,000,000, with dividend.....	2.57 cts.
Cost per passenger, exclusive of dividend	2.12 "
Maximum capacity of 167 cars all seated, and assuming all passengers as through.....	20,000,000
The comparison of running expenses above stated, with horse power per passenger.....	2.88 cts.
With pneumatic motor.....	0.89 "

And a very slight increase in the number of passengers would permit charges to be reduced to $2\frac{1}{2}$ cents, and still pay 6 per cent. dividends.

CONSEQUENCES.

The estimate herewith submitted, which is believed to be full and liberal, would seem to justify conclusions of great practical importance to stockholders of surface roads and to the public generally. The Second Avenue Railroad has been taken as an illustration, only because the data were accessible. The same results would, no doubt, follow a comparative estimate on other roads.

On the basis of sixteen millions of passengers carried on this road, operated by horse power, the actual results were:

Running expenses per passenger, inclusive of dividends and general expenses ..	2.88 cents.
Estimate by use of pneumatic motor ..	0.89 "
Cost per passenger by horse power, including general expenses, but not dividends ..	4.10 "
Estimate of use of pneumatic motor ..	2.12 "
Cost per passenger by horse power, including both general expenses and dividends.....	4.55 "
Estimate by use of pneumatic motor.....	2.57 "

What is the lesson which is taught by these figures? If, on the basis of the actual business of the Second Avenue Railroad, the economy of operation can be so greatly increased by the use of the pneumatic motor, that dividends can be paid on a charge of $2\frac{1}{2}$ cents per passenger from City Hall to Harlem, a distance of 8 miles, who can calculate the increase from greatly reduced fares coupled with accelerated speed?

The elevated railroads have been a complete success. Horse railroads and stages are doomed; their patronage is rapidly departing, but the compressed air motor comes forward opportunely to save surface roads from ruin, retain their efficiency, usefulness, and dividend earning capacity, utilize existing roads, plant, and employees, and secure a change of system almost without any expenditure of capital, since the sale of horses and harness will generally pay for the motors that supersede them.

If the Second Avenue Railroad Company would put the fare through from City Hall to Harlem at 5 cents, or half the elevated railroad charge, and run the 8 miles with compressed air in 40 minutes, a speed entirely practicable if street obstructions are not too numerous, the bulk of the population would patronize the surface roads; but if these improvements are not adopted, it is too clear to admit of controversy that horse railroads must succumb. A successful competition with elevated railroads is with horse power obviously impossible.

Respectfully submitted,
H. HAUPT, Consulting Engineer.

SUPPLEMENT.

For several days previous to March 12th, 1879, experiments were made with the motor on the Second Avenue Railroad, the results of which it is proper to note.

March 9th, started from depot at 127th street, and made three round trips, with the following record:

1st trip started with pressure.....	360 pounds.
Consumed	95 "
Returned with.....	265 "
2d trip started with.....	265 "
Consumed	95 "
Returned with	170 "
3d trip started with	170 "
Consumed.....	75 "
Returned with.....	95 "

This result was so remarkable, that the president of the company, Mr. F. Henriques, requested the writer to superintend some further experiments, to ascertain if increased duty would be secured by running at reduced pressures.

Accordingly, on March 10th, three more trips were made, with the following record:

1st trip started with.....	360 pounds.
Temperature of water	324°
Mean working pressure while running	120 pounds.
Water absorbed	31 "
Pressure on return.....	290 "
Consumed	70 "
2d trip started with.....	286 "
Mean working pressure.....	120 "
Consumed water.....	11.3 "
Temperature of water on return.....	198°
Pressure at end of trip	195 pounds.
Consumed.....	91 "
3d trip started with.....	195 "
Mean working pressure until pressure fell below	120 "
Water absorbed	19.8 "
Temperature on return.....	180°
Pressure at end of trip.....	95 pounds.
Consumed	100 "

The comparison of these two tests exhibits very remarkable results.

The total consumption of air in the three round trips was precisely the same, starting with 360 pounds and finishing with 95, consuming 265 pounds, or an average of 88.33 each trip. The last trip of the first series was run with 75 pounds. This fact it is difficult to explain, as the water was certainly much cooler than at the start, and it could not have contributed so large a proportion of vapor.

In the first run of the second series the air consumed was 70 pounds pressure, equivalent to 747 cubic feet, or 57 $\frac{1}{2}$ pounds at atmospheric tension, and this air absorbed the very extraordinary amount of 31 pounds of water, or more than half a pound of water for each pound of air, which is double the average consumption and four times the capacity of ordinary air for moisture.

It will be observed, also, that a great reduction of temperature from 324° to 190°, or 120°, was found in the two runs.

The large quantity of vapor and heat abstracted from the water in the first run will fully and satisfactorily account for the small quantity of air consumed, and would serve to indicate the possibility of increasing the distance run by burning gas or petroleum to replace the heat which the air absorbs. There must, however, always be a loss of power when air, after being compressed, is expanded to a lower tension without work.

In the last run of the second series 100 pounds were consumed. This was to have been expected, as the water at the end of the run was 32° below the boiling point.

On Tuesday, March 11th, further experiments were made to determine the effect of attaching additional cars to the motor. The following is the record taken by Mr. Harley:

1st trip started from 127th street with ..	300 pounds.
At depot, 97th street, air pressure..	250 "
Consumed in half trip ..	50 "
Coupled on 2 ordinary street cars, pressure at end of trip, 127th street.....	170 "
Consumed with the 2 cars and motor	80 "
Temperature of water	205°
2d trip started with.....	335 pounds.
Run at mean pressure.....	150 "
Cars in tow.....	2 "
Pressure at 97th street.....	275 pounds.
Consumed.....	60 "
Water used.....	14.2 "
Reduced pressure in heater to ..	130 "
2d trip, return, 2 cars in tow, started 97th street, pressure ..	275 "
Pressure at 127th street.....	190 "
Consumed pressure.....	85 "
Water used.....	14.2 "
3d trip, heated water again; 2 cars started from 127th street with & pressure of.....	330 "
At 97th street, pressure.....	265 "
Consumed	65 "
Water used	16 "
Return, no cars in tow, started from 97th street	250 "
At 127th street.....	200 "
Consumed	50 "
Water used.....	11 "

OBSERVATIONS.

It appears that the two up trips consumed 80 and 85 pounds of pressure, and the two down trips 60 and 65 pounds, and the up trips required 33 per cent. more than the down trips. This may be due to the very bad condition of the up track. The average round trip required 145 pounds, with two cars attached to motor, as against 90 pounds, with motor alone, an increase of 60 per cent., or 30 per cent. for each car hauled. The two cars probably weighed as much as the motor, and, if so, the traction of the cars would be 15 pounds per ton, assuming the motor at 25.

The data furnished by observations on the motor will serve to indicate the loss of power and of work in transmission from the piston to the rail; starting at 350 pounds pressure, the run of $9\frac{1}{2}$ miles was made with 270 pounds pressure, or 90 pounds per average run, or 298 cubic feet of air at atmospheric density per mile. Assuming for the present that the effect of heating and moistening the air is chiefly to compensate for the reduced temperature in expanding, and to secure the full benefit of isothermal expansion, the foot pounds of work per mile will be computed on this basis.

The volume required per mile to fill the capacity of the working cylinders is 720 cubic feet; the 298 cubic feet, therefore, filling 40 per cent. of the cylinder capacity, leaving 60 per cent. to be replaced by air from the exhaust passages by the opening of the suction valves.

If used under on average pressure of 170 pounds, = 11.33 atmospheres indicated, or 12.33 atmospheres actual, the atmospheric pressure would be reached in $13 \times 4 = 52$ inches of stroke in cylinders, and the mean piston pressure during the 5.2 inch stroke would be 1,732 pounds.

As there are 4 cylinder discharges to each revolution, and 720 revolutions to a mile, the travel of piston per mile run under pressure will be $720 \times 4 \times 5.2 = 14,976$ inches = 1,250 feet and $1,250 \times 1,732 = 2,165,000$ foot pounds of work done at piston per mile of actual run. If now it requires a tractive force of 25 pounds per ton on a level road to move the

motor, and the weight be 8 tons, then $8 \times 25 \times 5,280 = 1,056,000$ foot pounds per mile, which, if the road was level, would represent the actual work utilized from an expenditure of 2,165,000 foot pounds upon the piston, which is 50 per cent. nearly.

It would appear, therefore, that only half the power applied to the piston is actually utilized in propulsion on the track, and the balance must be expended in overcoming friction of motor and other resistances and losses. The power required to move the motor, if applied externally, and also the traction of the ordinary horse cars, is not known, and should be determined.

The computation of average run has been based on an expansion of twelve, and reaching atmospheric tension at $\frac{1}{4}$ of the length of the cylinder, using only one-thirtieth part of a cylinder of air at each stroke. If a full cylinder of air should be used, the power on the piston would be increased nearly nine times, but the consumption of air, thirty times.

This great reserve of power over the average for ordinary work is an advantage of no small importance. The reserve of power can be drawn upon to overcome great resistances, if of short duration.

As an illustration of this fact, and since the above paragraph was written, Mr. James states that on one occasion the motor got off the track at a sharp curve and switch at the 127th street depot. A ditch had been dug for gas pipes and filled in, but not paved. The hind wheels sank in the ditch until the frame of the motor rested on the pavement. A high pressure was let on, and the machine pulled itself out without further assistance.

The writer cannot close this report without an acknowledgment of the valuable information that he has received from the company's engineers, Messrs. Hardie and James, whose remarkable ingenuity and mechanical skill have secured the results detailed in this report. Mr. James is not only an accomplished machinist, but an expert mathematician, a Bachelor of Science, and a graduate of the University of Edinburgh.

Mr. Reynolds, the engineer of the Delamater Works, is too well and too favorably known to require indorsement from any one. The Pneumatic Tramway Engine Company have certainly been fortunate in securing an unusual combination of talent in their mechanical engineering department, and to this the success of the motor must be largely attributed.

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HOW MONEY IS MADE.

By A. E. OUTERBRIDGE, Jr.

ALTHOUGH the United States Mint is a never failing attraction to visitors, it is probable that but few obtain more than a very superficial glimpse of the manifold chemical and delicate mechanical manipulations through which the precious metals must pass before evolving into the noble double eagle, or the bright new silver dollar; and it is perhaps with a slight feeling of disappointment that the visitor, after completing the circuit of the operative rooms which are open to public inspection, is ushered into the cabinet of coins and politely invited by the guide to make himself perfectly at home, stay as long as he likes, and "look at the coins of all nations and specimens of gold from all parts of the world."

It is with the view of partially satisfying the curiosity which may have been whetted by such a visit that this descriptive article is written, and it is proposed to give the reader a little glimpse behind the scenes, and to initiate him into some of the delicate means by which the noble metals are prepared to receive the impress of Uncle Sam's bird of freedom.

The early history of the precious metals forms an exceedingly interesting subject of research, but an attempt to explore this tempting by-path of knowledge would be impossible within the brief space of one article.

The precious metals are never found in the pure state, and they are deposited at the mint alloyed with other metals and in a great variety of forms, such as native grains, dust, amalgam, bars or pigs, old jewelry, etc. The mixed metals are known under the generic name of "bullion."

The bullion is first weighed in the "deposit weigh-room," where several balances are kept for the purpose; the largest of these will weigh as much as ten thousand ounces in one draught, and the scale will readily turn, even when loaded to its full capacity, with a weight of one hundredth part of one ounce. The metal is then placed in a box provided with a cover and lock and taken to the "deposit melting room." Here it is put in a crucible which has been previously heated in the melting furnace and covered with a thin coating of borax, which forms a sort of fluid glass, acting as a hermetic cover to protect the metal, when it is molten, from the oxidizing influence of the air. A stalwart workman, wearing a pair of large canvas mitts (somewhat resembling boxing gloves) stands guard, and grasping, with a pair of iron tongs, a rod or stick made of plumbago, he stirs the now fluid mass back and forth, up and down, round and round, for the purpose of rendering it thoroughly homogeneous; the metal is then cast into an iron mould called a "shoe." It is plunged into water to cool, as well as to dissolve off any particles of the borax glass which may have adhered to its surface. It is now returned to the weigh room and reweighed.

A slight loss in weight usually occurs owing to a practical refining out of the base metals, and the new weight is the amount with which the depositor is credited.

Let us suppose that a depositor brings a miscellaneous assortment of old gold; watch cases, jewelry, dentist's plates, etc., representing every grade of fineness or proportion of pure gold, desiring to obtain its equivalent in coin. We will follow in imagination the usual course pursued.

After the metal has been returned from the melting room (where it was cast into the shoe mould) and the bar reweighed, a small chip is cut off from one end of the bar and taken to the assay laboratory.

THE ANALYSIS.

The sample is laminated or rolled into a thin ribbon and stamped with the number of the deposit which it represents, it is then assayed to determine the proportion of gold, silver, and base metal, and so accurate are the processes of assay, that the exact value of a deposit, frequently aggregating many thousands of dollars in value, is determined to the fraction of a cent by calculations based on the assayer's report.

The largest weight which the assayer uses in making an analysis of gold bullion is the French half gramme (or about seven and three-quarters grains Troy).

The balances used in this work are marvels of mechanical construction; they are so sensitive that a weight of one-

twentieth of a milligramme (less than one-thousandth part of a single grain) will cause the indicator needle to deflect a very appreciable distance from the zero point on the graduated scale marking the equilibrium. These little balances are inclosed in glass cases, provided with sliding windows to exclude any draught of air. The beam is usually made of aluminum, one of the lightest metals, and the knife edges rest on jewels. The weights are made of gold, silver, and aluminum, and are graduated from the half gramme, which is arbitrarily denominated "1,000," down to the ten thousandth degree.

The assayer first determines approximately the relative proportions of the metals existing in the alloy, and from this bases his more careful determinations; he weighs out on the balance exactly one-half gramme, or 1,000 parts of the alloy; he wraps this in an envelope of pure lead and rolls it into the form of a "bullet." The bullet is then placed in a small "cupel" or cup, made of calcined bone dust, which has been brought to a white heat in the muffle or oven of the assay furnace.

The mass melts immediately, and the lead oxidizes rapidly by absorbing oxygen from the heated air which passes continually over its surface, and on account of the extreme fluidity of the oxide it sinks into the pores of the cupel, which absorbs it as readily as a sponge absorbs water; the lead also carries with it all the base metals which may be originally combined in the alloy, but the precious metals not being oxidizable, simply melt, and are not so fluid as to be capable of sinking into the cupel. A preparation thus takes place, and at the moment when all the base metal is removed a beautiful "flash" is observed to take place on the surface of the metal; the "button" of purified gold and silver resulting from this operation is then removed from the cupel, returned to the balance, and weighed; the loss indicates the proportion of base metal. Another weighing of the sample is then made, to which is added pure silver in the form of fine granules, in the proportion of about two parts of silver to one of gold, the alloy is inclosed in a sheet of lead and cupelled as before; the silvery button remaining is laminated, coiled into a roll called a "cornet," and boiled in nitric acid. The acid dissolves the silver, leaving a little roll of pure gold. This gold cornet is then annealed in the furnace to give it toughness, and is finally weighed; this weight represents the proportion of pure gold. The proportion of silver is ascertained by subtracting the weight of the pure gold plus the weight of the base metal from the original weight of the assay sample.

Silver was formerly assayed in the same way, but it was long known that the result was not quite accurate, owing to a partial volatilization of the metal when exposed to the high temperature of the fire. Experiments were some years since instituted by the French government to overcome this difficulty, which resulted in the beautiful "humid process" devised by a celebrated chemist, Gay Lussac. This is one of the most accurate methods known to chemical science, and so complete was Gay Lussac's original description that but little room has been left for any improvements, and many thousands of dollars' worth of silver bullion are rapidly and accurately determined every day in the mint in this way. The rationale of Gay Lussac's method is very simple, viz., a given amount of chlorine gas will precipitate a definite proportion of pure silver from its solution in nitric acid.

The assayer prepares two solutions of common salt water (chloride of sodium); one is known as the "normal solution," and the other as the "decimal solution." One begins and the other finishes the assay.

The sample of silver to be assayed is weighed out, as in the case of gold, the assayer taking care to place a sufficient weight of the alloy in the scale pan to contain at least one gramme (a little over fifteen grains) of pure silver; the weighed sample is then placed in glass bottle and a charge of nitric acid is added to it; the acid is caused to boil, and in a short time the silver alloy is completely dissolved.

A charge of the normal salt solution is then allowed to flow into the bottle from a glass "pipette," which is made of such a capacity that it shall contain just enough salt water to precipitate one gramme of pure silver; the chlorine in the salt water combining instantly with the silver, precipitates it in the form of a white cloud; the bottle is agitated rapidly for a few moments, when the precipitate settles to the bottom, leaving a clear solution above; the assayer next allows a charge of the "decimal solution," which is one-tenth the strength of the normal solution, to flow into the bottle from a glass tube with graduated divisions, each division marking one-hundredth the capacity of the large pipette. If any silver remains in the solution a cloud will be observed on the surface. Now, as this decimal charge is one-tenth the strength and one-hundredth the volume of the large pipette, it will, of course, precipitate just one-thousandth as much silver, or one milligramme. The bottle is again agitated to settle the precipitate, and successive charges of the "decimal solution" are added until all the silver is precipitated, and then a simple rule of three sum gives the exact proportion of pure silver contained in the original weight of the alloy. The assayer guards against all probable sources of error by an elaborate system of checks, and each set of assays is accompanied in all its mutations by one or more "proofs" or synthetic assay, made either from pure metal or from alloys of known composition.

After the exact proportions of gold, silver, and base metal constituting the alloy are reported by the assayer to the superintendent the value of the deposit is calculated, and the depositor is paid the full equivalent, less the charges for refining, the amount of charges depending, of course, upon the nature of the bullion.

THE REFINING PROCESS.

The metal now passes into the hands of the "melting and refiner."

We will suppose that the representative deposit that we have already alluded to contains a small percentage of base metals, such as tin and lead, which tend to make the alloy brittle or "short," rendering it unfit for coin. The first operation to which it is subjected is intended to eliminate these impurities, and is called "toughening." The metal is melted in a crucible and an oxidizing flux (saltpeter) is added to it while fluid, the saltpeter or niter decomposes and liberates oxygen gas; the oxygen seizes the base metals forming oxides; these rise to the surface and are dissolved in the flux; the flux, when sufficiently thick, is skimmed off, and the purified metal, consisting only of gold and silver, is cast into a bar or poured into ice water to form granulations. The next operation is designed to remove the silver; this is effected by boiling in nitric acid, when the silver dissolves, leaving the gold in a finely divided state.

The "plant" used for this purpose consists of a number of large porcelain jars capable of holding about fifty gallons of nitric acid each. These are arranged in a double row

and heated by steam pipes; they are inclosed in a chamber provided with sliding doors to prevent the escape of the noxious fumes, which are carried into a tall chimney from which they issue in a yellowish cloud. The dissolved silver is drawn off by means of a large siphon made of native California gold (valued at three thousand dollars) and transferred to a vat made of wood, resembling those used in breweries. The vat contains several hundred gallons of salt water, and the silver is precipitated by the chlorine, a workman facilitating the operation by agitating the liquid with a large paddle provided with a long handle.

The precipitated silver is drawn off into large filters placed on trucks and thoroughly washed by running water until the test of litmus paper shows that all trace of acid has been removed. The chloride of silver now resembles pure white cottage cheese. It is transferred to another vat lined with lead. Zinc (which has been previously granulated by pouring while melted into cold water) is added to the silver, together with a little sulphuric acid; the chlorine deserts the silver for the baser metal, forming a soluble salt of zinc. The solution is allowed to flow off, and the precipitated silver is pressed into round cakes called cheeses, dried in an oven and melted in the furnace; it is finally cast into a bar, and is found to be uncontaminated with its former base associates.

The gold which remained in the porcelain jars is in the form of fine powder, and resembles sifted gravel as nearly as may be. It is also pressed into cheeses, dried, and melted under a covering of borax or charcoal, and cast into a bar of nearly pure gold.

All that now remains for the melter and refiner to do is to weigh out the requisite amount of copper to form the coin standard, which is nine parts of gold or silver (as the case may be) and one part base metal. In other words, our coin standard is nine-tenths fine.

The alloy is melted in large crucibles made of plumbago and constantly stirred to render the mass homogeneous. The standard metal is cast into flat bars called ingots, twelve inches long, one-quarter of an inch thick, and from three-quarters to one and a half inches wide; the ingots are filed to remove the ragged edges, and the rough tops are cut off with large steam shears. Two samples from each melt are assayed, and if the alloy is found to be of the proper fineness and of uniform composition, they are delivered to the coiner.

THE MECHANICAL PROCESSES.

The coiner transfers the ingots to the rolling mill, and when they have been sufficiently laminated by successive rolling and annealing, the strips are passed through a machine called the "draw bench," for the purpose of reducing them to the exact thickness required for the coin; this operation is similar in principle to wire drawing, and consists simply in squeezing the flat strips of metal between two stationary steel cylinders set to the desired gauge. The strips are now passed to the cutting press, which consists essentially of a round punch, the size of the "planchet," or blank required for the coin, working up and down very rapidly into a hole on the steel bed plate.

The strips are passed by hand through the press, and the blanks fall into a box below. The unused portion of the strips, or "clippings," is returned to the melter and refiner and remelted. The planchets are next taken to the "adjusting room," where may be seen a number of ladies seated at a long table, each one provided with a little balance and a file. Every lady is supplied with a pile of planchets, and she proceeds very deftly to weigh each one against a properly adjusted counter-weight. The planchets that are too light are thrown into a separate pile and returned to the melter and refiner, to be remelted with the clippings, while those that are too heavy are adjusted by filing on the edge. Within a very few years a novel automatic adjusting machine, designed by Mr. Ludwig Seyss, of Vienna, has been introduced for the purpose of facilitating the work and diminishing the necessity of hand labor. It is an exceedingly beautiful and ingenious piece of mechanism, but is too complicated to admit of an intelligible description without the aid of sectional drawings. A description of this instrument will be found in the Journal of the Franklin Institute. It not only weighs the blanks automatically, but separates them into three kinds; those that are too heavy falling into one box, the light ones into another, and those of the right weight into a third. The machine never makes a mistake, and will weigh and assort as many pieces in an hour as five expert ladies can do by hand, but when we consider that there are ten balances in the machine engaged in weighing at the same time, and only five used by the ladies, they must be awarded the palm for expedition.

The machine also requires the constant attention of one person to supply the blanks or planchets, and when the additional cost of steam power and wear and tear of the parts are added to the original expense of the apparatus, its merit from an economical point of view is not so great as would at first sight appear.

The next operation to which the blank pieces are subjected is to impart the raised edge, technically called "milling."

The machine used for this purpose is an American invention, and is admirable for its simplicity as well as for the rapidity with which it accomplishes the work.

The blanks are fed by an attendant into a tube, and they are drawn horizontally, in single file, through a gradually narrowing channel formed by a groove in the periphery of a rapidly revolving disk on one side, and a stationary segment of corresponding curve on the other, keyed a little closer to the wheel at one end. The blanks are in this way compressed on the rim, acquiring the "milled edge." This machine is capable of milling as many as 1,200 pieces per minute.

The blanks are now taken to the pickling vats, where they are immersed for a couple of minutes in weak sulphuric acid for the purpose of removing the black oxide of copper; they are then washed in pure water and placed in a rotating cage filled with sawdust. This rapidly dries the blanks, and when removed to the coining room they have acquired a fine, bright surface.

THE COINING.

The early methods of coining were exceedingly crude and imperfect. The metal was hammered into a thin plate; pieces of irregular size were cut out and beaten into a bullet shape; this bullet was placed on a sort of anvil having the reverse die cut upon its face.

The obverse die was held in the hand like a punch, and by the aid of a heavy hammer the bullet was flattened out and coined at the same time.

There are many interesting specimens of this antique coinage to be seen in the mint cabinet. The oldest pieces are to be found in the case devoted to coins of the Greek Republic,

dating back to seven centuries before the Christian era. It was not until the middle of the sixteenth century that the forge and hammer were succeeded by more scientific methods.

In the British mint the coins are struck in presses worked by a screw; but we have adopted the admirable invention of a Frenchman, named Thenollier, which has been further improved upon by the skill of a former coiner, the late Mr. Franklin Peale. This machine operates on the mechanical principle of the "toggle joint" (of which the elbow-joint is a familiar example). It is controlled by a lady who feeds it with the blanks, which she places in a vertical tube. A pair of "feeders" catch the bottom piece and carry it forward, where it rests in the "collar" between the upper and lower dies; the lever is now descending with the upper die while the lower die remains fixed; the pressure increases with perfect uniformity up to the maximum, which is equivalent to about 10 tons for the dime, 80 tons for the double eagle, and 120 tons for the silver dollar. The pressure gradually decreases again by reason of the relaxation of the upper joint, the lower die pushes the piece out of the collar into which it has expanded, and from which it acquires the "reeded edge." Meanwhile, the feeders have provided another blank, and as they bring it forward they push the coined piece into a channel, through which it slides into a box beneath the machine. The coins are then inspected by the foreman, and any cracked or defective pieces set aside.

The larger denominations of coin are counted by hand, and the smaller pieces, as well as the "bronze" and "nickels," are numbered by means of a simple and ingenious arrangement called the counting board.

After the coins have thus been counted and weighed, they are tied up in linen bags and delivered to the treasurer in drafts of \$5,000 each. The accuracy of the adjustment of the weight is so nice that there is rarely a deviation from the true standard weight of as much as one hundredth of an ounce in any delivery of either gold or silver coin.

As a final precaution, the assayer is required by law to select at random one coin from every lot of twenty thousand dollars; these are sealed in envelopes, numbered, and placed in a strong box provided with two locks; the key of one is kept by the treasurer and the other by the assayer. These sample pieces are called the "pyx." They remain sealed until the commissioners appointed by the President assemble at the "annual assay" in February of each year to test their purity and weight; and it has rarely, if ever, happened that any piece has been found to exceed the small limit of "tolerance" allowed by law.

The manufacture of the dies for coin requires a high order of artistic and mechanical labor, involving "the talent of the designer and the skill of the engraver and sculptor." A detailed description of the processes involved would necessarily extend this article beyond the limits assigned to it. A brief outline must, therefore, suffice. The artist first makes a free sketch on paper, he then models his design in wax upon a glass plate, and it is probably five times the size intended for the coin; from this he takes a cast in plaster, which serves, when coated with plumbago, as a matrix from which an electrotype in copper is obtained. The electrotype rilievo, after being finished by hand, is used as the model from which the steel die is cut by means of a reducing pantographic cutting machine, somewhat similar to those used for reproducing designs for steel rolls used in making printed fabrics. A traveling pointer attached to the long arm of a lever is caused to move back and forth over all portions of the raised model, and a steel drill attached to the short arm is thus caused to cut an intaglio design in a block of steel corresponding in all its details to the model, but reduced to the proper diameter for the coin; the stars and lettering are now added, and the whole is finally touched up by the hand.

This intaglio is not used for coining, but from it a rilievo called the "hub" is made. A block of steel having been softened by annealing, is placed in a screw press carrying the "hub," and by a succession of blows, followed by frequent annealings, the die from which the coin is to be made is produced.

It is possible (owing to the great value of the raw material) to bring the processes involved in our gold and silver coinage to a perfection which would not perhaps be found profitable in any ordinary industry, and this fact, together with the national pride which is felt in the matter, should offer encouragement to the invention of all practicable methods of producing perfect work and preventing losses.

POROSITY OF STONE.

PROFESSOR DOREMUS, of the Buffalo Medical College, recently performed an interesting and instructive experiment before his class. A block of sandstone, such as is usually employed for window caps and sills, and about twelve inches square and four or five inches thick, had a panel one-half an inch deep sunk in each side. In each panel was fitted a block, which was perforated by a piece of common gas pipe, and this was cemented about the edges. The whole was then coated with an impervious varnish. Air now entering the pipe on either side had access to the clean surface of the stone beneath the panel, and it was found that if the mouth be applied to the protruding pipe on one side, and a candle be placed in front of the opposite one, it could very readily be blown out by the air, which, with very little effort, was forced through the stone. When a rubber tube was connected with the house gas pipe on one side of the stone, and a burner was attached on the opposite side, the simple pressure from the gas mains was sufficient to force the gas through the stone till it was lighted at the burner on the opposite side. When by any means the pressure was increased, a very large flame was thus produced.

DISASTROUS EARTHQUAKE IN PERSIA.

WE recently published news of an earthquake which had occurred in Persia. The following particulars have now reached us, and unfortunately show that the loss of life and damage to property as stated in the original report were in no way exaggerated: "On the 22d of March, at 3:42 A.M. (London time, 12:37 A.M.), a severe earthquake, lasting 12 seconds, was felt here (Tauris) and east as far as Zeudjan; no damage was caused in this city, but in the vicinity of Miandeh, where the shocks continued with more or less vigor up to the 2d of April, great damage and loss of life have occurred. An official report prepared for the Persian Government by the Persian Telegraph authorities at Miandeh gives the damage, as far as is at present known, as follows: 21 villages totally destroyed, 54 greatly damaged, 922 persons killed, together with 2,660 sheep, 1,125 oxen, 124 horses, and 55 camels. The center of the disturbance was the mountain of Bousgouche."—*London Times*.