set by a skilled mechanic, and all is ready for action. The vertical rod, which extends upward to a quadrant of brass below the fly-arms, is part of the feeding apparatus, and, when in motion, it forces a pair of sliding forceps backward and forward beneath the receiving tube.

Two lines are close to the right hand of the press attendant, and these pass through pipes under the platform to the vacuum-pump. These are the starting and stopping lines. Let it be supposed, now, that the press is completely prepared, and that we are looking on. The first movement of the young coiner will be to pull tightly a cord, and attach it, by means of a loop, to a stud in the "press-hole;" his next to give a sudden jerk to the other cord. The result is, the sharp descent of the press-screw, with its accompanying die, upon the face of a golden disk, which has been laid by the feeder on the lower die. At the instant that this blow was given upon the softened metal, a steel collar, which has its inner edge milled, had risen and enclosed the disk, thus forming a mold for its edge. It will now be understood that as a reverse sovereign die was placed face downward in the upper die-holder, and that an obverse die rested face upward in the lower one, and the blank was between the two, a sovereign has been produced by the downward traverse of the press, and such is the fact. The edge, also, has been milled, and the whole operation has not occupied more than a second of time! It is impossible to show by the pencil the exact position in which the dies and blank were when the fly-arms performed a partial revolution and the blow was administered; but the accompanying illustration (Fig. 2) of a pair of sovereign dies and milled collar will give a clearer conception of the operations. It must be remarked that the collar fits easily round the neck of the obverse die, and is readily moved by small levers and springs up or down. After the first piece of money has been struck, the collar is pressed downward, and the flattened forceps are already advancing with a second blank. In approaching the die, the point of the forceps pushes forward the coin into a pan placed on the other side of the press to catch it. The forceps open self-actingly, and deposit, with wondrous precision, a second blank on the obverse die. The instant it is so deposited, the reverse die descends upon it, giving it the imprinting squeeze, the collar rising as before, to prevent its too great lateral expansion, to mill it, and to preserve its perfect circularity. It is pushed into the catch-pan as described. Others follow in the same course, the attendant taking care that the feeding-tube is constantly kept supplied with new candidates for sovereign honors. Thus the press is allowed to go on in noisy harmony so long as it yields good work; and its productions are keenly examined at intervals by inspectors, in order to insure that desideratum, or until the supply of blanks is exhausted. A mint coining-press will strike 25,000 pieces of money per day, whether they be of gold, silver, or bronze; and as there are 8 presses, their aggregate yield is 200,000 coins per day.

It may be well to state that the cords referred to above, and which are so magical in their effects, are attached to the two valves of the vacuum-pumps. When the first is looped up, it allows the outer valve to close by the pressure of a spring. The tug at the second cord opens the inner valve, and this effects a communication between the pump and the vacuum-pipe below it. The consequence is obvious; the atmospheric column exerts its natural force upon the piston, and the latter falls under its weight, carrying with it the rods and the press. In its descent, however, it is accompanied by a "tappet," which closes the inside valve, and then the press rebounds upward, dragging with it in its turn the piston. The inside valve springs open when the piston has reached the extent of its stroke—some fifteen inches—the air impinges once more upon it, and so the alternations go on until the looped cord is released and the outward valve prevented closing. This brings the press to a dead standstill, as no vacuum can then be formed within the pump, and the air presses with equal force on both sides of the piston, keeping it quiescent.

Literally, therefore, the atmosphere coins money, and the beautiful impressions on the sovereigns owe their existence to the air we breathe. The gold coins resulting from each day's workings are gathered carefully together, and weighed in quantities of 15 pounds each. Silver coins are weighed in 60 pound drafts, and bronze in 56 pound. They are all transferred to another room for the closer inspection of each individual coin, and, in the case of the gold and silver moneys, for the weighing by automatic machines of each separate piece.

On their tiny steel pans each gold coin from the press is made to rest for the space of three seconds, and then it is decided whether it shall pass out into circulation or be returned to the crucible. The extreme limit of variation allowed between sovereign and sovereign is one quarter of a grain on either side the standard weight, which is 256 thousandths of an ounce.

As a rule, 95 per cent of the gold coin struck at the mint presses pass through the ordeal of the automatic balances, and are then sent forward to the bank, in return for the ingots supplied. Eventually the full 100 per cent reaches the same establishment; the expense of the remeltings and reworkings of the metal falling upon the public treasury.

Fallacious Theories of Boiler Explosions.

II.—EXPLOSIVE ELECTRICITY.

When the apparently mysterious and powerful effects of electric discharges are seen by persons who are satisfied with superficial knowledge, with little reasoning, and less thinking, it is not surprising that they will ascribe almost every thing they can not explain to electricity. Therefore so-called "unaccountable steam-boiler explosions" were explained, of course, by "electricity," which, in some unexplainable manner, had accumulated in the boiler. We have always been fighting against the idea of speaking of "unaccountable disasters;" every thing has a cause, and if some people can or will not account for it, it is that they are either too obtuse to see this cause or that they are culpable and wish to hide their neglect of duty by the plea of an "unaccountable accident." We repeat here, perhaps for the twentieth time, that the sole cause of all boiler explosions is always *that the tension produced by the steam pressure is greater than the tensile strength of the weakest part of the boiler*; and we have now the satisfaction of seeing this theory verified by the results of the extensive and truly grand experiments referred to in our preceding number, and by the fact that the deductions of the experimenters agree in every particular with the theory we have always advocated.

The absurdity of the explosive electricity theory was so little realized, and the knowledge of this natural agent so little understood only ten years ago, that actual experiments were made to get rid of this "dangerous explosive agent." We find that a certain Perry, of Philadelphia, applied for a patent, May 2d, 1864, to discharge the electricity from the steam-boiler; but his claim was refused for reason of its absurdity. He did not give it up, however, till October 31st, 1865, when he obtained a patent, (No. 50,773,) in which he claims—First, "suspending within a steam-boiler one or more permanent magnets for inducing an electric current." This claim amounts simply to a confession of the most deplorable ignorance, as the mere suspension of any number of permanent magnets can never induce any electric current whatsoever; one may as well claim to suspend a kettle of hot water in a room, in order to illuminate it. Heat is related to light, but it is not light itself; and in like manner magnetism is related to electricity, but it is not, therefore, electricity. The second claim of Perry's patent is a hollow box with isolated lining, through which a conducting-rod projects. This was evidently intended to give an exit to the explosive electricity.

Competition is a peculiarity of the American character. When a man has started any kind of business whatsoever, it may be an eating-saloon or a millinery-shop, and when it is expected that he will prosper, others start in the same line and as near as possible in the same neighborhood to get their share of the expected profits. It is the same with patents. Perry had his patent scarcely granted, before one Porter, also of Philadelphia, was in the field and obtained a patent for a similar isolating arrangement, and an isolated point projecting out of the boiler, evidently again to discharge the explosive electricity. But he added a long spiral wire such as is coiled around a wrought-iron bar in order to charge it with magnetism by means of a galvanic battery, only the iron-bar and the battery were left out; what this spiral wire is for the patentee, of course, does not know himself. It is utterly useless, but a novelty; that's enough. This spiral is at one end connected with the boiler, and at the other isolated end a disk is attached with a few small steel points which were magnetized. It is evident that the inventor acted blindly, in utter ignorance of the principles he attempted to apply, and was not at all clear as to the results at which he would arrive. It was a hap-hazard undertaking, the main idea being to get a patent on the plea of novelty, no matter if it was most ridiculously absurd; then, when the patent was granted, somebody might be made to believe in it, and when that somebody happened to have money to spare he might buy, during the illusion of great expectations. This is the history of half the patents sold.

Now, the thing had to be applied practically, and the steam-boilers to which it was applied did not explode. Now, this was quite favorable; but, unfortunately, it was a negative proof, because no one was sure that the boilers would have exploded if the electric steam-battery had not been applied; but ingenuity is a great gift, and it came to help the patentee out; it was asserted that an unexpected result had been obtained. The boilers to which the patent was applied remained free from incrustation; so the patent, originally intended to be an anti-explosive, was said to turn out an anti-incrustator. In the mean time, a company was formed by a party of very enterprising gentlemen from the city of brotherly love; the stock of the so-called Porter's Steam-Battery was given a value in the market, and such amounts of it sold as to make a little fortune to a few individuals who had failed in other enterprises, (one party made $80,000.) This was chiefly effected by a scientific explanation given by John C. Cresson, Esq., a well-known chemist of Philadelphia, in a letter to Messrs. Baldwin & Co., which we find published in the circulars of the company. We give it here, in full, for curiosity's sake:

PHILADELPHIA, Dec. 6, 1865.

MESSRS. M. W. BALDWIN & Co.:

GENTLEMEN: In reply to your inquiries I beg to present the following brief statement:

The occult principle of diamagnetism, which is brought into useful action by the apparatus of Mr. Porter, was discovered by Faraday, the eminent Fullerian Professor of Chemistry in the British Royal Institution, at the close of his elaborate series of "experimental researches in electricity," commenced in 1831, and continued until 1845.

This discovery was made public in December, 1845, and has remained for twenty years a merely scientific fact, without any practical application until the present time.

It is now made valuable for a purpose not second in importance to any of the various applications of the ungovernable agencies in which modern art and modern science have made such wonderful progress.

The general principles discovered by Professor Faraday show that all the solids and liquids—animal, vegetable, or mineral—have a definite relation to terrestrial magnetism; and can be arranged in two distinct classes; one of which he terms magnetic, and the other diamagnetic.

The first class includes a few of the substances whose predominate relation to the magnet is attraction by either pole. Iron, nickel, and bismuth are the principal types of this class.

The other class includes organic bodies, earth, water, and most of their elements and compounds. These have the property of repulsion by the magnetic poles in different degrees; and the degree of development of this property varies in each substance, with changes in its condition. For example, a substance belonging to either class will retain its characteristic property of attraction or repulsion when held in solution in water, and in some other liquids; but the degree or force of its action will be altered according to the density or diluteness of the solution. It follows from this that a dense solution of any diamagnetic mineral will be repelled from a magnetic surface more forcibly than a weaker solution, and still more forcibly than water.

On this fact depends the action of Porter's apparatus. If the interior of the surface of a steam-boiler be put into a condition of magnetic polarity, it will repel a concentrated solution of earthy minerals more forcibly than a weaker solution, and the water, which has by evaporation become highly charged with such substances, will be forcibly kept away from the iron surface, and the weaker portions kept in contact with it, and thus no deposit of scale can take place on such surface until the water is charged to saturation. And further, where a scale has already been deposited, there will be a tendency in pure water to penetrate between the mutually repellent surfaces of scale and iron, when the latter becomes magnetic.

Respectfully, JNO. C. CRESSON.

It is seen that the whole tenor of this letter serves but to throw sand in the eyes of the ignorant, by a display of scientific phrases, such as "the occult principle of diamagnetism," which, in fact, has nothing to do with this humbug. When the writer speaks of "the ungovernable agencies in which modern art has made such wonderful progress," it is doubtful if he means the "ungovernable steam" or the "ungovernable electricity" which causes the boiler explosions. However, for all that, this letter had the effect of receiving an order to apply Porter's steam-battery to all the locomotives of the Pennsylvania Central Railroad to the number of 400, at a price of $100 apiece. The cost price of the apparatus was $8 or $10, so the stock went up, great sales were made to greedy buyers, and that was the end of the whole affair.

The true scientific fact that electricity is developed by all evaporation, as proved by Pouillet and Peltier, and recorded in the *Anales de Chemie*, third series, Vol. IV, page 1414, and the fact that there exists such an apparatus as a steam electric machine, described by us on page 265 of our third volume, would have been the best apparent support of the fallacious theory in question, and it is surprising that no use was made of it in the above letter in place of the rhapsody on diamagnetism and magnetic polarity, which, surely, has not increased the estimation in which the writer was held as a scientist.

At one of the late meetings of the Polytechnic Club of the American Institute, a weak attempt was made to defend this electric theory, in combination with that of explosive gases; the latter we will treat in our next.

Notes on Carpentry and on Strains in Structures.

IV.

THE choice of the kind of timber to be used in any proposed structure is a matter of some importance. There is strength to be considered, and also durability, and they do not always go together. Then there is the quality of stiffness, which is distinct from that quality which gives ultimate strength to timber. Thus in a roof the weight to be carried is not great, being not more than 60 lbs. per square foot, that is 20 lbs. for the roof and 40 lbs. for the wind; whereas floors carry more than twice as much, common warehouse floors three times as much, and corn warehouse floors four times as much; but in a roof, subject to the percussive action of the wind, it is necessary that it should be stiff rather than strong, and that timber which (being not more expensive than another) is stiff is better than another which may be stronger, if at the same time it be not so stiff. A roof might be perfectly safe as far as strength is concerned, but if it were subject to vibration the covering would soon be loosened. But in another structure, as, for instance, in a bridge, sheer strength is better than mere stiffness, a property which prevents the material giving any warning of its being overloaded, but when it yields makes it yield suddenly. Experiments on the strength and deflection of timber have been quite numerous, nearly every one who has had much practice in its use having made from time to time his own experiments; but few private experimenters (as may be said) have had sufficiently extensive opportunity to render their own observations complete for all cases, and perhaps the chief use of such experiments lies in the satisfaction one feels in an ocular demonstration of the truth of propositions made by those whom we take as authorities.

The strains produced in a beam by a load placed crosswise of it, being the most important and often to be considered, we will consider first. In a former article we said that the power with which a beam resists the strains produced in it by a load is inversely as its length, directly as its breadth, and as the square of its depth. Now, whatever the actual dimensions of the scantlings may be which are experimented on, they can all be reduced, on this supposition, to a simple dimension of a foot long, or rather a foot between the bearings, an inch wide, and an inch deep; and the weight that would break a bar of this size, if placed upon the centre of it, and supposing it to be supported at both ends, is the measure of the transverse strength on the particular kind of wood experimented on. Thus, if we were to find, on trial, that a scantling of red pine, 2 in. wide, 3 in. deep, and four feet between the bearings, broke with a weight of 2000 lbs. on the centre of its length, we should deduce from that experiment a constant, or coefficient, for the breaking-weight, of 444; thus, according to the proposition above given, if a bar 2 in. in breadth would break with 2000 lbs., another bar of the same material, one inch broad, would break with 1000 lbs.; and if a bar an inch broad and 3 in. deep would break with 1000 lbs. weight on the centre, another bar 1 in. deep would break with a weight of $\frac{1000}{3 \times 3} = \frac{1000}{9} = 111$ lbs. in the centre; but the length of the bar supposed to be under trial is 4 ft., and if a bar 4 ft. long, an inch broad, and an inch deep, would break with 111 lbs., another bar 1 ft. long, 1 in. broad, and 1 in. deep, would break with a weight of $111 \times 4 = 444$ lbs. This is the actual breaking weight of a bar of red pine of these dimensions, and in calculating the dimensions of any other bar or beam of red pine, to carry any other weight, 444 is called the constant multiplier of such calculation, or the coefficient of strength, when the beam of which the dimensions are to be found is to be loaded in the same manner, that is, in the middle, the beam being supported at both ends; and, to reverse the process, the breaking weight of a bar of red pine of 4 ft. bearing, 2 in. wide, and 3 in. deep, would be found thus: W, the breaking weight in lbs., in the centre $= \frac{4444\ b\ d^2}{l}$; that is to say, 444 times the breadth in inches, multiplied into the square of the depth of the bar in inches, and divided by the length in feet, thus: $\frac{444 \times 2 \times 9}{4} = 2000$, the breaking weight in lbs. as before.

Again, to take a larger beam, let it be required to find what dimensions a beam of 12 ft. bearing should have, to carry six tons in the centre, or 13,440 lbs. Let any convenient breadth be assumed—say, in this case, 12 in. Now, if the beam is to carry an actual load of six tons, its breaking strength, or ultimate strength, must be, of course, much greater. How much greater, or what ratio the safe load should bear to the breaking weight, has never been agreed upon. Some have ventured so far as to recommend a permanent load of one third of the breaking weight, others one fourth, and others, again, not more than one tenth. A good deal depends upon the kind of load—whether it be a steady load or a moving, or live load; and a good deal, also, on the quality of the piece of timber; but, assuming a good sound quality and a steady load, about one fifth seems to be as much as ought to be reckoned upon. If, then, we adopt one fifth, the breaking weight of the beam we have taken for an example should be $6 \times 5 = 30$ tons, or 67,200 lbs. The depth of the beam would then be found, thus:

$$d^2 = \frac{l\ W}{444\ b}\ ;\ \text{or thus, } d = \sqrt{\frac{l\ W}{444\ b}},$$

l, the length in feet, being 12; W, the breaking weight in lbs., in the centre, being 67,200; b, the breadth in inches, being 12; $d^2 = \frac{67{,}200 \times 12}{444 \times 12} = \frac{67{,}200}{444} = 151$, and the square root of $151 = 12\frac{1}{4}$ nearly = the depth required in a beam of red pine of sound quality, the length of bearing of which is 12 ft. and breadth 12 in., in order to carry a load of six tons in the centre, without straining the fibres of the wood to more than one fifth of their ultimate strength.

All these dimensions are transmutable among themselves; thus, if the breadth had been required, the length, depth, and weight, being given, the figures would have stood thus: $b = \frac{l\ W}{444\ d^2}$.

If the greatest safe length had been required, thus: $l = \frac{444\ b\ d^2}{W}$.

If the breaking weight had been required, thus $W = \frac{444\ b\ d^2}{l}$.

And in all cases, if we put W = the breaking weight, l = the length, b = the breadth, d = the depth, and c = a constant multiplier, or coefficient of strength, to be determined by experiment, $l\ W = c\ b\ d^2$.

We showed in a former article that in respect of central and distributed loading, a distributed load may be twice as much as a central one without producing greater strains in the beam; and in the case just supposed 12 tons might be uniformly distributed over the beam, while the strains would remain of the same intensity (at the centre) as under a central load of 6 tons; or, on the other hand, the load remaining 6 tons, but being distributed uniformly, the length of the beam might be 24 ft., instead of 12 ft., or the breadth 6 in. instead of 12 in., or any other combination of dimensions and weight might have been made that would have produced the result of $\frac{444\ b\ d^2}{l} = W = 30$ tons = 67,200 lbs., as before.

New Glue Size for Paper-Makers.

THE *Chemical Review* finds in a German journal a description of a new glue size for paper-makers, which, compared with the old one, is said to be nearly 50 per cent cheaper, and much more suitable to the paper. To produce this size, dissolve in a copper pan, heated by indirect steam, 45 lbs. to 50 lbs. of soda in 200 lbs. to 240 lbs. of boiling water; then add to it, stirring well at the time, 300 lbs. of powdered resin, keeping the whole continually boiling until all the resin is perfectly dissolved, which is generally completed in three or four hours. This soda-resin composition, dissolved in the proportion of 1 lb. of resin to 30 lbs. or 40 lbs. of water, is to be mixed well together with a glue solution, made by dissolving 100 lbs. of glue in about 300 lbs. to 400 lbs. of water; then boil up both solutions together for about ten minutes, after which run it through a fine sieve or filter, and it is then ready for use. The best proportions for mixing the vegetable and animal sizes are, for one and a half parts of resin add one part of glue; or, for some purposes, equal parts of each can be taken. The addition of starch, if required, can be performed as usual, and also the mixing of this improved size with the pulp.

HOW THE FRENCH BUILD.—The French practice in building is a good one. Instead of using flimsy lath for thin partitions, they employ stout pieces of oak, as thick as garden palings. These they nail firmly on each side of the framing of the partition, and fill the space between with rubble and plaster of Paris. They coat the whole with the plaster. The floors are managed in the same way, as well as the under side of the stairs. Houses are thus rendered more "fire-proof" or rather less combustible. In Nottingham, England, where they have gypsum in the neighborhood, as in Paris, they form their floors and partitions in the same solid manner; consequently a building is rarely burned down in that populous manufacturing town.