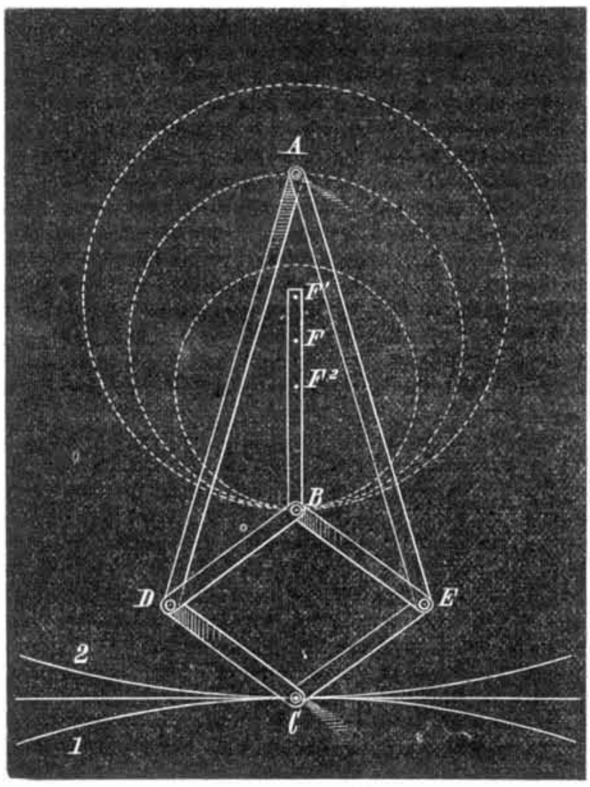
A NEW PARALLEL MOTION.

Parallel motion is the conversion of circular motion into rectilinear or the contrary, the best if not the most familiar example of which is found in the action of the beam and piston of the ordinary steam engine. Watt's parallel motion is to be found, in principle, embodied in almost every device of the kind; but that it is not mathematically exact, has long since been proved.

Professor Sylvester, in a recent lecture, a report of which we find in *Iron*, states that an absolutely perfect parallel motion has been discovered by M. Veaucellier, a young French officer of engineers, who gave to it the name of compound compass. The invention is illustrated in the annexed engraving, from which the reader can readily construct a model for himself in order to verify its action. It consists simply of six pieces jointed together, and A is the fulcrum around which the entire apparatus moves. B is the power point, and C the weight point. The figure formed by the four short arms, between B, C, D, and E, is the rhomb, and A D and D E, the connections. The form of the rhomb and the actual length of the connectors is immaterial, the only conditions being that the latter are equal, and that the three points, A B C, lie always in the same line, no matter what the position of the machine may be. A moment's consideration will show that if the near point, B, be brought to A, the further point, C, will recede, so that the path followed by C, when it is moved, will be inverse to that of B in respect to A. If by any means the point, B, be made to travel in a determinate course, the curve described by C will be equally definite and invariable. At B, the bar, B F, is added, forming the radius of a circle, which B will describe about F F¹ F², as centers. If now the center of this circle be fixed at F², so that the circumference falls inside the point, A, then C will describe the external or convex circle, marked 1. If the radius be lengthened so as to reach F¹, and to be greater than half the distance, A B, then the orbit of B will contain A within it, and C will move in an arc of a circle concave to A, marked 2. It requires no mathematical reasoning to show, for it is self-evident, that the curves thus described will grow flatter and flatter the nearer the center of the circle of B is to the actual center of the line, A B; and as Nature never acts *per saltum*, there must be a point in the process of change from one kind of curve to the other where the inverse path of C ceases to be a curve, when it theoretically describes two arcs of infinite radius, each looking to a center infinitely distant: in other words, a straight line. This clearly cannot happen when the radius, B, is either greater or less than half of A B, and therefore it can only be when F actually coincides with the center of A B. But in this case B, in its orbit, will evidently pass through A, and, by geometrical laws, the inverse, described by C, will be a straight line, so that the result is not merely practically but theoretically a perfect parallel motion. It gives us the means of converting circular into rectilinear motion with perfect accuracy, without friction and without any necessity of packing or any other faulty contrivances which have been inseparable from every system hitherto desired for the purpose of producing the same result.



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Absorption of Hydrogen by Gray Pig Iron.

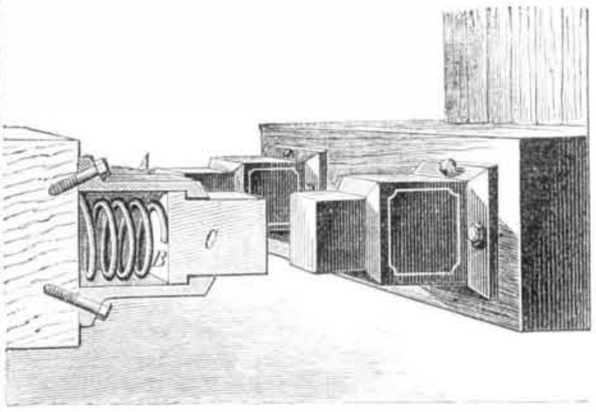
Mr. John Parry lately read a paper before the Iron and Steel Institute on the above subject, also on the probable absorption of zinc, cobalt, cadmium, bismuth, and magnesium, by gray pig iron heated in vacuo, in vapors of the same. This was exclusively a chemical paper; and so far as the experiments detailed can be as yet considered conclusive, it adds, to our previous knowledge of the strange absorbent and occluding power of iron for gases, that it possesses the like power in reference to a number of metallic vapors, among which that of metallic arsenic is remarkable from the circumstance stated by the author, that its vapor when once absorbed is not again evolved upon heating the iron.

* * *

BY the new postal treaty, letters of half an ounce may be sent from the United States to France for 9 cents.

IMPROVED CAR BUMPER.

Mr. Richard Lloyd, 265 Walker street, Cleveland, Ohio, has patented, April 28, 1874, through the Scientific American Patent Agency, a novel bumper for railroad cars, which is claimed to be more durable and elastic than those now in use. Our engraving exhibits the device in perspective and also in section.



A is a shell of cast iron, surrounded by a flange by which it is bolted to the timber of the car truck. Within the shell is a spiral or rubber spring, B, and on the interior of the former is a shoulder, with which the head of the bumper block, C, projects sufficiently to engage. The head and shoulder are held in contact with each other by the spring except when the cars come together; then the spring is compressed. The two bumpers, thus coming in contact, prevent the violent concussion and jar, alike disagreeable to passengers and destructive to the vehicles. The shell and block may be of any form and size. The device is stated to be cheap and durable, and may be easily applied to any car. Further information may be obtained by addressing the inventor as above.

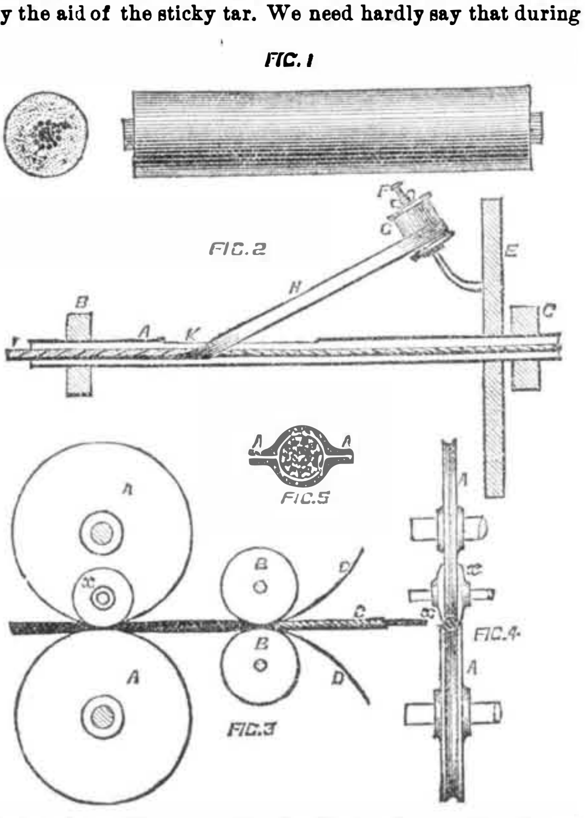
* * *

THE NEW ATLANTIC TELEGRAPH CABLE—HOW IT WAS MADE.

As the new Atlantic telegraphic cable, which is to extend from Ireland direct to the United States, landing on the New Hampshire coast, is nearly completed and is soon to be laid, we have thought that our readers would be interested in knowing just how the great conductor was manufactured. We take the following description from the *Engineer*. The cable was made at the works of Messrs. Siemens Brothers, Charlton (near London), England.

The new cable is rather peculiar in construction, and we append a full sized section and elevation of a portion of the core, Fig. 1. It will be seen that it consists of one thick central wire, round which are spun eleven fine copper wires, the core passing first through a peculiar composition, which, when cold, serves to bind the whole copper rope, as we may call it, strongly together. By this arrangement the largest available sectional area of copper is got with a given diameter. It is evident, however, that all elasticity, except that due to the stretching of the internal wire, is lost; whereas in an ordinary stranded wire rope, there is always a small amount of resilience due to the spiral lay of the strands. The wire, having been coated with gutta percha, is then "served" with manilla fiber to a diameter of ¾ inch, and this is in turn covered with ten iron wires spun on, each wire being itself first covered with hemp; after this the rope passes through two tar troughs, tar being continually poured on it by an endless chain. It is then wound with twine in a very open spiral, to hold the main strands in close contact till the tar is cold; and the rope then passes to one of three or four enormous tanks on the premises until it is wanted on board ship, the only further preparation it goes through being to coat it with powdered chalk to prevent the coils from adhering to each other by the aid of the sticky tar. We need hardly say that during the whole process of manufacture testing is carried on almost continuously, so that a fault cannot escape detection.

FIG. 1



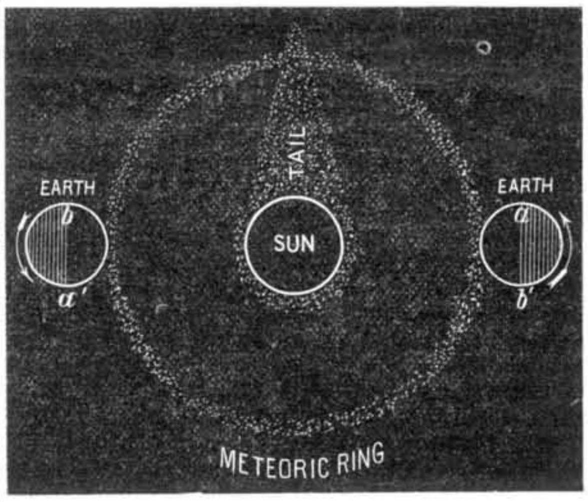
We cannot leave the subject, however, without describing the way in which india rubber is used to cover cables, as the process is exquisite and totally different from that employed when gutta percha is used. At the time of our visit some cable was being made, for what locality we do not know. The core consisted of six thin copper wires, spun together with a long twist; all the wires were tinned separately before spinning. The india rubber, which comes over to this country in large lumps or bottles, is masticated and washed, and worked between rollers, in a way too well known now to need description. It is finally reduced to a thin sheet, a little thicker than the air balls sold as children's toys in the streets. Strips of this, about ⅜ inch wide, are cut out and wound on a reel or bobbin; this is mounted on a spindle on a disk, as in the annexed sketch: A is a piece of iron tubing about 3 feet long, revolving on bearings at B and C, and fitted with a disk, F, which carries the inclined stud, which can be shifted on F. This supports the bobbin, G, round which is wound the strip of india rubber, H, a thumb screw adjusting the resistance of G. The wire is shown at I, and passes from one reel to another down the tube, A; at K a long slot is made in the tube, through which the strip of india rubber passes. It is obvious that if the wire is prevented from rotating, and proceeds from coil to coil, while A and F rotate round it, that the strip of india rubber will be wound off G and on the core. In this way the core receives its first coat. For the second, it passes through an elegant little machine, the principle of which is sketched in Figs. 3 and 4. Here C is the core, with its first coat of india rubber put on as just described; B B are two small rollers through which it passes, and D D are two strips of thin india rubber about ¾ inch wide, one over, the other under, the wire. These are drawn in with the wire, which next passes between the edges of the grooved disks, A A. These compress the edges of the rubber and coat the wire equally. If there were nothing more the wire would appear as in Fig. 5, two fins of rubber, A A, sticking out at each side. It will be seen, however, from Fig. 4, that the lower disk has a thick edge, against which rotates the sharp cutting disk, *x*; this shears off the superabundant fin, A A, Fig. 5, and so the wire comes out coated with three coatings—for it passes through two machines like Fig. 3—pink, round, and smooth, and ready to be served with canvas for use.

Correspondence.

The Zodiacal Light.

To the Editor of the Scientific American:

On page 320 of your current volume, Professor Wright is credited with being the discoverer of the cause of the zodiacal light. It seems that he has satisfied himself of the fact that the said light is "derived from the sun" and reflected to us from solid or meteoric material, "small bodies," as he calls them. Now I told your readers all that, and much more, over five years ago, as can be seen in your issue of January 8, 1869. Then I stated substantially what I say now: That the zodiacal light is not on two sides of the sun, neither is it all around the sun, nor is it a solar atmosphere, nor a nebulous vapor; but, on the contrary, it is ever on one side of the sun only, his hinder side, if you will, and is purely meteoric.



I said, further, that the said light was and is a longitudinal appendage or tail of the sun, and is so long that it stretches some 37,000,000 miles beyond the earth's orbit. I said also that the earth either passes through it or by it, on about the 14th of every November. In addition to that, I say now that the earth passes through it every 33 years, and by it, at more or less distance from it, in the intervening years, the cause being that the plane of the terrestrial orbit is but slightly out of the plane of the solar orbit.

Professor Wright is doing for me, in his practical way, in reference to the zodiacal light theory, what Professor Agassiz did in reference to my glacial epoch theory: he is proving my theory to be true; but that he is the discoverer of the theory, I claim, is not the fact.

That the zodiacal light is solar light reflected to the earth from meteorites, is undoubtedly the fact. But one thing remains to be settled; it is this: Is the zodiacal light a ring or a longitudinal tail of meteors?

The zodiacal light is seen after sundown, in this latitude in April and May; and before sunrise in October and November. If it were a ring, it could be seen at evening and morning of both periods. Any person can prove the fact by a diagram such as the one annexed.

In the figure, *a a'* represents morning, *b b'*, evening. From which it may be seen that, at *a*, a person could see the tail, but while at *a'*, he could not see it. So while at *b* he could see it, but at *b'* he could not see it. At the same time, if the said light were a ring, he could see it evening and morning, at *a a'* and *b b'* of both seasons. It cannot so be seen, and therefore it is not a ring, as is supposed by Professor Wright and others. JOHN HEPBURN.

Gloucester, N, J.

The Recent Boiler Explosion in Philadelphia.

To the Editor of the Scientific American:

We have read, in your issue of May 30, the article of W. Barnet Le Van on the boiler explosion at the mills of Mr. Henry Hoppen, Philadelphia. In his allusion to the work of the Hartford Steam Boiler Inspection and Insurance Company, the impression is carried that it was carelessly and inefficiently done. The facts are these: We formerly had charge of Mr. Hoppen's boilers; but at the inspection which was made in June last, we pronounced the boiler which exploded unsafe until repaired, and declined to assume any risk or responsibility, either pecuniarily or morally, until such repairs were made and the boiler re-inspected. The repairs were not made under our supervision, nor were we called to make an inspection after they were made. We had issued no certificate, and had no responsibility whatever in the matter. The intimation that the boiler was under our care and considered safe by us is entirely gratuitous.

Hartford, Conn. J. W. ALLEN, President of the Hartford Steam Boiler Inspection and Insurance Company.

A Curious Freak of Nature.

To the Editor of the Scientific American:

A few days since there was hatched under one of my hens a double bodied chicken, having but one head. The two bodies were perfectly developed up to the point where the vertebræ of the neck began. There was but one breast bone, which ramified towards each body. There mere two complete backbones, four perfect feet, and four wings. Unfortunately this curiosity was accidentally killed. A dissection showed but one heart, one liver, and one gizzard. There was but one bowel leading from the gizzard. This extended about one inch from the gizzard and there ramified, giving the two bodies each a full set of bowels. The specimen is now preserved in spirits in one of our physician's offices.

Louisville, Ill. C. H. MURRAY.

Refraction of Sound.

Professor Osborne Reynolds, in a recent paper read before the Royal Society, shows that sound, instead of proceeding along the ground, is lifted or refracted upwards by the atmosphere in direct proportion to the upward diminution of the temperature.

The lifting of the sound is shown to be due to the different velocities with which the air moves at the ground and at an elevation above it. Owing to friction and obstructions the air moves slower below than above, and the bottom of the sound waves will thus get in advance of the upper part, and the effect of this will be to refract or turn the sound upwards; so that the rays of sound which would otherwise move horizontally along the ground actually move upwards in circular or more hyperbolic paths, and may thus, if there be sufficient distance, pass over the observer's head.

It was found (as indeed it was expected) that the condition of the surface of the ground very materially modified the results in two ways. In the first place, a smooth surface like snow obstructs the wind less than grass; hence over snow the wind has less effect in lifting the sound moving against it than over grass; and it is inferred that a still greater difference would be found to exist in the case of smooth water. Under ordinary circumstances, the sounds which pass above us are more intense than those we hear. The general conclusions drawn from experiments are:

1. The velocity of wind over grass differs by ½ at elevations of 1 and 8 feet, and by somewhat less over snow.

2. That when there is no wind, sound proceeding over a rough surface is destroyed at the surface, and is thus less intense below than above; owing to this cause, the same sound would be heard at more than double the distance over snow at which it could be heard over grass.

3. That sounds proceeding with the wind are brought down to the ground in such a manner as to counterbalance the effect of the rough surface (2), and hence, contrary to the experiments of Delaroche, the range of sound over rough ground is greater with the wind than at right angles to its directien or than when there is no wind. When the wind is very strong, it would bring the sound down too fast in its own direction, and then the sound would be heard farthest in some direction inclined to that of the wind, though not at right angles.

4. That sounds proceeding against the wind are lifted off the ground, and hence the range is diminished at low elevations. But that the sound is not destroyed and may be heard from positions sufficiently high (or if the source of sound be raised) with even greater distinctness than at the same distances with the wind.

5. In all cases where the sound was lifted, there was evidence of diverging rays. Thus, although on one occasion the full intensity was lost when standing up at 40 yards, the sound could be faintly and discontinuously heard up to 70 yards. And on raising the head, the sound did not at once strike the ear with its full intensity nor yet increase quite gradually; but by a series of steps and fluctuations in which the different notes of sound were variously represented, showing that the diverging sound proceeds in rays separated by rays of interference.

On one occasion it was found that, with the wind, sound could be heard at 360 yards from the bell at all elevations, whereas at right angles it could be only heard for 200 yards standing up, and not so far at the ground; and against the wind, it was lost at 30 yards at the ground, at 70 yards standing up, and 160 yards at an elevation of 30 feet, although it could be distinctly heard at this latter point at a few feet higher.

It is argued that, since wind raised the sound simply by causing it to move faster below than above, any other cause which produces such a difference in velocity will lift the sounds in the same way. And since the velocity of sound through air increases with the temperature—every degree from 32 to 70 adding 1 foot per second to the velocity—therefore an upward diminution in the temperature of the air must produce a similar effect to that of wind, and lift the sound. Whereas Mr. Glaisher has shown by his balloon observations that such a diminution of temperature exists; and further he has shown that, when the sun is shining with a clear sky, the variation from the surface is 1° for every 100 feet, and that with a cloudy sky it is only half what it is with a clear sky. It is hence shown that rays of sound, otherwise horizontal, would be bent upwards in the form of circles, the radii of which with a clear sky are 110,000 feet, and with a cloudy sky 220,000 feet, so that the refraction is doubly as great on bright hot days as it is when the sky is cloudy, and still more under exceptional circumstances, and comparing day with night.

It is then shown by calculation that the greatest refraction—110,000 feet radius—is sufficient to render sound from a cliff 235 feet high inaudible on a ship's deck 20 feet high at 1¼ miles, except such sound as might reach the observer by divergence from the waves above; whereas when there-fraction is least—220,000 feet radius—or where the sky is cloudy, the range would be extended at 2½ miles with a similar extension for the diverging waves. It is hence inferred that the phenomenon which Professor Tyndall observed on July 3, and other days—namely that, when the air was still and the sun hot, he could not hear guns and sounds from the cliffs of South Foreland, 235 feet high, for more than two miles, whereas, when the sky clouded, the range immediately extended to three miles, and as evening approached, much farther,—was due, not so much to stoppage or to reflection of the sound by invisible vapor, as Professor Tyndall has supposed, but to the sounds being lifted over his head in the manner described.

There are many other phenomena connected with sound, of which this refraction affords an explanation, such as the very great distances to which the sound of meteors has been heard, as well as the distinctness of distant thunder. When near, guns make a louder and more distinctive sound than thunder, although thunder is usually heard to much greater distances. In hilly countries, or under exceptional circumstances, sounds are sometimes heard at surprising distances. When the Naval Review was at Portsmouth, the volleys of artillery were very generally heard in Suffolk, a distance of 150 miles; the explanation being that, owing to refraction, as well as to the other causes, it is only under exceptional circumstances that distant sounds originating low down are heard near the ground with anything like their full distinctness, and that any elevation either of the observer or of the source of sound above the intervening ground causes a corresponding increase in the distance at which the sound can be heard.

The Measurement of Flowing Water.

There is probably no point which has occasioned more dispute and litigation than the conflicting rights of persons entitled to take water power, in certain proportions, from a common source, where the demand exceeds the supply. The experiments, conducted by mathematicians and philosophers, have been, many of them, conducted on a small scale, and the results are not regarded as entirely conclusive, as the causes of contraction and other phenomena in a vein of water an inch in diameter would hardly bear the same proportion to the waters of a river discharged through a sluice. As a consequence, persons having charge of large works have endeavored to form rules based on their own experience. English engineers, on their own account, have made many experiments to determine the difference between the theoretic discharge (computed by the laws of gravitation) and the actual discharge, as modified by friction, lateral retardation, reaction of adjacent fluid, and other causes of diminished velocity and volume, and consequently of quantity. The French government also, some twenty-five years ago, appointed a commission to determine the question, and elaborate experiments on a very extensive scale were made by competent engineers, and the results of these experiments have brought the question within narrow limits.

In the "Philosophical Transactions" of the Royal Society of London, we have the following conclusions, which have been deduced from the experiments just referred to: 1. That the quantities, discharged in equal times, are as the areas' orifices. 2. That the quantities, discharged in equal times under different hights, are to each other nearly in the compound ratio of the areas of the apertures and of the square roots of the hights. The hights are measured from the centers of the apertures. The mean result, also, of several experiments, all the openings being formed in brass plates 1·20 of an inch thick, showing that, for round, triangular, and rectangular holes, the average of the numbers showing the proportion, between the theoretic discharge of the water calculated as a falling body, and the actual discharge as measured, was 6·1, and for the rectangular holes it was 6. It has also been found that the effect of gravity may be represented by 64 feet 4 inches, or 64·3—that is, the hight in feet through which the body falls, being multiplied by 64·3, will give the square of its velocity in feet per second. For the actual discharge per second in cubic feet, multiply the product of the altitude or head of water in feet, the area of the orifice in square feet, and the time in seconds, by 64·3, then extract the square root, and multiply by 6. It is found also, that with small orifices the effect of a high head is to contract the vein and to diminish the discharge, so that the nearer the orifice can be brought to the surface, and yet the water be kept running with a full stream and without causing any eddy or depression of the surface, the greater will be the discharge. But with larger apertures, as, for instance, one with 3¼ feet in length by 1¾ feet in width, or 5⅝ square feet of area, the discharge increases with the increase of head.

As to the discharge of water from open notches in dams it is found to be equal to ⅔ of the discharge from an orifice of the same size with a full stream under the same head. The proportion between the theoretic and the actual discharge from the open notches varies with the depths, the factors used being less with the greater depths. An English handbook of tables gives 214 cubic feet per minute as the quantity which would run over every foot in width of a regular notch 1 foot in depth from the water's surface. The amount discharged depends very much on the form of the notch or aperture. A plain rectangular notch, cut with square edges in a three inch plank, will discharge very much less than one which has its inner edges beveled or rounded off in the parabolic form of the contracted stream or vein of water. If the aperture be small, the difference may amount to a fourth of the whole quantity. Care should also be taken to form the wing-walls to sluices with curved or trumpet-shaped approaches, conformed to the natural contraction which may be produced by the overflow or sluice way.

To obtain the quantity which passes through a parallel channel in a given time, the sectional areas should be multiplied by the mean velocity, the latter element being obtained by adding the velocity of the water at the surface and that at the bottom of the current and dividing the sum by two. As it may not be convenient, in every case, to ascertain the velocity at the bottom, the mean velocity may be determined, with accuracy sufficient for practical purposes, by ascertaining the surface velocity in inches per second in the middle of the stream, and the mean velocity will be equal to this velocity less the square root of this velocity *minus* five. If, for example, the surface velocity in the stream is equal to 36 inches per second, the mean velocity will be found by subtracting 5 from 36, leaving 31, then extracting the square root of 31, which is 5·5, and subtracting this last figure from 36, giving 30·5 inches per second for the mean velocity. Multiplying this number by 60 and dividing by 12, or, which is the same thing, multiplying it by 5, will give the velocity in feet per minute. In the case just supposed the velocity per minute will be 152·5 feet. If, then, the water course be 4 feet wide and 2 deep, the amount of water discharged per minute would be 152·5x8 or 1,220 cubic feet.

When the overfall is a thin plate, it will discharge a greater proportionate quantity when the stream is only one inch deep than with greater depths. When the overfall is of two inch plank, the flow of water is more retarded, a greater head is requisite, and the maximum discharge is given by a head of seven inches. When the length of the overflow plank is ten feet, the coefficient is greater with a depth of five inches; and when wing boards are added, causing the stream to converge toward the overfall at an angle of 64°, the coefficient is greater even when the head is less, showing the utility of proper wing walls on sluices.

To determine the hight of the waterfall in a running stream, a small temporary dam, unless one exists, must be made, so as to secure a still surface. Take two poles sufficiently long to reach from the bottom of the water to the required line level. Make a plain mark or notch on both sticks, at a distance from the upper end equal to the distance of the intended line level above the water, marking that distance in feet and inches. Push the poles down through the water into the earth at the bottom until the notches are both at the level surface of the water, care being taken to have the poles plumb and at a convenient distance apart. Sight across the tops of these two, and set as many more as may be desired to run the line of level to the desired point, and the tops, being ranged accurately by the first two, will show a water level so many feet above that of the water. It is estimated that this is a more accurate way than the use of the ordinary spirit level.—*Boston Lumber Trade.*

Comparative Economy and Intensity of Electric Light and Gas.

The London *Daily News* says: Some curious and useful information about the lights displayed from the Clock Tower of the Houses of Parliament is given in a report just made to the House of Commons. It appears that the two semi-lanterns, which a spectator at Westminster sees 250 feet above him in the Clock Tower, are in the hands of two rivals—one of whom employs gas, and the other electricity, as the source of illuminating power. The Wigham light has three burners, each composed of 108 jets, placed one above another on the same axis. The electric light is produced by an electromagnetic machine, worked by steam power, the currents being conducted from the machine to the lantern along 1,700 feet of copper wires. The report is decidedly favorable to the electromagnetic process. Thus Mr. Douglas states that the electric light has a superior intensity of 65 per cent when one 108 jet burner is used, and of 27 per cent when three are employed. So, again, as to cost: the electric method produced a saving of 162 per cent, measured in cost per candle per hour, when a 108 jet gas burner is used, and of 133 per cent when three burners are used."