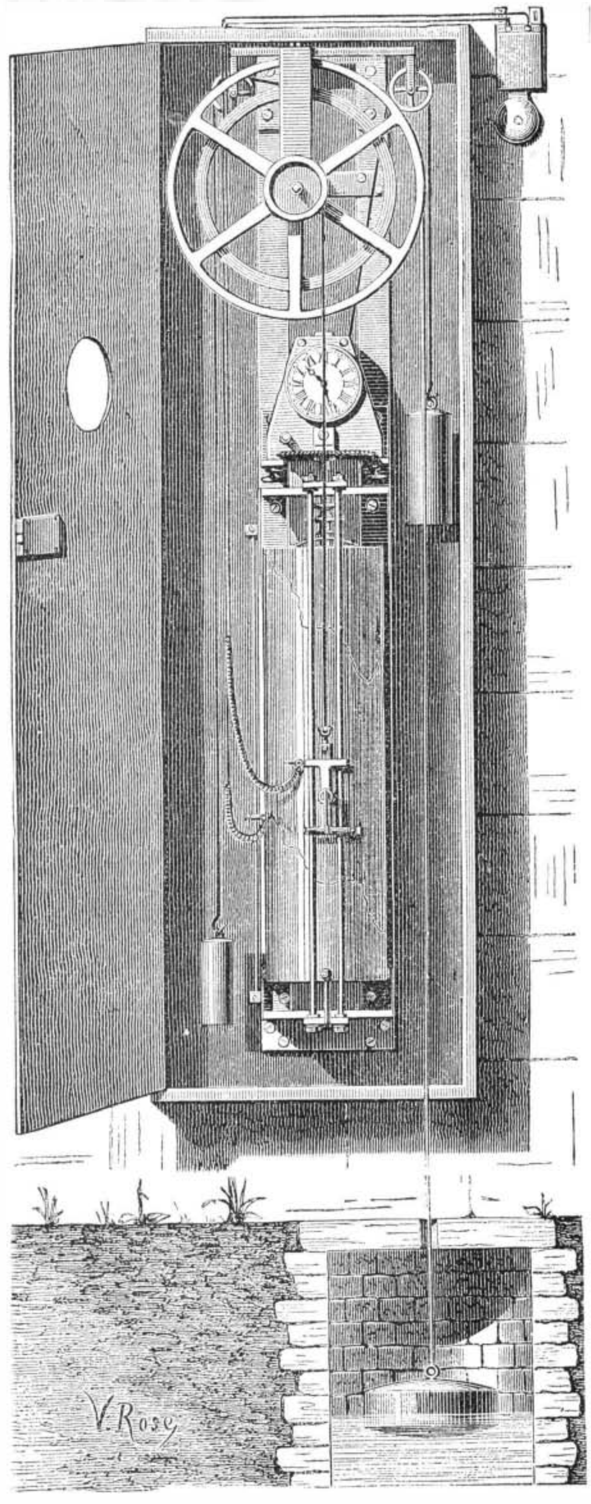
NEW TIDE AND RIVER GAGES.

The study of the variations of level of the ocean, and also of the rises and falls of rivers, canals, and streams, is an important adjunct of meteorological science, and is constantly followed in all countries in which regular observations of the weather and like natural phenomena have been established. We represent in the annexed engravings, for which we are indebted to *La Nature*, two new registering devices, one termed the maregraph, designed for tide measurements, the other the fluviograph, intended for similar examination of river and canal levels.

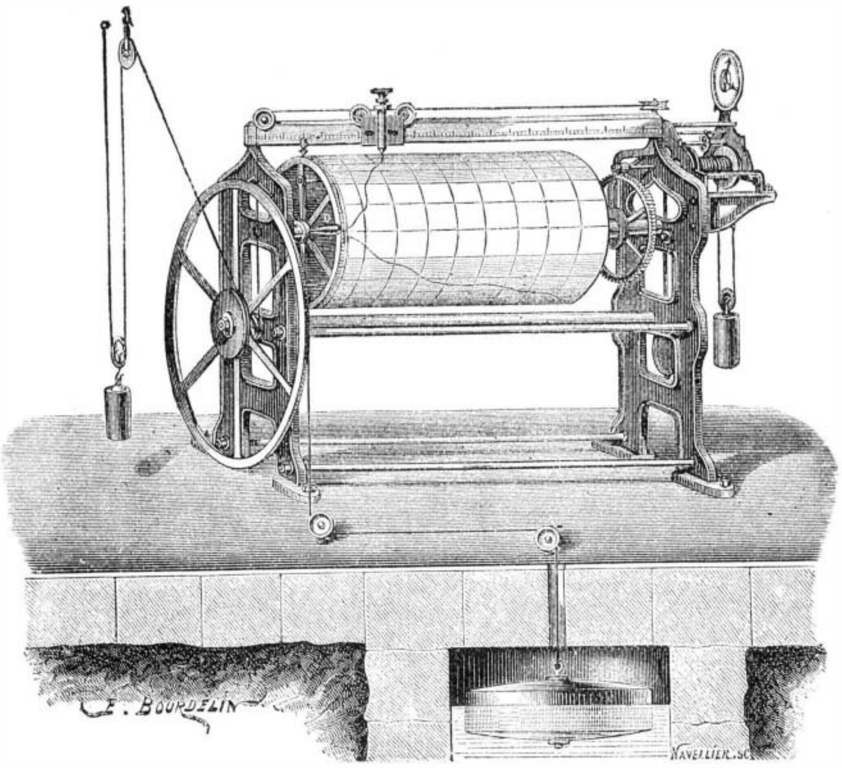
The maregraph (Fig. 1) is operated by an endless cord which connects with a float located in a suitable reservoir, into which the sea water enters. The changes of level of the water are registered on a large horizontal cylinder which is rotated by clock mechanism once in 24 hours. The cylinder is covered with a sheet of paper, changed fortnightly or monthly, and which is divided into longitudinal divisions, giving, on a reduced scale, the hights of the tides in meters and centimeters. A carriage, mounted on rollers upon a steel rule above the cylinder, carries a pencil, which is pressed against the paper by a spring. The carriage communicates by an endless cord with a small grooved wheel mounted on the shaft of the larger wheel which receives the motion of the float previously referred to.

On a third wheel, of medium diameter, is wound a cord, which is drawn by a weight in an opposite direction to that of the cord of the float. When, therefore, the float rises, the effect of the weight is to remove the shaft so as to take up the slack of the cord so that the latter is always kept taut. The pencil carriage is similarly actuated, and traces on the cylinder a mark of which the extremity is the maximum hight of the water. If the level is constant, the carriage remains motionless, and the pencil traces on the cylinder a line parallel to the transverse divisions



THE FLUVIOGRAPH.—Fig. 2.

A dial placed above the mechanism shows the hour, and at the same time serves to regulate the changing of the paper, and to indicate the moment at which the apparatus should be started on its daily motion. An electric indicator serves to give warning of any desired level being reached by the water. The indicator is movable, and is set on a special rod on the rule at the point corresponding to the hight of water to be denoted. When the carriage, onreaching that



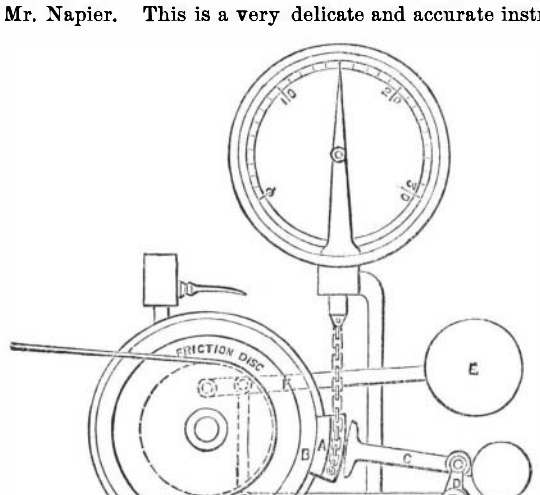
THE MAREGRAPH.—Fig. 1.

point, comes in contact with the indicator, the effect is to sound a bell.

The fluviograph (Fig. 2) is more compact in form than the instrument just described, owing to the cylinder being placed horizontally. By mechanism very similar to that of the maregraph, it registers, on marked paper, variations of level of the water, which, on a canal, may be used to indicate the passages of boats through locks. It also has an electric attachment for indicating certain levels, and also may be used as a watchman's time detector, by locking the door of the case and causing the watchman to press a button which makes a mark on the paper on certain divisions corresponding to the hours shown by the clock above. This apparatus has been successfully tested. It doubtless would prove valuable as a means of showing coming floods, and giving timely warning of the same.

IMPROVED FRICTION METER.

A friction meter and oil tester has recently been invented by Mr. Napier. This is a very delicate and accurate instru-



ment for ascertaining the lubricating properties of any material. The illustration above shows the general arrangement of these machines. The block, A, is pressed against the periphery of the wheel by an arm, C, which is a segment of a roller, balanced and pivoted on the short arm of the bell crank, D D, the long end of which is connected by a link to the lever, F, which has a weight, E, on the outer end of it; and a chain connects the friction block, A, to a spring balance. The wheel is to be made to turn to the right at any desired velocity of circumference, by means of a band from a lathe or otherwise, when the friction of the wheel on the friction block will tend to carry the latter along with the former; but it is prevented from doing so by the chain to the spring balance, which indicates the amount of the tendency of the block to move along the wheel, or, in other words, the total amount of friction on the rubbing surface.

IN the best work, slates are secured by copper nails. Iron nails dipped in boiled oil to prevent their corroding may be used. The nails should have large heads, thin and flat, so that they may not prevent the slates from lying close. Every slate should be secured with two nails; and in fastening, care should be taken not to bend or strain the slates, or they will crack and fly under sudden changes of temperature

CAPTAIN WEBB'S GREAT SWIMMING FEAT.

We have already chronicled Captain Webb's second attempt to swim across the British Channel, which was successful, being probably the greatest feat ever accomplished by a swimmer; and we publish herewith a portrait of the hero, and a chart showing the course of both attempts. The following facts are taken from *The Field*:

On the first occasion, when Webb left the water (see chart), he had been swimming 6 hours, 38 minutes, and 30 seconds, and had gone over $13\frac{1}{2}$ miles of ground, and had been carried $9\frac{3}{4}$ miles to the eastward of his course by the N. E. stream. On his successful voyage, he started $3\frac{1}{4}$ hours before high water, which gave him $1\frac{3}{4}$ hours of the S. W. stream, wherein he made $1\frac{1}{2}$ miles of westing; $5\frac{1}{2}$ hours N. E. stream caused him to make $8\frac{1}{2}$ miles easting; $7\frac{1}{2}$ hours S. W. stream took him $2\frac{3}{4}$ miles to the westward of his course, and 7 hours N.E. stream drifted him $7\frac{1}{4}$ miles to the eastward. It will thus be seen that he occupied three tides, in addition to $1\frac{3}{4}$ hours S.W. stream at starting, and about $\frac{3}{4}$ hour slack water at the finish under Calais pier, which protected him from the S. W. stream, then just beginning to ebb. His point of landing was $21\frac{1}{4}$ miles distant, and the length of ground swum over was $39\frac{1}{2}$ miles. Boyton, in his successful trip, paddled over about 29 miles of ground in 1 hour 33 minutes longer than Webb took to swim 10 miles further. As a performance of pluck and endurance, Boyton's is completely put in the shade by Webb's, though, on the score of utility, both may be placed on a par, as Boyton's suits are too expensive and require too much stowage room to come into general use, while swimmers of Webb's physique and courage will ever be *raræ aves.* Boyton took repeated rests on the occasion of his first attempt, although only 15 hours in the water, while Webb hardly rested at all, in fact never for more than a minute or two at a time, and that only while treading water to take refreshment.

CAPTAIN MATTHEW WEBB.

Captain Webb is eminently a salt water swimmer. He progressed with a slow and steady breast stroke, on an average of twenty to the minute throughout, which would make him take about twenty-six thousand strokes during the $21\frac{3}{4}$ hours. He possesses marvelous power in the legs and loins, while at the end of each stroke the soles of his feet emerge out of water. In fact, he altogether swims very high in the water, and his style would delight an Eton swimming master. The most extraordinary part of the feat is that the swimmer never complained of want of blood circulation

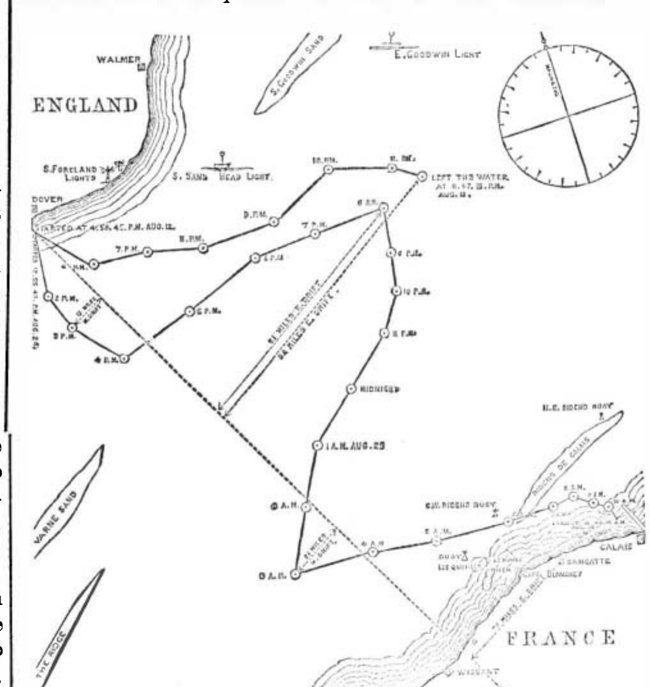


CHART OF CAPTAIN WEBB'S COURSE.

even at the last, after 21 hours immersion, but only of drowsiness from want of sleep and fatigue from prolonged ex ertion. As regards immunity from cold, we think the well-rubbed-in porpoise oil was not without good effect, as the sailors who helped him into the carriage on Calais Sands described him as feeling like a lump of cold tallow, and they themselves got lubricated with the remains of the oil. Whether his heart and physique are in any way specially adapted to stand such long immersions can only be ascertained by medical examination.

Matthew Webb was born at Irongate, Shropshire, England, on January 19, 1848, and was therefore just over twenty-seven years and seven months of age when he started. He is 5 feet 8 inches high, measures 43 inches round the chest, and weighs about 203 lbs. He learnt to swim at seven years of age. In 1870 he dived under a ship—whereon he was rated —in the Suez Canal, and cleared a foul hawser. On April 23, 1873, when serving on board the Cunard steamer Russia, he leapt overboard to save the life of a hand who had fallen from aloft while the watch was taking in second reef int opsails, the ship being then running free under all press of steam and canvas. Of course it was a long time before she could be brought head to wind and a boat lowered. However, Webb was saved with difficulty, after having been upwards of half an hour in the water, although he failed to rescue his shipmate, who was probably stunned, and sank at once. A subscription of $500 was collected for him on board, and he received three medals. When he first went to Dover to train for the present event, he successfully swam out to the N. E. Varne Buoy—more than half way across—by way of a feeler. The only things he suffered from, after his recent great feat, were an excoriated neck from constantly turning his head to protect a weak eye from the waves, and inflamed eyes from the salt.

In his training Captain Webb wisely took long and steady exercise in preference to sharp work. Being naturally a quiet and moderate liver, this came more easily to him, and very long walks, alternated with a three or four hours' swim, were the chief order of the day. In fact, when he dived, he was anything but a highly trained athlete in the usual acceptation of the term.

Correspondence.

What is the Electric Force?

To the Editor of the Scientific American:

In continuing the explanation of my views on this subject, commenced by me on page 196 of your current volume, allow me to say:

In the point of sound force, we have accurately determined the number of vibrations of matter per second necessary to the production of a certain sound; in that of light force, we have approximately estimated the number of vibrations, waves, or molecular motions per second necessary to the production of the various colors. In the point of heat force, we have determined that it exists in a certain violent molecular motion; and in the point of electric force, we have determined that it also exists in a certain molecular motion. And I may here mention, as being one of the strongest proofs, the fact that a current transmitted through a bar of iron will not disturb it, the fact that a current transmitted around it will not disturb it, and the fact that a current transmitted simultaneously through it and around it will cause it to twist in a very appreciable degree, which would not be the case unless the electric force consisted of molecular motion. If we were in possession of no other proof that the idea of a fluid flowing through an electric wire is a myth, we might easily be assured of it by the fact that molecular motion alone is the necessary condition of all other forces. This motion, beyond doubt, varies in intensity and form in different forces, but that it is the one condition of force there can be no doubt: and that the only difference between the forces is the difference between molecular actions may be accepted as a truism. To my mind the force of attraction of gravitation, and perhaps the more remarkable orbital motions of the planets, are forces to which the electric force bears no comparison. The electric force, in fact, is no more mysterious than is any other force. When one pulls a bell cord, and instantaneously a bell is rung in a distant room by the molecular transmission over or through the bell wire of the force applied at the cord, does not one realize that he is as veritably, as wonderfully, and by a similar molecular motion, transmitting that signal as though he were transmitting it by applying a battery to a telegraph wire and thus setting the atomic particles in motion? Cannot one realize that, if there are bells at different places upon a long wire, the nearest bell will ring first and the most distant last? But no one would speak of a subtle fluid as the cause of the ringing, although there is just as much subtle fluid passing over the bell wire as there is when a telegraph operator in New York makes a signal in Chicago by applying the battery to the line of wire connecting the two distant places.

As in this force, so in electricity, nothing flows through the wire. There is, in fact, the most striking analogy between the molecular transmission of electricity and the molecular transmission of all other forces. The stronger and more rigid the lever, the larger and firmer the belt, the larger the tube for water or air, the better the transmission of the forces applied. The larger the conducting wire, the more perfect the transmission of the electric force: because the larger conductor we have, the more perfect must be the molecular motion.

We are now brought to consideration of one of the most important facts bearing upon the question of molecular motion and the theory of a subtle fluid. The force of the electric current is as the square of the distance or length of the conductor. A battery is a constant generator of electric force. These are our premises, and it is not difficult to understand that if, as according to the subtle fluid theory, a wire have a certain capacity to hold that fluid, just as a tube has a certain capacity to hold a liquid, it cannot matter what the length of the wire may be. It is well known, also, that the resistance of a wire varies as the square of the diametric amount of metal. Therefore, in considering the electric force as a fluid, we are bound to consider the wire as a reservoir for that fluid. Now an immense quantity of electricity passes over a very small wire in a certain period of time; and a wire $\frac{1}{8}$ of an inch in diameter, the battery being of proper dimensions, will charge a condenser up to a certain point in one half the time that a wire of less diameter, composed of $\frac{1}{2}$ the diametric amount of metal will charge it, and in one fourth the time that a wire composed of one fourth the diametric amount of metal will charge it; but the smallest wire will charge it to its full capacity as well as the longest wire. merely requiring more time in proportion. Therefore, if a battery be attached to a wire 100 miles in length, the subtle fluid theory would, as soon as the battery should have sufficiently charged the wire, make it necessary that the strength of the electric force in the 100 miles of wire should be as great as though the wire were but a mile, or a few feet, even, in length. This statement cannot be controverted.

Very far from this, however, is the case. We may have our battery upon the wire for any length of time, and we shall find that the force of the electric current still varies as the square of the length of the wire. This, alone, utterly disproves the theory that, in transmitting a signal by telegraph, the wire is charged by a subtle fluid, and proves beyond doubt that the action of the battery is to impart a certain force to the atomic particles of the conductor, which act, each in turn, upon the next and the next, losing force in each successive action, just as we behold every day in the operation of all the forces surrounding us, as, for instance, the ripples occasioned by the dropping of a pebble into a still pond, widening and widening and decreasing in force and intensity as the square of the distance. In the molecular action, there must be a loss of force every time one atomic particle imparts the electric force to another. This we know is the case. According to the subtle fluid theory, this could not be the case.

Again, if we can prove, as in the case of light, that one transparent substance will transmit certain rays of light and not others, we prove that the transmission of the light force is due to molecular action, that the light force itself, in fact, is a certain molecular action. This will be conceded; and I suppose I need not at this point endeavor to prove that such is the case, as the facts have been set forth by students in this line of science, among them Professor Tyndall, in far weightier terms than I am able to command. The one and only deduction to be made from the results attained is that certain atomic conditions are necessary to the transmission of certain forces, and that certain substances are incapable of assuming the atomic conditions necessary to the transmission of certain forces. The same general law holds good in respect of the electric force.

Without entering into all details of the subject, it may be asserted that the very fact that one metal is a better conductor of electricity than another proves conclusively that the propagation of the electric force is dependent upon the atomic structure of the metals; that as its propagation is dependent upon this atomic structure, the propagation of the electric force is by the atomic or molecular action of the metals; and that as this is true, so the electric force is a certain molecular action. The conductivity of the metals is expressed by their resistance, the metal offering the least resistance to the propagation of the electric force being the best conductor. Thus with the resistance of silver expressed as 107, the resistance of quicksilver is 5,550, the latter metal, which is almost without tenuity of the atomic particles, being the poorer conductor, as would inevitably be the case under the molecular theory, and so would not be the case upon any other hypothesis. There are other causes, however, for the difference in the conductivity of different metals. Heat, we know, is a violent molecular motion. The electric force, being or consisting of a certain molecular action, should therefore be disturbed by the molecular action which constitutes heat; and we find that the resistance of a metal to the propagation of the electric force is increased by increase of temperature in the metal. The violence of the molecular action which is the electric force must be apparent to any one who witnesses the wonderful deflagrating effects of that force. Intense, we know, is the molecular action which constitutes heat; and it is a remarkable fact, as pointed out by Forbes, that the order of the metals as regards their conductivity for heat is the same as their order in conductivity of the electric force.

I will conclude the present article with one more argument in proof of the assertion that electricity is nothing more nor less than a certain condition of the atomic particles of matter.

The majority of the readers of the Scientific American have doubtless witnessed the discharge of electricity from a condenser, such as a Leyden jar, or from a battery or induction coil. They have beheld the brilliant sparks, and very many are cognizant of the fact that every spark is a particle of the metal of the discharging point heated to the state necessary to the production of the light witnessed. The electric light is not something which has passed over or through the wire, or something partaking of the nature of many metals which may compose the wire, but it is confined in kind to the properties of the metal composing the discharging point. Thus of platinum, silver, iron, copper, of which the discharging points may be composed, each gives its own peculiar light, no matter of what metal the greater length of the conducting wire may be composed: as, for instance, we may transmit the electric force through a hundred miles of copper or iron wire, and finally, when we get the discharge, it passes through a film of platinum $\frac{1}{10000}$ of an inch in thickness: but we get the same result in the kind of light produced as though the whole of the wire were platinum. Yet the electric force is the same no matter of what the conductor may be composed; and no reasoning can account for the projection of a flaming atom of matter from the discharging points, oftentimes with force sufficient to penetrate a piece of glass several inches in thickness, beyond the theory of intense molecular action.

The simple fact that the electric light which we witness is composed of the atomic particles of the conductor, heated to the state in which we observe them, and projected or following from the mass of the conductor, from one electrode to another (atomic particles which we know never have passed through the conducting wire, but have existed at and are wearing off from the terminal alone), proves beyond doubt that nothing that we witness in electrical phenomena has passed over the conducting wire in the sense of a current; that as this force is manifested at the distant end of the conductor in the shape of projected atomic particles of matter, it is clear that the electric force is a certain intensely active condition of the molecules of matter, which activity is set up by the violent action of acids upon metals or chemicals, by heat, or by friction, and transferred from one atom to another with inconceivable rapidity; and that as no heat can exist except by combustion or by friction (unless imparted heat, which is itself sustained by combustion or friction), the voltaic arc, the most intense heat, which is not sustained by combustion but exists in all its intensity in a vacuum, can only be the result of friction; and inasmuch as the mass of the metal is not subjected to friction, the friction can only exist in a violent action of the atomic particles of the metal.

Knowledge is of two kinds, positive and negative, namely, that which we know is, and that which we know must be, because it can be nothing else. It is more by the negative than by the positive reasoning that we can determine the nature of electricity. Deschanel, recognizing the crudities of the electric fluid theories, said of the positive and negative currents: "It is conceivable that the two electricities, instead of being two kinds of matter, may be two kinds of motion, or in some other way may be opposite states of one and the same substance." The reasoning by which we establish the verity of this conception is both positive and negative, and the reasoning of analogy.

Washington, D. C. W. E. Sawyer.

Remarkable Explosion.

To the Editor of the Scientific American:

On August 28, a terrific explosion took place at the works of the Milburn Wagon Company at this place, under the following circumstances: The shop is cleared of shavings by a system of pipes and pneumatic fans. The magazine was located in the boiler room, and was about 25x10 feet, and 28 feet high. Near the top of the magazine was a 20 inch sheet iron pipe leading into the main chimney stack, and immediately under it was a second one, similar in all respects. These were used to take the fine dust out of the magazine. Six feet below them were four 12 inch pipes leading in to the furnaces, and entering under the grate bars, These had valves to them, and were mostly kept closed. The works were running at the time of the occurrence; and a fire had just been put in, and the door closed, when it "kicked," as the term is, and an explosion took place in the magazine, which completely wrecked the boiler room and magazine, tearing the roof off and blowing the wall down. Fortunately no one was injured.

This should be a warning to wood workers not to have direct communication between shaving magazines and furnaces, if fans are used, as few understand the explosive nature of the fine dust from woodworking machines.

Toledo, Ohio. Toledo.

[We are exceedingly obliged for this note. We have often seen miniature explosions of the kind described by our correspondent, but have very seldom seen an account of one so violent. Our correspondent is deserving of great credit for the clear explanation which he has given.—Eds.]

The Solar Chronometer.

To the Editor of the Scientific American:

It may be interesting to your American readers to know that the solar chronometer illustrated in your issue of September 11 was invented by one of their number.

In 1868 I invented the same instrument, though in a slightly different form, and applied for a patent. The claim was rejected on the ground that the invention was not new. The "equation curve," which I constructed, was identical with the one illustrated, and was constructed as follows: A meridian is assumed as the axis of abscissas, and the equator as the axis of ordinates, their intersection being the origin of the curve. The sine of the sun's longitude is the abscissa and the equation of time is the ordinate for the corresponding point of the curve. The *plus* and *minus* signs to the equation of time project the curve on opposites of the axis of abscissas; but as the ordinates for two opposite points, in two opposite quadrants of longitude, are not equal, the curve is not symmetrical, though it is nearly so. Instead of reading the time on the meridian line, as in the ordinary dial, the time is read on the curve, at a point indicated by the declination of the sun shining through the lens. The reading,