a double flued boiler for alternate firing, productive of economy of fuel and consumption of smoke, improvements of feeding apparatus in millstones, the adoption of a better principle of suspension and the use of ventilated buckets in water wheels, the invention of the riveting machine, and, finally, in 1836, the introduction of improved architecture for factories.

Experiments upon canal boats engaged Fairbairn's attention in about the year 1821, and through these researches he was led to examine the advantages of iron for the construction of vessels. One of his earliest attempts was the building of a small iron ship, which was set up at his works and carted through the streets of Manchester to the water. His experiments thus begun resulted, five years later, in his development of iron construction in ships of the largest class, at Millwall, London, on the premises afterward occupied by Mr. Scott Russell. Here more than one hundred vessels were built by Fairbairn's firm, ranging from frigates to small boats. It is to Fairbairn that we owe the repeated enforcement of the fact that a ship is, in many respects, to be regarded as a huge beam or girder.

In conjunction with Mr. E. Hodgkinson, the subject of our sketch conducted a series of experiments, resulting in the determination of the comparative strengths of hot and cold blast iron, of the tenacity of boiler plates of various thicknesses, of the best form of section of cast iron beams, of the resistance of hollow tubes to outside pressure, and also in the general use of wrought iron plate girders in ordinary building operations. One of the first edifices ever constructed of iron was a corn mill, manufactured in 1838 by Fairbairn, the castings, etc., of which were sent to Constantinople, where it is still standing.

Mr. Fairbairn's experiments on tubes were conducted during the erection of the celebrated tubular bridge over Menai Straits; and although considerable controversy was engendered at the time, the original plans of Robert Stephenson were modified in accordance with the results. Stephenson suggested a circular tube supported by chains, but Fairbairn found that a rectangular structure, strengthened by a series of cells at the top and the bottom, and suspended, without supports, from pier to pier, was best adapted to the stipulated conditions.

Subsequently to this period, Mr. Fairbairn made researches into the strength of wrought iron plates and rivets for shipbuilding, and also into boiler explosions. He believed that steam could be worked with greater economy at a pressure of from 150 to 200 lbs. per square inch, and that at a high rate of expansion, with two or more cylinders. With this view he first constructed the Lancashire boiler, and subsequently, in 1872, a fire tube boiler, which was tested safely to 400 lbs. per square inch, and found to stand uniformly the first mentioned high pressure.

Mr. Fairbairn was one of the founders and afterwards President of the British Association. His published works, besides a large number of papers on special subjects, are: "Iron, Its History and Manufacture," "Mills and Mill Work," "Application of Iron to Building Purposes," "Iron Ship Building," and three series of "Useful Information for Engineers," all standard volumes of reference. He was a corresponding member of the Institute of France, a Chevalier of the Legion of Honor, and a Baronet, the last named honor being conferred upon him in 1869.

NEW INDUSTRIAL RESOURCES OF FRENCH COLONIES.

A French commission has recently carried on extensive investigations into the resources of the colonies of France, with a view of determining as to whether certain indigenous productions can be utilized for industrial purposes. From the results elicited, it appears that active measures will be taken for the introduction of some products and for the cultivation of others. Special attention is to be given in the Réunion Islands to the cultivation of vanilla. Plantations are established, which will be renewed every ten years, and are designed solely for the propagation of healthy slips for distribution, it being hoped that, by this means, the gradual disappearance of healthy plants may be checked.

The Tahiti Islands furnish the finest variety of mother of pearl now known; but commerce therein is at present carried on by English and German merchants. French government officials have been supplied with funds, and efforts will, through them, be made to establish a French trade, both in this substance and in tortoiseshell. Ramie is found in large quantities in Tahiti, but is too costly a production to figure in commerce. Another variety, also adapted to textile manufacture, has been recognized in the Antilles and in French Guiana. The crop averages about 3,420 pounds to the acre, the white fibers being some 6 feet in length, and worth 18 cents per pound. This yield per acre is superior to that of sugar. The sap of the *balata minusops*, or Guiana gutta percha tree, was rejected, in 1867, as valueless, on account of the friable properties of the resulting product, and the resinous effervescence which appeared thereon. Some fragments of the plates employed in the tests have lately again been experimented upon, and the material is now found to possess all the qualities of good gutta percha. The former defects were due to bad preparation. Further investigations into this product will be inaugurated.

The commission has also found a large deposit of valuable fertilizer in the bones of the cod from the fisheries of St. Pierre and Miguélon. The remains are rich in phosphate of lime, and contain 21 per cent of ossein.

JUMPING OF GAS FLAME.—This is caused by water condensing in some low place in the fittings. Have the pipe cut, and a T piece put in, with a small tap, so that water may be let out before turning on the gas.

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Contents:

(Illustrated articles are marked with an asterisk.)

THE TORPEDO PRACTICE AT NEWPORT.

The torpedo practice during the recent fleet drill at Key West, it will be remembered, was not exactly of a nature calculated to impress the public mind with a sense of the tremendous destructive force of bags of powder poked out on the ends of sticks; and consequently, since that time, slurs upon our naval torpedo system have been more frequent than commendations for the efforts of the very zealous corps of officers, who, for several years past, have been quietly working and experimenting, at their station on the bleakest of the islands in Newport Harbor. With the publication of the excellent results of the recent trials at Newport, however, the cloud which has obscured the labors of the experimenters is dispersed; and we must admit that, in lieu of sticks and powder sacks, the torpedo officers, Professor Moses Farmer and Lieutenant John P. Merrell, have developed for us a means of warfare of terrible efficiency.

The recent trials took place on successive days, in the presence of a congressional committee, and a large concourse of spectators. The initial experiment was the explosion of a ground torpedo of fifty pounds of powder enclosed in an iron-cased shell. This was blown up by Professor Farmer's dynamo-electric machine. Two fifty pound torpedoes were then fired by the contact of a boat with the circuit closers; and the blowing up of apparatus improvised from ordinary water breakers followed, to show how easily these destructive weapons could be constructed from the simplest materials, and without special machinery.

The plane table was used in the explosion of a three hundred pound torpedo, the current being established at the instant the approaching vessel was seen through properly adjusted sights. A column of water, two hundred feet high, marked the tremendous violence of the escaping gases. An attempt was made to blow up an old hulk, by the aid of submarine torpedoes; but through some mal adjustment of the latter, the vessel, though badly damaged, was not destroyed. An excellent feature of the operation was, the firing of a torpedo through a mile of cable, the main object being to show that this means of offense or defense could be safely carried on beyond the range of the enemy's fire. An explosion of 500 igniters simultaneously, proving that several mines could readily be blown up at once, concluded the experiments of the first day.

An old coal schooner formed the objective point of the second day's operations, the interest of which was greatly hightened by the participation therein of the new ironclad torpedo boat Intrepid. This vessel is a small steamer, built expressly for torpedo manœuvering. She steams at a rate of about nine knots per hour. The hulk being stationed out in the stream, the Intrepid backed astern for about a mile in order to get good way on, and then rushed ahead at full speed. The Harvey torpedo, which she towed on her starboard side, was brought in contact with the hulk and, at the instant of touching, fired by an electric fuse, smashing in a huge hole in the vessel's side. Immediately the Intrepid dashed up for a second trial, and this time exploded a spar torpedo, rigged out from her port side, directly under the bottom of the fated craft. A fearful explosion, followed by the hurling aloft of great fragments of wood and masses of water, showed that the weapon had done its work. The ship was literally torn to pieces, leaving but a few large portions drifting about. A second torpedo blew these out of existence, and the total disappearance of hulk marked the close of, probably, the most successful extended series of torpedo experiments conducted under naval auspices in this country.

RECENT METALLURGICAL RESEARCHES.

Some facts of interest to metallurgists, in gold and silver, are to be found in a recent memorandum of Mr. Chandler Roberts, chemist to the British Mint. We learn that the spectroscopic assays, begun last year, have been successfully prosecuted, giving results that prove that, for purposes of quantitative analysis, the spectroscope must form an auxiliary of the highest value. It is stated that differences of composition amounting to less than $\frac{1}{10000}$ part may thus be determined.

Mr. Roberts quotes the interesting results obtained by M. Serol, of the Paris Mint. This chemist finds that, while a silver copper alloy containing 71·893 per cent of the former metal is homogeneous, in all alloys containing more silver than this amount the center of the solidified mass is richer than the interior. A mass of 112 ozs. of silver copper alloy, melted, carefully stirred, and allowed to solidify, was found not to be homogeneous. The silver accumulated at several points, not bearing any apparent relation to the geometrical form of the mass. A homogeneous plate was at last obtained by assaying all parts of a plate of standard silver and cutting off those portions which varied from the required standard. Perfectly pure gold was obtained by reducing the chloride of gold with oxalic acid and fusing in a clay crucible with bisulphate of potash and borax. The electrolysis of cyanide of gold and potassium gave a product containing 999·9 of fine gold in 1,000, while reduction of the chloride with sulphate of iron and subsequent fusion gave only 999 85.

PROTECTION FROM LIGHTNING.

During a recent thunderstorm in the village of Trumbull, Conn., a family of three persons, husband, wife and child, who had taken refuge on a feather bed, were instantly killed by lightning; the house had no rods. In the same village, during the same storm, a dwelling house, which had two lightning rods upon it, was seriously damaged. Several of our readers, who have seen the accounts of these disasters, and others who cite analagous examples, have had their faith in feather beds, as a place of safety during thunder storms, severely shaken; while some of them would fain believe that lightning rods serve to destroy rather than to preserve life and property. We are asked to print something upon the subject; and we cheerfully comply, premising, however, that there is little that is new to be said, and that the subjoined information has for the most part been heretofore reiterated in our columns.

ARE FEATHER BEDS A PROTECTION FROM LIGHTNING?

Feather beds are not a protection from lightning, and the popular belief that they are, doubtless results from a misapprehension of the laws that govern the passage of electricity. The human body is a better conductor of electricity than feather beds or other objects ordinarily contained in the apartments of dwellings, and therefore, *a priori*, when the lightning enters an apartment, the human body is likely to form one in a chain of inductions, determining the path of an electrical discharge, unless better conductors are in its vicinity to divert this action.

WHAT IS THE SAFEST PLACE DURING A THUNDERSTORM?

The only place of absolute security in a thunderstorm is an iron building; or next in safety is a building properly protected by lightning rods.

Houses constructed entirely of iron manifestly stand in no need of lightning rods at all, because the electric fluid, on striking so good a conductor, would rapidly diffuse itself in all directions and flow into the ground, provided, of course, that the construction of the building is such as to allow its free escape.

ARE LIGHTNING RODS OF ANY REAL VALUE?

Unquestionably they are. Examples are numberless where the lightning has been seen to fall upon the rods of buildings and descend harmlessly to the earth; while the fact is undisputed that the principal damages suffered from lightning are in connection with buildings that are not provided with conductors. Notwithstanding these facts, some people are apt to be indifferent whether their houses and stores are provided with lightning rods or not, and are always ready to give an example where some building so provided was struck in spite of its protection. Such cases are quoted by the old fashioned "practical men" with much satisfaction, because they hail in them what they are pleased to call the victory of their sound common sense and the discomfiture of the scientific man. This class is, however, rapidly diminishing in numbers under the influence of the extensive diffusion of scientific education among the people.

It may be well to assure unbelievers that the efficacy of the lightning rod is no longer an open question, and that any failures are attributable *to bungling or ignorant construction.* It would be an easy matter to multiply statistics in proof of the assertion; but none would carry with them more force than the following statement obtained from the records of the British navy, by Sir Snow Harris, F. R. S :

"Between 1810 and 1825, before rods were introduced, no less than thirty-five sail of the line and thirty five frigates and smaller vessels were completely disabled; and in 200 cases recorded, 300 seamen were either killed or injured. When the lightning rod was introduced, every mast was furnished with a capacious conductor permanently fixed and connected with bands of copper passing through the sides of the ship under the deck beams, and with large bolts leading through the keel and keelson, and including, by other connections, all the principal metallic masses employed in the construction of the hull" (Harris). Since the adoption of this arrangement, "it appears that damage by lightning has positively vanished from the records of the navy."

In England, the various telegraph companies suffered serious damages by every thunderstorm, by the destruction by lightning of their poles. The poles are now provided with small lightning rods, and all damage has ceased.

In this country the Western Union Telegraph Company has suffered in the same manner, especially, says a recent number of the *Journal of the Telegraph*, "upon the plains and prairies, where every lightning storm formerly shattered and destroyed more or less of our poles, but which are now fully protected by a conductor (No. 8 wire) placed on every fifth pole. Wherever telegraph poles are provided with such lightning rods, all damage is prevented. Where the poles are not provided with rods, damage ensues.

WHAT IS THE PROPER SIZE AND MATERIAL FOR HOUSE LIGHTNING RODS?

According to the best authorities, a copper rod of one inch in diameter, or an equal quantity of copper under any other form, will resist the effect of any discharge of lightning hitherto experienced. The copper rod is therefore the safest and best material that can be used, but it is expensive. Iron rods of one inch in diameter are very commonly used, and, if pointed with solid copper and properly put up, are efficacious in the great majority of cases. The particular form of the rod makes no difference. It may be round or square, twisted or hollow, composed of one solid piece or made of wires twisted together. It is the quantity of metal contained in the cross section of the rod that is of value, not the form.

WHY SHOULD THE ROD BE POINTED?

The reason for terminating lightning rods in a point is as follows: When a thunder cloud highly charged with positive electricity comes up, it repels the positive electricity of all bodies on the surface of the earth coming within its influence, and causes negative electricity to accumulate in them. This is called induction, and it always takes place before a discharge. Now it has been discovered that, when electricity is accumulated in a body in this manner, it can most readily escape by sharp points because in them it meets with the least resistance. A lighted candle held near the prime conductor of an electrical machine furnished with a point will be nearly blown out by the current of air produced by the escape of the electricity. Lightning rods are therefore provided with sharp points to allow the accumulated negative fluid to pass off readily into the air and neutralize the positive fluid of the thunder cloud.

HOW SHOULD RODS BE MADE AND APPLIED?

The object being to make so good a passage for the lightning to the ground as to remove all danger of its leaping to some conductor in the house, the greatest care must be taken not to have any break in the conductivity. As it is inconvenient to manufacture or transport the rods in one piece, the different parts must be in intimate connection when they are put up; it is best to have them soldered and the joints protected from the air and moisture.

The point of the rod should be extended a little above the chimney or highest part of the building, and should be fastened in contact with the building by staples or cleats. Glass insulators should not be employed. It makes no difference in conductivity whether the rod is painted or not painted.

No building can be said to be properly rodded or protected against lightning, unless the lower part of the rod or terminal under the ground is made quite extensive. The extremity of the rod should connect with masses of good conducting materials, such as old iron, or iron ore, or coke, or charcoal, laid in trenches, or the rod itself should be elongated, sunk deep in the ground, and carried a considerable distance from the building, and put in connection with water or moist earth if possible. The golden rule for safety is: "Provide the largest possible area of conducting surface for the terminal of the rod."

LOOK TO YOUR TERMINALS.

A lightning rod which is not properly connected with the earth is quite dangerous. The very common method of merely sticking the lower end of the rod down into the dry earth near the surface of the ground is bad, and endangers the building, because dry earth is such a poor conductor, and the amount of rod surface in contact with the earth is so small. Under such conditions, a portion of the electric current will be likely to find an easier path to the earth, through the building than through the rod; and a part of the electricity will therefore leave the rod, strike into the building, and down in various directions into the earth, making havoc as it goes. As a measure of prudence, house owners should *look to the terminals* of their lightning rods, and place there a considerable amount of the conducting materials above named.

By adopting this simple expedient, many buildings, otherwise unsafe, will be rendered comparatively secure from damage by lightning.

As an electrical conductor, well burnt charcoal ranks next to the metals. Metallic ores come next to charcoal. Water and moist earth, which are so frequently recommended as terminals for lightning rods, are among the poorest of conductors.

One of the best protected buildings that we have heard of is that of Mr. John Knox Smith, an intelligent English merchant residing at Singapore. His country house is built on a prominence, upon a bed of iron ore, with which the house lightning rods are made to communicate. The lower ends of the rods thus have a very extensive conducting surface, and the protection afforded is considered perfect. Thunderstorms and lightning strokes are very frequent, but the house has never been injured.

PROTECTIVE AREA OF RODS.

It was supposed to have been established by Charles and Gay Lussac that a lightning rod protected an area whose radius was double the hight of the rod extending above the building, but this rule is no longer reliable by reason of the extensive use of metals in the shape of pipes, etc., in the construction of the buildings of our day.

WATER AND GAS PIPES SHOULD BE CONNECTED WITH THE LIGHTNING ROD.

When electricity finds several paths to the ground, it will prefer the best, it is true; but some portion will also pass along the poorer conductors. If, therefore, any metallic substances lie within the area supposed to be protected, they are in danger of being struck. This is especially true where the lightning has a chance to jump to the gas and water pipes of a building. It is a good plan to connect these pipes with the lightning rod; if the rod is struck, the electricity will then have an excellent path into the ground and will be rapidly diffused over the vast underground network of pipes The danger to the inmates of the house of being struck from these pipes is less than that of receiving a shock from the powerful induced currents, liable to be developed in them, if unconnected, during a thunderstorm.

IS MORE THAN ONE ROD USEFUL?

The more rods on a building the better, especially if all are connected with each other near their upper ends.

Multiple lightning conductors are useful because each one helps the others, and if the discharge is too great for one, they will be able to carry it between them, but what is more important is this: The less the total resistance of the conductor to earth, the more certain is it that no other, undesirable line will offer an approximately good path to the earth, and so get a part of the flash. Thus, suppose a single rod whose resistance is 1, and that a series of bolts, hinges, gutters, stove pipes, etc., offers another line (passing perhaps through the walls of the house or the body of its occupant) whose resistance is 2. Now, under these conditions, a flash would be likely to divide itself, and while $\frac{2}{3}$ would go safely down the rod, $\frac{1}{3}$ passing along the other line might burn the house or kill the man. But if two rods were connected, the resistance in this line would be but half, hence $\frac{4}{5}$ would take this road and but $\frac{1}{5}$ tend to go by the other. Again, the less the resistance of any line, the higher the opposite charge developed in it by induction, and hence the greater its attractive influence, leading the discharge to prefer it as a path. This bears upon the importance of connecting all accidental lines of conductors, such as gas and water pipes, with the lightning rods. Insulated, these are opposition lines, soliciting the lightning to come into house and traverse them; connected, they help the rod as we have seen to get and keep the lightning outside.

METAL ROOFS, GUTTERS, LEADERS, AND WATER TANKS SHOULD BE CONNECTED WITH THE LIGHTNING RODS.

Finally, in the way of general advice, we would say: Connect all your lightning rods together, and also to your iron tank, and water, gas, or other pipes, not by separate connections, but so that there is some connection between all, which connection should be *as high up as possible*. If you have a metal roof, connect all rods with it. If the roof is not of metal, then connect your rods together by means of a good sized conductor *running along the ridge of the roof*. Bear in mind that, to carry off the heaviest lightning flash known, a copper rod one inch in diameter is not considered too large; and though of course such flashes are of very rare occurrence, they may come. Hence the great value of uniting your different rods high up.

THE ELECTROMOTOGRAPH---A NEW DISCOVERY IN TELEGRAPHY.

Within the past few days, we have had under examination, in practical operation in our office, a novel electric telegraph apparatus, which presents some very remarkable features, and promises to result in the creation of an entirely new and advantageous system of telegraphy. It is the discovery of Mr. Thomas A. Edison, of Newark, N. J., who is well known as a telegraph engineer of the highest ability, and the inventor of a larger number of electrical devices, probably, than any other person living. His improvements are employed upon all the various telegraph lines in this country.

The present discovery relates to that form of apparatus known as the automatic or chemical telegraph, in which signals are made and recorded by causing the electricity to pass through paper, the latter being saturated with a chemical substance, which changes in color when the current acts. Lines, dots, and dashes are thus produced with great facility. In the ordinary working of this form of telegraph, the electricity is sent over the line wire by a key, in the usual manner, and passes through a pen, stylus, or lever, which has no movement, but simply rests upon the paper, the latter being moved by a weight or clockwork. No magnet and armature are used.

The salient feature in Mr. Edison's present discovery is *the production of motion and of sound by the pen or stylus*, without the intervention of a magnet and armature. By the motion thus produced, he works any of the ordinary forms of telegraph printing or sounding instruments or relays, and is enabled to send messages, by direct transmission over thousands of miles of wire, at the highest speed, without re-writing, delay, or difficulty of any kind. More than this, his apparatus operates in a highly effective manner, under the weakest electric currents, and he is able to receive and transmit messages by currents so weak that the ordinary magnetic instruments fail to operate or even give an indication of the passage of electricity. Thus, when the common instruments stand still, owing to weakness of current, the Edison telegraph will be at work up to its fullest capacity.

The author has baptized his discovery the Electromotograph, which is, perhaps, as good a title as could be adopted.

We subjoin the following original notes by the author, which explain the peculiar principle that lies at the base of his discovery. These notes, we are confident, will be read with very general interest.

To the Editor of the Scientific American:

In my new system of telegraphy, it would seem that power was obtained or that electricity had been passed into a new mode of motion, as with magnetism; but this is only apparent, not real, if I understand it right.

The electricity, acting by electrolysis, changes the nature of the surface of the paper, either by depriving it of some constituent, or the hydrogen, in conjunction with the metal and paper, form substitution compounds, the surfaces of which are smoother than the paper in its natural state, in the manner that the surface of rough paper is made smooth by dipping it into sulphuric acid. The strangest thing connected with this phenomenon, however, is this:

In trying to ascertain what caused the lever to move, whether it was by reducing the lead by hydrogen to a finely divided powder that acted as a lubricant, or whether the nature of the surface of the lead were changed by the absorption of hydrogen, like palladium, or whether the effect were due to the effort of the gases to escape from under the lever: I was led away from these notions by finding that platinum, with sulphate of quinine, will likewise show the movement. It then struck me that the nature of the paper was changed by the electrolysis. To test this, I had a long message received over the Automatic Telegraph wire from Washington (this wire runs in my laboratory at Newark), and recording the same on ordinary chemically prepared paper. The speed with which the message was sent from Washington was about 800 words per minute, and the colorations forming the dots and dashes were rather faint. I then passed the strip into the electromotograph (I use this name for the want of a better one), the colorations being in a direct line with the lead point. On rotation of the drum, and when no coloration was under the lead point, the lever was carried forward by the normal friction of the paper. But the moment a coloration passed under it, the lead point slid upon the paper as upon ice, the friction was greatly reduced, and the lever moved in an opposite direction to the rotating drum.

In this experiment, no battery was connected to the instrument. This proves that electrolysis produces a change in the nature of the paper.

I afterwards found that, if a tin pen were used to receive the message from Washington, although no marks were seen, the paper appearing unchanged, yet, on passing the paper through the instrument, the movement of the lever was more marked than before Receiving the message with a lead pen did not give so good results, although lead is the best when used, standing at the head of the twelve metals tried. The next is thallium. On paper moistened with aqueous solution of pyrogallic acid, tin is as good as thallium. Of all the solutions yet tested, potassic hydrate has been found to give the most marked results. The second best is sulphate of quinine. Third, rosaniline oxidized and discolored by nitrous acid.

A peculiarity of the quinine solution is that platinum shows an action, and shows it when either oxygen or hydrogen is evolved on its surface. With hydrogen the friction is lessened, as with all other metals; but with oxygen the friction is increased. This is so with all the metals subject to oxidation; but it appeared strange, at first, that it would show with a metal upon which the nascent gases had no effect.

With a lead point and a solution of the disinfectant known as bromo-chloralum, the evolution of hydrogen increases the friction of the paper enormously.

Silver seldom shows a movement with any solution; and when it does, it is very weak.

Sulphuric acid shows least movement with any metal.

It appears to be a matter of indifference as to the character of the metal used for the drum, which acts as one of the decomposing electrodes. Considering that the lever will close a secondary circuit under the great pressure used upon the lever, its sensitiveness to electricity is wonderful. With a delicately constructed machine, moved by clockwork, which I have nearly finished, I have succeeded in obtaining a movement of the lever, sufficient to close the local circuit with a current (through one million ohms, equal to 100,000 miles of telegraph wire), which was insufficient to discolor paper moistened with potassic iodide, or move an ordinary galvanometer needle. Messages may be read from the sound of the lever, when the most delicate telegraph magnet shows no current.

The uses of this instrument are many; in fact, it gives an entire new system of telegraphy.

As no secondary currents are generated, as with an electromagnet, to prevent the instant magnetization or demagnetization of the iron cores, and electrolysis being instantaneous, it is obvious that the lever will respond to signals transmitted with great rapidity. I have succeeded in transferring signals from one circuit to another at the rate of 650 words per minute; hence it may be used to repeat the rapid signals of the automatic telegraph into secondary circuits.

By attaching an ink wheel to the extremity of the lever, opposite a continuous strip of paper moved by clockwork, messages transmitted at a speed of several hundred words per minute may be recorded in ink. By attaching a local circuit to the repeating points, and adding thereto a sounder, it may be used as a Morse relay to work long lines of telegraph. T. A. EDISON.

Newark, N. J., August, 1874.