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NEW YORK, SATURDAY, DECEMBER 25, 1875.

Contents.

(Illustrated articles are marked with an asterisk.)

THE END.

With this issue, the time for which a large number of our subscribers have prepaid expires. We hope that all will renew their subscriptions, and bring some of their friends and neighbors with them. The safest way to remit is by Postal Order, Express, Bank Check to order of Munn & Co., or Registered Letter. But little risk is incurred in sending bank bills by mail, although the above-named methods are safest.

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THE ORIGIN OF LIFE.

Whether the line of experimental investigation adopted by Bastian and other students of spontaneous generation will ever lead to a convincing demonstration of the origin of life *de novo* is very doubtful. However fine the apparatus employed, however exacting the precautions against the slipping in of germs from without or their escape from destruction within, the ingenuity of the opponents of the theory will always be able to discover a possible broken link in the chain of evidence.

Like many another point of scientific controversy, this, we suspect, will be flanked rather than carried by direct assault. As in the case of magic and witchcraft—belief in which died a natural death in the minds of intelligent people, superseded by more rational views of man and Nature, but never logically demolished—so, we are inclined to think, the mystery of life's beginning will undergo a natural solution.

Those who hold to the dogma of "no life without antecedent life" are compelled to assume, at some point in the history of the Universe, the occurrence of nothing less than a miracle—that is to say, a phenomenon unknown to Science, and logically unsupposable from a truly scientific point of view.

Life must have begun somewhere, once at least. If it was not a natural product of material conditions, its beginning must have marked a positive breach in that causal connection of events without which Science would be impossible. The weight of all experience is against assumption of such a breach of continuity: in other words, against a miraculous origin of life. On the other hand the weight of experience is equally against the assumption of a material condition absolutely unique in character. If life arose once in consequence of material conditions, Science affords no justification for the assertion that such conditions may not be repeated, possibly in our laboratories.

This is substantially the position taken by Mr. Proctor in the latest expressions of his views, and by Professor Tyndall in his latest discussion of matter and life; and such appears to be the growing conviction of those of the present generation of scientists most pervaded by the spirit of scientific progress. Says Professor Tyndall: "The conclusion of Science which recognizes unbroken casual connection between the past and the present would undoubtedly be that the molten earth contained within it elements of life, which grouped themselves into their present forms as the planet cooled." The context shows that by "elements of life," Professor Tyndall does not mean entities but possibilities of molecular condition by which the phenomena of life were to be evolved in the natural course of events, not by the miraculous addition of a new force but by means of the forces already in play.

"The difficulty and reluctance encountered by this conception," he continues, "arise solely from the fact that the theologic conception obtained a prior footing in the human mind. Did the latter depend upon reasoning alone, it could not hold its ground for an hour against its rival. * * * Were not man's origin implicated, we should accept without a murmur the derivation of animal and vegetable life from what we call inorganic nature. The conclusion of pure intellect points this way and no other."

Admitting the natural origin of life, the question arises: When did life begin?

One branch of the evolution school delights to trace the existing forms of life back to some primodial germ: through changing conditions, the tendency of living things to vary from generation to generation, the survival of the fittest, etc., the one has become many. But there is from this point of view no satisfactory accounting for the persistence of so many primitive forms, or for the present preponderance of undeveloped forms. Nor is there any sufficient reason given for assuming that life began once, and once only, in the distant past.

A more logical position is occupied by those who favor the hypothesis that the material conditions: under which life originates are common conditions; consequently that the low forms of life which swarm in the waters of today are low because of their recentness. If they resemble long past fossil forms, they do so from some natural law of evolution, rather than in consequence of direct descent. From this point of view there may be no closer kinship between humanity and existing brutes than arises from a common relationship to Mother Earth. Man may be cousin to the ape; but that does not necessarily follow from the theory of evolution, as the Science of the future will regard it.

HEAVY LOSS FROM LIGHTNING ROD IGNORANCE.

On the 6th of September last the large woolen mill of Robert Fitton, Esq., at Cavendish, Vt., was struck by lightning and consumed, with a loss of $100,000; 130 persons were thrown out of employment. The mill was 45 feet wide, 106 feet long, 4 stories high. It had a flat, gravel-covered roof, and around the eaves ran a ¾ inch iron lightning rod with vertical points every four feet. From the eaves rod six branch rods extended to the ground, five of which terminated at a depth of three feet below the surface, and the other was carried thirty feet underground to the bank of a pond. These particulars have been mostly furnished to us by the proprietor of the mill. The Boston *Commercial Bulletin* states that the insurance underwriters regarded the mill as particularly well protected against lightning, as there was upon it an unusual array of rods, which had been overhauled and put in good order during the year. Yet the mill was struck, the flames flashing instantaneously through the spinning room. The *Bulletin* thinks that the loss of this mill shows what value there is in lightning rods. The insurance companies had to pay $84,000 in settlement.

The principal comment we have to offer is that the burning of the Cavendish mill was a glaring example of the results of lightning rod ignorance. It would be difficult to find a more sagacious or enterprising body of business men than are the presidents, directors, secretaries, inspectors, and agents of our fire insurance companies. It would naturally be supposed that, in a matter which so directly affects their pecuniary interests as fire losses from lightning, they would take great pains to acquire knowledge concerning the means of safety, and promulgate the strictest requirements among insurers. But they appear to be lacking in this respect, although year after year the records of annual losses of millions in property, by fire caused by lightning, are forced upon their attention, and large sums of money in damages are drawn from their coffers. By consulting the naval records they may easily satisfy themselves that, while formerly the losses of ships and lives by lightning were enormous, the losses immediately ceased when rods were introduced upon vessels; and at the present day we seldom or never hear of a serious injury to or loss of life from lightning, upon a properly rodded ship. The same appliance that protects a wooden vessel at sea will protect a wooden building on land, and we will here briefly describe this appliance, though in doing so we only repeat what we have oftentimes published.

In general terms, a ship's lightning rod consists of a rope or rod of copper or iron wire, lashed to the rigging and extended from the sky pole down so as to connect at any suitable place with the copper bottom, which is in contact with the sea. The rod thus has for its terminal a very large surface of conducting material, larger in fact than the deck surface of the vessel, and the lightning passes off harmlessly.

The golden rule of safety for rodded buildings is analogous to the above. *The rod must have for its terminal a very large surface of conducting material*, placed underground in contact with the earth. Without such a terminal, no rod can be considered safe.

How large should be the conducting surface of the terminal, and of what materials made? The area of conducting surface necessary to ensure safety varies with the nature of the soil. If the ground is always moist, a smaller extent of conducting surface for the bottom of the rod will be safer than if the soil is generally dry.

To meet the contingency of a very dry soil at the driest season of the year, the electrician, Mr. David Brooks, of Philadelphia, recommends that the rod have for its terminal a conducting surface, placed underground, equal in area to that of the roof of the building; if this rule errs, it is probably on the side of safety.

Applying the Brooks rule to the Cavendish mill, the rods should have had for their terminals, underground, 4,770 square feet of conducting material, in contact with the earth, instead of which they only had the beggarly amount of less than thirteen square feet. No wonder that the building was struck.

Of what material should the terminals of lightning rods be composed? Iron or copper plates or pipes are the best material. In all cases where there are underground water pipes, the rods should connect with them. If these are of any considerable extent, nothing more is required. In cases where metal terminals cannot be provided, then good charcoal may be used in quantity sufficient to furnish the required extent of conducting surface. This substance ranks next to the metals in conductivity. It may be placed in a trench leading away from the building, with the rod extended along the center. Full particulars concerning lightning rods, the electrical laws concerning them, the electrician's tests for safety, and the best methods for their construction have been given, many times over, in our back numbers; but we propose to continue the subject from time to time so long as may be necessary. We are confident that, if the insurance companies were each to spend seven dollars and place the SCIENTIFIC AMERICAN and SCIENTIFIC AMERICAN SUPPLEMENT on file in their respective offices during the year 1876, they would derive many most valuable suggestions from our pages, not only concerning the means of safety from lightning, but the prevention of fires of every description: suggestions which, if required to be carried into practice by insurers, would save large sums of money to the companies.

LIGHT IN COAL MINES.

Two or three years ago the SCIENTIFIC AMERICAN suggested a plan of lighting coal mines from without, so as to do away with miners' lamps, and thereby avoid the explosions of fire damp inseparable from their use. The terrible explosion which occurred on December 6 in a Yorkshire colliery, a colliery said to be worked entirely with safety lamps under very rigid discipline, gives fatal emphasis to the demand for a different mode of illuminating such works.

The experiments described in this paper (page 129, volume XXXI.) amply demonstrate the unsafety of safety lamps in places where blasting is practised, the sound wave generated by a blast driving the flame through the wire mesh of the lamp and firing the explosive air without. However perfect the lamp may be, however carefully managed, the protection it affords is only partial; and explosions are liable to occur so long as they are employed. The safety of the miners demands, therefore, the exclusion of all illuminating flames, wherever fire damp is liable to exist, and the lighting of the mines by luminous radiations incapable of exploding fire-damp.

This could be accomplished very easily, we believe, by the generation of the light without the mine (or else at the foot of a ventilating shaft), and its conveyance through tubes to the points requiring illumination. Beams of concentrated light could be sent to any distance through pipes having reflectors suitably placed at bends and angles, or without reflectors, provided the interior of the pipes were smooth and bright. The cost of such lighting would probably be less than the cost of lamps, and the degree of illumination might easily be such as to flood the mine with the brilliancy of daylight.

Another substitute for treacherous safety lamps might be found in electricity, the lanterns being closed so as to make it impossible for explosions to occur. If the insulation of the conducting wires should prove a serious obstacle, it is quite possible that Mr. Edison's "etheric force" would do the work as well without insulation.

THE DISCOVERY OF ANOTHER FORM OF ELECTRICITY.

Several years ago, it was accidentally discovered that, when the contact of an electric current which magnetized a large electro-magnet was broken very near one of the poles of the electro-magnet, the spark was so much increased in intensity as to produce a powerful snap, like that of a small pistol; while the breaking of the contact at a distance from the electro-magnet produced by no means such effect. The next thing observed was the drawing of sparks from the iron electro-magnet, or from its armature; but neither of these phenomena led any investigator to search out their origin, or to try to find what further results of the same class could be obtained.

This appears to have been done at last by Mr. Edison, of Newark, well known among electricians for several valuable inventions relating to electric telegraphy. He investigated the nature of the spark which could be obtained from the iron core of the electro-magnet, which, according to his statement, recently published, does not manifest the ordinary properties of electricity. The galvanometer is unmoved, the delicate gold leaf electrometer exhibits no signs of deflection, a Leyden jar is not charged by it, etc. But we consider the conclusion that this manifestation shows the existence of a new force, to be rather hasty.

It is well known that static electricity, which will produce a shock, will not move the galvanometer, and that the current of a large element of a voltaic battery will neither move a gold leaf electrometer, charge a Leyden jar, nor produce a shock. Therefore to say that the phenomena observed at

test new "principles, until now buried in the depths of humanignorance," as some of the reporters of the daily papers have done, is, to say the least, rather premature.

We will here call attention to the fact that at present three principal forms of electricity are known, and they vary so much in their nature that formerly some investigators inclined to consider them as separate forces or fluids. First we have the so-called static electricity, possessing great tension; it is developed on a small scale by friction, and on a large scale by evaporation and induction, as manifested in thunder storms. For this form of electricity, not only all kinds of metals, but water and the human body are good conductors, even the dry skin of the hands forming no obstacle. Secondly, we have the voltaic or galvanic electricity, originated by chemical action, and developed in our galvanic batteries. For this form of electricity, only some metals are good conductors, others poorer, while water and the human body are bad conductors; its effects on the latter cannot be studied without wetting the skin, as the dry skin is a non-conductor of it. This form of electricity is used for telegraphy, while, as is well known, the static electricity (as obtained by friction) is not so useful for this purpose, its great tension causing it to escape too easily. Thirdly, we have the thermo-electricity, discovered in 1820, by Seebeck in Berlin, which differs as much from the galvanic electricity as the latter does from static electricity. For this thermo-electricity, water or the human body is an absolute non-conductor, and a thin metallic wire is but a poor conductor; so that it can scarcely pass through the whole length of the coil of a common galvanometer, and does not act on this instrument, but is powerfully indicated by one made with very thick and short wire, even if the galvanometer consists of one single, heavy, and uninsulated wire, in a coil of one turn or only half a turn.

Now it appears to us that the form of electricity discovered by Mr. Edison, may be:

1. A fourth kind of electricity, requiring as little or less insulation than the thermo-electricity of Seebeck. It is said to pass over the ordinary gas pipe, and can equally well be drawn from several of the chandeliers in a house, or even in other houses, if one of them is connected with the source of the new electricity.

2. It may consist of a continually reversing current of inductive electricity of a form in quality between the static and galvanic kinds. This appears the more probable as its source is said to be a vibrating armature, in which of course there are continuous interruptions, the induced currents formed by the interruptions running in an opposite direction from those formed at the making of the contacts, as is well known by all electricians. Such continually reversing currents of course cannot act on the galvanometer, gold leaf electroscope, or Leyden jar, as their rapid reversion neutralizes all possible charge, the only manifestation being the sparks, of which, however, the rapidity of the succession causes an abundance, little affected by imperfection or even absence of insulation.

At the same time, this would explain why one end of a long wire, bent over the other end connected with the electric generator, will produce a spark. Electricity is present in such abundance that branch currents are easily supplied; while at the same time the two polarities are continually and so perfectly balanced as to exactly counteract one another, so as to be unable to charge any conductor, or to manifest the results of such charge, as in an electroscope, or to establish a polar current and manifest its results, as with a galvanometer. It is undoubtedly a manifestation of electricity; and being neither positive nor negative, as is the case with all the forms of electricity thus far known, it might be called neutral electricity.

The sparks investigated by Dr. Reiss, the well known German electrician, and called by him weak sparks, have polarity, being either positive or negative; and although they have certain resemblances to the electricity obtained by the method of Mr. Edison, they appear to be of a different nature, having a very different origin.

The most remarkable feature of this new form of electricity, which proves its perfect neutrality, is that it has no apparent effect on the human body, and none on even that most delicate of all electric tests, the properly prepared frog's leg, unless an exceedingly strong galvanic current is used around the magnet.

Two New Street Engines.

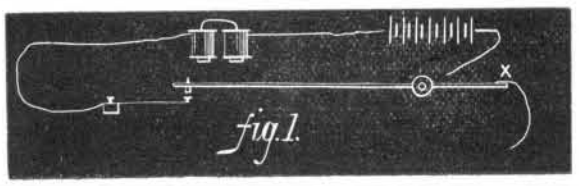
A new traction engine for street usage has recently been tested in Brussels, Belgium, with satisfactory results. Exteriorly it resembles an ordinary street car, with the exception of the chimney which projects through the roof. The body is placed quite low, and the wheels, which run on rails, are concealed to within a short distance from the ground. The boiler is tubular and inexplosible, and is heated by coke. The engine is one of the Brotherhood three-cylinder pattern. The exhaust is condensed in a tubular condenser, and the boiler is fed by a separate steam pump. The machine traveled without smoke or escape of steam, made no more noise than an ordinary horse omnibus, and turned sharp curves very easily. Another engine has been introduced in Paris; but instead of running on a tramway like the above, it is a kind of omnibus or steam carriage. It accommodates 12 passengers and weighs about 5 tuns. A vertical engine supplies the motive power and occupies a space in the rear of but 39 inches high by 31 inches broad. A Giffard injector forces in the feed water, which is taken from the gutters or any other convenient source. The machine will travel at the rate of 9 miles per hour. About 13 horse power is utilized, requiring 600 quarts of water, and 110 lbs. of coal per hour.

THE NEW PHASE OF ELECTRIC FORCE.

In our number for last week, we called attention to what we at first supposed to be a similarity between the prior experiments of Professor Reiss and those of Mr. Edison. A further examination of the Reiss reports satisfies us that the results obtained by Mr. Edison are novel, and have little or nothing in common with those of Professor Reiss.

We have had an opportunity of closely examining the apparatus by which Mr. Edison and his assistants obtained the evidences of the supposed new kind of electricity which has lately elicited so much inquiry and speculation, and we present herewith three diagrams of some of the apparatus used by Mr. Edison during his experiments.

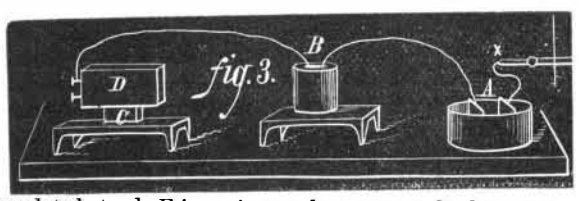
The first recognition of the distinctive character of the spark occurred on the evening of November 22. Mr. Edison and his assistants, as we have already stated, were experimenting with a vibrator magnet, consisting of a bar of Stubb's steel, fastened at one end and made to vibrate by means of a magnet, when they noticed a spark coming from the core of the magnet. They had often noticed the same phenomenon in connection with telegraphic relays, in stock printers when there were iron filings between the armature and the core, and in the new electric pen, and had always supposed it to be due to inductive electricity. On this occasion the spark was so bright that they suspected something more than induction. On testing the apparatus they found that, by touching any portion of the vibrator or magnet with a piece of metal, they got the spark. They then connected a wire to the end of the vibrating rod (the wire leading nowhere), and got a spark by touching the wire with a piece of iron. Still more remarkable, a spark was got on turning the wire back upon itself and touching any part of the wire with its free end. The end of the vibrating rod was then connected by means of the wire to a gas pipe overhead, whereupon a spark could be drawn from any part of the gas pipes in the room, and subsequently it was found that the spark could be drawn from any part of the whole system of city gas pipes. The vibrator and battery were next placed



on insulated stands, and the wire, connected with x, Fig. 1, was carried over to the stove, about 20 feet distant. On rubbing the end of the wire against the stove, splendid sparks were observed. With the wire permanently connected with the stove, sparks could be drawn from any part of the stove with a piece of metal held in the hand. Again, while the vibrator was in action, a block of iron was placed near x, but not touching the bar, nor connected with it in any way except by the wood of the base through the table, and sparks could be drawn from the iron.

These and other experiments which we have had the pleasure of witnessing show conclusively that the new force is not amenable to the laws of voltaic or static electricity.

An experiment made with the apparatus figured in the large engraving (Fig. 2) will satisfy any electrician that the force in action is not induced electricity. All the parts are insulated except the gas fixture. A is the battery; B, a common telegraphic key; C, an electro-magnet; D, a bar of cadmium (or other metal, cadmium being the best) supported by an



insulated stand; E is a mirror galvanometer; F, the gas pipe; G, a dark box enclosing pencils with graphite points (common lead pencils). The unknown current passes from the bar of cadmium through the galvanometer, without causing the slightest deflection, and—notwithstanding the gas pipe connection, which would drain the wire of induced electricity, if there were any—bright sparks are visible between the graphite points in response to the motion of the telegraphic key.

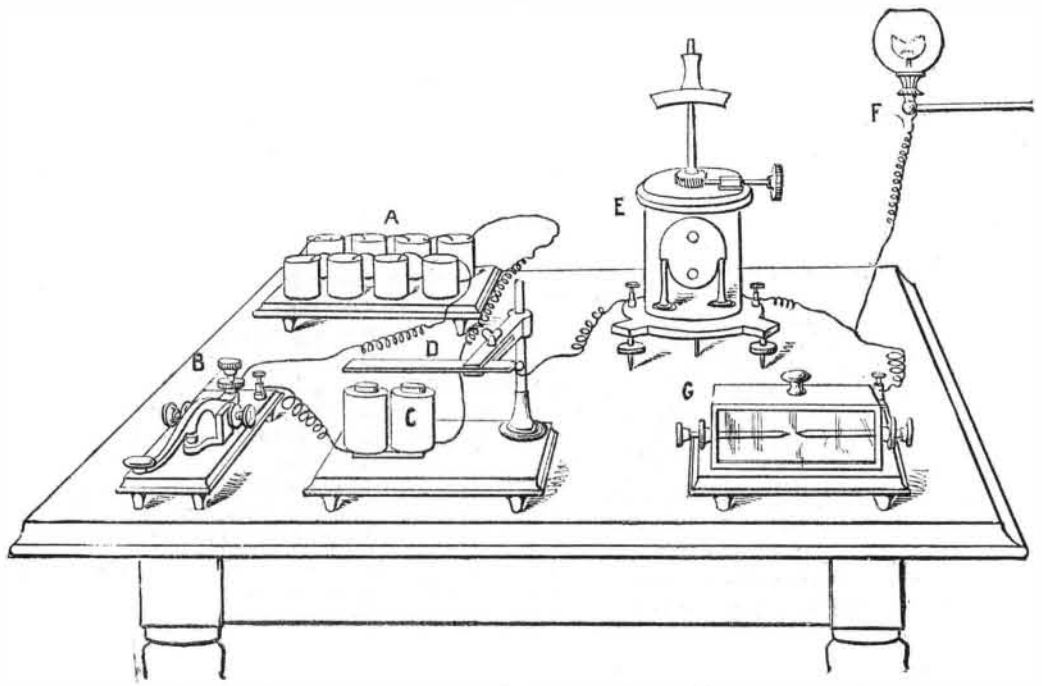
Standing on an insulated stool, the experimenters draw sparks from the following arrangement (Fig. 3), in which x is the end of the vibrator (which, as well as the battery, is insulated); A, a secondary battery; B, a 200 ohm coil of copper wire; C is a block of iron, and D, a condenser, all well insulated except A, which is of glass, and stands on the table.

In another experiment a glass rod, four feet long, with a piece of carbon fixed to one end, was well rubbed with a silk handkerchief over a hot stove, and the carbon point presented to the apparatus, the other end of the rod being held in the hand with the handkerchief: sparks were drawn, yet the galvanometer chemical paper, the sense of shock in the tongue, and a delicate gold leaf electroscope were not in the least affected by the mysterious current.

Tested in whatever way the experimenters have been able to devise, the new current refuses to obey any of the established laws of electricity further than that it traverses metallic conductors, manifests itself as light, and can be controlled by making and breaking connection. Among its observed peculiarities may be noticed its lack of polarity, indifference to the earth (and consequently its capability of transmission through uninsulated wires), its power of producing action when turned back upon itself, its independence of electric non-conductors, and seeming lack of mechanical and physiological effect.

Mr. Edison has proposed the name "etheric force."

Since the above was put in type, Mr. Edison has sent us a variety of additional particulars pertaining to his new and interesting discovery, which we shall give to our readers in our next number.



MR. EDISON'S APPARATUS, EXHIBITING THE NEW PHASE OF ELECTRIC FORCE.—Fig. 2.

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