THE ELECTRIC LIGHT.

A modification of Geissler's tubes has recently been made for the purpose of illumination. It consists of a carbon and vacuum tube, of about one sixteenth of an inch internal diameter, wound in the form of a flattened spiral. The ends of the tube, in which the platinum wires are sealed, are about two inches in length, and half an inch in diameter. They are inclosed in a wooden case, leaving only the spiral exposed. When the discharge from a Ruhmkorff coil is transmitted through the platinum wires, the spiral becomes intensely luminous, exhibiting a brilliant white light. The quantity of the light, however, is small, and it is of no practical value. It is only valuable as an experimental apparatus, or for scientific exhibitions.

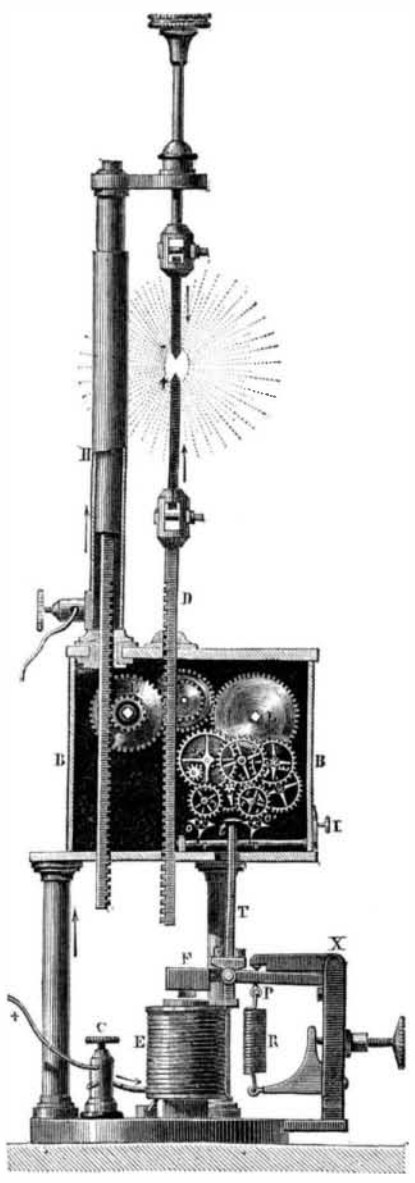
Electricity of great tension and power is required for the electric light, and the easiest and least expensive mode of getting it for these experiments is by using a large Ruhmkorff coil, but the current from a battery of 200 cells would answer the same purpose. An electric light, without mechanism at the burner, can be made by placing two carbon points in hollow brass rods which are connected by wires with a galvanic battery. The rods slide in the heads of two glass pillars, so fixed to a stand as to admit of the points being placed at different distances. The wires from the battery poles being properly connected, the points are made to touch, and are then just separated, when the most dazzling light appears, rivaling the light of the sun in purity and splendor. The light is due chiefly to the intense whiteness of the tips of the carbon rods, and partly from an arch of flame extending from the one to the other. The positive pole is the brighter and the hotter, a fact which may be proved by intercepting the current, when the positive pole continues to appear red for some time after the negative pole has become dark. Any kind of carbon is well suited for the points. The more compact forms of charcoal answer very well, but baked carbon answers better. This is made as follows: The fine dust of coke and caking coal is put into a close iron mold, of the shape required for the carbon pencils, and exposed to the heat of a furnace. When taken out, the burnt mass is porous and unfit for use: but by repeatedly soaking it in thick sirup or gas tar, and reheating it, it acquires the necessary solidity and conducting power. The best carbon points, both for brilliancy and durability, are made, however, from the coke that is sublimed inside the retorts in the distillation of coal in gas works. During the maintenance of the light, a visible change takes place in the condition of the poles. The positive pole experiences a loss of matter; particles of carbon pass from it to the negative pole, some of them reaching it, and some being burnt by the oxygen of the air on the way. The same occurs, though to a much less extent, with the negative pole; so that, while the positive pole becomes hollowed out or blunt by its losses, the negative pole is kept pointed by the additional particles.

The wasting away, particularly of the positive pole, in a short time renders the distance between the poles too great for the passage of the current, and the light is suddenly extinguished, until again renewed by contact between the carbon points and their separation. If a powerful battery is used, the points may be removed one sixth or even one fifth of an inch before the circuit is broken. The transfer of matter between the poles is considered to account for the existence of the arch of flame, and the passage of the current through the air, as thereby a conducting medium extends between the poles. The light is not caused by the combustion of the carbon, but by its being brought into a state of incandescence. With a battery of fifty Grove or Bunsen cells, a a light of very great brilliancy is produced; but when very great power is to be obtained, as well as brilliancy, twice or thrice that number must be employed. Fifty cells give electricity of sufficient tension to produce the light; and if more are used, they should be so arranged as to add to its strength and not its tension. Thus, if 150 cells be used, they should be arranged in three series, the positive poles of all three being joined to form one positive pole, and similarly with the negative poles. With a battery of 50 cells it is not necessary to point the rods, as the action of the electricity will do it. A battery of 50 large-sized Grove or Bunsen cells will produce a light 34 times the power of the lime ball light, or one fifth as great as that of the sun.

Various arrangements have been invented for maintaining the steadiness of the electric light. The aim in all such is to keep the carbon points by some mechanical contrivance within such a distance of each other that the current can pass between them. Duboscq constructed an electric lamp of this description. In it, by aid partly of clockwork, the two points are made to travel towards each other at rates corresponding to those of their consumption, the positive pole in this way traveling faster than the negative.

Foucault's form of regulator, Fig. 1, has two systems of wheel work, one for bringing the carbons nearer together, and the other for moving them further apart. Fig. 1 represents the apparatus, with the omission of a few intermediate wheels. L′ is a barrel driven by a spring inclosed within it, and driving several intermediate wheels which transmit its motion to the fly, *o*. L is the second barrel, driven by a stronger spring, and driving in like manner the fly, *o′*. The racks which carry the carbons work with toothed wheels attached to the barrel, L′, the wheel for the positive carbon having double the diameter of the other. The current enters at the binding screw, C, traverses the coil of the electro-magnet, E, and passes through the wheel work to the rack, D, which carries the positive carbon. From the positive carbon, it passes through the voltaic arc to the negative carbon, and thence, through the support, H, to the binding screw connected with the negative pole of the battery. When the armature, F, descends towards the magnet, the other arm of the lever, F P, is raised, and this movement is resisted by the spiral spring, R, which, however, is not attached to the lever in question, but to the end of any other lever, pressing on its upper side, and movable about the point, X. The lower side of this

FIG. 1.



lever is curved, so that its point of contact with the first lever changes, giving the spring greater or less leverage according to the strength of the current. In virtue of this arrangement, which is due to Robert Houdin, the armature, instead of being placed in one or the other of two positions, as in the ordinary forms of apparatus, has its position accurately regulated according to the strength of the current. The anchor, T *t*, is rigidly connected with the lever, F P, and follows its oscillations. If the current becomes too weak, the head, *t*, moves to the right, stops the fly, *o′*, and releases *o*, which, accordingly, revolves, and the carbons are moved forward. If the current becomes too strong, *o* is stopped, *o′* is released, and the carbons are drawn back. When the anchor, T *t*, is exactly vertical, both flies are arrested, and the carbons remain stationary. The curvature of the lever on which the spring acts being very slight, the oscillations of the armature and anchor are small, and very slight changes in the strength of the current and brilliancy of the light are immediately corrected.

Mr. Hart, of Edinburgh, Scotland, has invented a simple lamp, in which the weight of the rod, in which the carbon is fixed, supplies the place of the clockwork in the above described lamp of Foucault, and an electro-magnet lets it descend, or locks it, as the carbons are consumed.

The attempts which have been made to substitute the electric light for coal gas, in lighting up streets and public places, have hitherto proved unsucessful. One element of imperfect success, in the practical use of the electric light, is due to the uncertainty of the light and the care attending its use. By contrivances like those we have described, the light may be continued for hours; but even then it is by no means steady, and the apparatus cannot be safely left without an attendant. It has, however, been used with excellent effect where a limited space had to be lit up for a few nights, as well as for lighthouse illumination. Its power to penetrate fogs is immensely superior to that of the usual oil light. Lighthouses at Dungeness and elsewhere have been lit with electric lights since 1863, the current being obtained from magneto-electric machines driven by steam engines. Fig. 2 represents the machine. It has eight rows of compound horseshoe magnets fixed symmetrically round a cast iron frame. They are so arranged that opposite poles always succeed each other, both in each row and in each circular set. There are seven of these circular sets, with six intervening spaces. Six bronze wheels, mounted on one central axis, revolve in these intervals, the axis being driven by steam power transmitted by a pulley and belt. The speed of rotation is usually about 350 revolutions of the axis per minute. Each of the six bronze wheels carries, at its circumference, sixteen coils, corresponding to the number of poles in each circular set. The core of each coil is a cleft tube of soft iron, this form having been found peculiarly favorable to rapid demagnetization. Each core has its magnetism reversed sixteen times in each revolution, by the influence of the sixteen successive pairs of poles between which it passes; and the same number of currents, in alternately opposite directions, are generated in the coils. The coils can be connected in different ways, according as great electro-motive force or small resistance is required. The positive ends are connected with the axis of the machine, which thus serves as the positive electrode; and a concentric cylinder, well insulated from it, is employed at the negative electrode. Two of these machines are provided for each light, though only one is used, except in very foggy weather. These are driven by a six horse power steam engine, and all parts of the machinery, including boilers, are kept in duplicate. Coke is used for fuel, and about 56 lbs. are consumed each night. The machines are connected with the lamp by means of underground cables. Each lamp contains two pieces of carbon, about ten inches long by three eighths of an inch square. They are made from coke dust, and are consumed at the rate of thirty four inches per night for each light, at a cost of two cents per inch, exclusive of waste and breakage. They are moved toward each other by means of automatic apparatus; and the only danger of irregularity of the lights arises from the presence of foreign matter in the carbons. This, however, is instantly corrected. The annual cost of the electric light at Dungeness is about $4,000.

The most powerful light which has yet been constructed is that of the flashing electric light at Soutter Point, England, three miles below the mouth of the Tyne, the condensed beam of which is equal to 800.000 candles.

There are two electric lights situated on the South Foreland, three miles from Dover. These are 1,000 feet apart, one being 372 and the other 275 feet above sea level. The rear light is utilized, by means of totally reflecting prisms, to reinforce the front light, which is required over a range of 180° only. Both lights are fixed. The power of each beam is estimated as equal to 180,000 candles; and when observed from Dover, a distance of three miles, they throw a very distinct shadow from objects on the pier.

In addition to the above mentioned electric lights, there are in France two fixed lights at La Hève, and a revolving light at Cape Grisnez; in Egypt, a revolving light, at Port Said; and in Russia, a fixed light, at Odessa. The plan in operation at La Hève is very similar to that of the South Foreland. Six-plate magnets, of a power of 145 to 155 lbs., are used, and some three-plate magnets, with a power of 75 lbs. The carbon points are manufactured from the residue contained in gas retorts. They are 10 inches long, and from one third to one half of an inch thick. The optical apparatus is about 1 foot in diameter, and it sends the light tangentially to the surface of the sea. Many accidents, however, have occurred at La Hève; in one instance the lights were extinguished for a space of an hour. Much trouble has been experienced with the machinery, which is now placed in a more satisfactory condition. Of the cost of this light, we have no data later than 1869; but it appears that the average of that and the four previous years was $3,215.34, the total number of hours of illumination averaging 4,135 annually. The machines are started 10 minutes before the time of illumination, so that the currents may be well established, and the light is exhibited 15 minutes after sunset, and extinguished 15 minutes before sunrise. Double lights are produced whenever the fog is so dense that the keepers cannot see the beacon lights on the north pier at Havre, and this occurs about eighty hours every year.

The disadvantages attending a general use of electricity are due chiefly to the large amount of space required for the steam engines and the magneto-electric machinery, for storing coal, coke, etc., and for collecting and preserving the

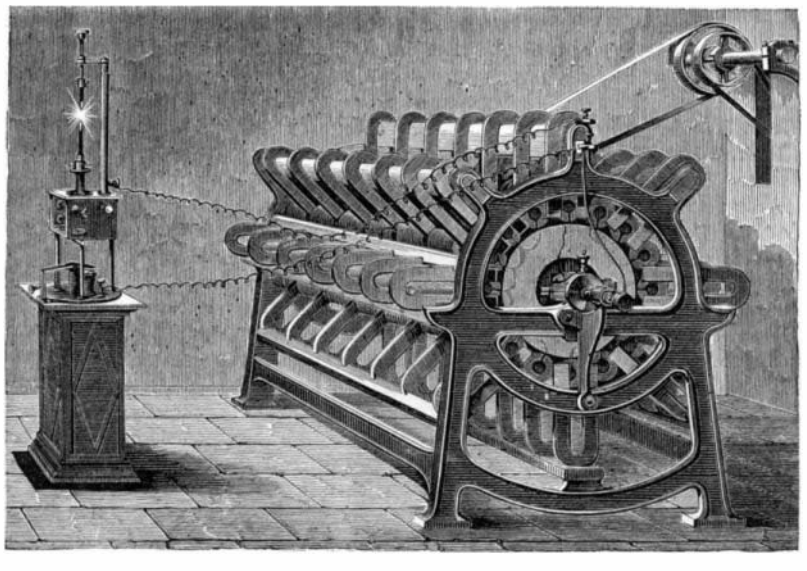


Fig. 2.—MAGNETO-ELECTRIC LIGHT MACHINE.

water for the engines. The repairs needed require also special workmen, not usually found in the vicinity of lighthouses. Consequently the electric light can at present be made available only in certain localities. It would be disadvantageous in lighthouses at sea, or that are not easily accessible, or those which are distant from centers of population But where there is plenty of space, and where cities are within easy reach, their substitution for other lights is strongly approved by mariners.

Correspondence.

The Keely Motor.

To the Editor of the Scientific American:

In your paper of June 26 there is an elaborate editorial article entitled "The Keely Motor Deception," in which article you treat the alleged invention of Mr. Keely contemptuously, and speak of him and his "confederates," myself included, as juggling tricksters "whose chief purpose appears to be the wriggling of money out of silly people." I am not willing to believe that journalists professing to conduct a publication devoted to inventions, and advocating, professedly, the rights of inventors, will persist in denouncing an alleged discovery with which personally you are wholly unacquainted, especially when your denunciation involves, necessarily, an assault upon the integrity of reputable gentlemen. I have practised my profession in Cincinnati, O., and in this city uninterruptedly for a period of about eighteen years, for about eight years of which time I have devoted myself exclusively to patent litigation, with probably the average success of professional men: not altogether unknown in my profession, I would be entirely willing now and at all times to leave the vindication of my professional character, when assailed, in the hands of my professional brethren, and to the judges of the courts before whom I have practised. Therefore, if I alone were involved in your article referred to, I should remain silent; but inasmuch as others than myself are also impugned, and inasmuch, further, as the alleged invention of Mr. Keely, for which interest I have been and am counsel, is derided, it is proper that I should publicly notice your article.

The invention of Mr. Keely is controlled by a company organized under the laws of the State of Pennsylvania; and probably I can best vindicate the invention, the inventor, and those connected with him, whom you call his "confederates," by stating in outline my connection with the enterprise up to the present time.

A year ago, several gentlemen of this city, one of New Jersey, and another of New York, held contracts with Mr. Keely whereby they were entitled to certain rights in his invention thereafter to be patented. By mutual consent of the contracting parties, it was agreed to merge their respective rights into a corporate company, thereafter to be organized and now known as the "Keely Motor Company." The writer was asked to act as their counsel. The initial step desired to be attained was the procurement of the requisite amount of money necessary, first, to discharge some indebtedness theretofore contracted by Mr. Keely for materials supplied to him; secondly, to complete his structures then being constructed; and thirdly, to defray the expenses incident to the procuration of letters patent in our own and in foreign countries. At this time, personally I knew but little of Mr. Keely's invention. I had seen in his workshop, a room say ten feet square, a "receiver" charged with a vapor or gas having an elastic energy of 8,000 lbs. to the square inch. I interrogated Mr. Keely critically as to how he had produced this substance; pointing to an inoffensive-looking machine, which stood in close proximity to the receiver, he said to me that he introduced a certain quantity of air into that machine under no greater pressure than was the capacity of his lungs, a certain quantity of water under no greater pressure than was the ordinary hydrant pressure at his residence, and then, by a simple manipulation of the machine, unaided by any chemical substances, heat, electricity, etc., he converted a small portion of the introduced water and air into the cold vapor then contained in his receiver. My credulity, as may be supposed, was taxed to its utmost limit. Before undertaking to enlist a dollar of capital in the enterprise, I instituted the most careful inquiry as to the character of Mr. Keely. Those of whom I inquired endorsed his integrity in unqualified terms; and one gentleman, Mr. Boeckel, for whose mechanical ability and moral integrity I had great respect, and who knew much of the invention, and who spoke without having a fragment of interest in the invention, impressed me greatly by what he communicated to me. So also did Mr. Rutherford, Chief Engineer, U. S. Navy. Thereupon, I had a conversation with Mr. Keely, in effect as follows. I said to him: "Mr. Keely, you profess to be grateful to me for kindnesses received at my hands, the importance of which, indeed, you greatly exaggerate. I am asked to become the exponent of your invention, and to enlist capital for its development. While I may with propriety expend my own money as I please, I cannot, except with greatest caution, enlist the money of others. You, Mr. Keely, know absolutely whether you produce the results which I have seen as you state to have produced them. This, with you, is not matter of opinion, but of absolute knowledge. If, therefore, you do not so produce these results, and I, upon the supposed truth of your statement, am the means of procuring the capital of others to be invested in your enterprise, I will have suffered at your hands as great a wrong as one man can inflict upon another." He reasserted that which he had before said in the most solemn language. I reduced his declaration to writing, and he signed it, I at the same time telling him, in the presence of his wife, that, if I procured a dollar for the enterprise, it would be based upon the truth of his written declaration, which, if false, made him a criminal, and that for my own vindication I would see that he was appropriately punished. With such precautions I visited your city, called together some of your best known and influential citizens—among whom was Charles H. Haswell, Esq., who himself, prior to this time, had visited Mr. Keely's place, seen his receiver when charged with this enormous vaporic pressure, and had reported upon it. I said to these gentlemen that I had not seen Mr. Keely make the power, and therefore had no personal knowledge of how it was done; stating, at the same time, however, the result of my inquiries as to his character as above, and, further, that there was the negative evidence, afforded by the total absence of anything (so far as I could discover) to produce the power other than the simple machine whereby he claimed to produce it. As the result of my interview, the gentlemen present subscribed for $10,000 of the stock of the proposed company. I made Mr. Keely's written declaration a part of my contract with them. They paid to me $3,000. I returned to Philadelphia, and gave this to Mr. Keely; and within two hours, he had paid to the constructors of his machine $2,850 of it.

By the terms of the agreement, entered into by me with these parties, Mr. Keely was obligated, before any further money was to be called for, to explain the principle of his invention. I took with me to his place my engineering assistant, Mr. Bell, and we entered upon the subject, but neither of us—although having before us a sectional drawing of the machine, made from the machine, by Mr. Bell—could understand why the result would follow from its operation, as claimed by Mr. Keely. I so stated to him, and requested that he should repair, put together, and operate the machine (then dismantled), and produce for me the result which he claimed to be able to produce. This he did, giving to me (in the presence of ten other gentlemen, among them Mr. Boeckel, Mr. Rutherford, and Mr. Bell) an exhibition on the night of the 10th of November, 1874, the result of which exhibition I reduced to writing and subsequently to print, for the information of those only who were interested in the enterprise. This report you evidently have seen, as it is commented upon in your article.

After I had written this report, I submitted it to Messrs. Rutherford, Boekel and Bell, for their careful examination, and for their endorsement of it, if they found it correct. They gave it their unqualified endorsement Next, I submitted it to Professor B. Howard Rand, of this city, an eminent scientist, as a precautionary measure, in order that he might, if he could, account for the results alleged to be produced, through any known chemical agencies or laws of physical forces. He said that, assuming the truth of my statements of facts—for he had not seen the machine, and of his own knowledge knew nothing of it—he could not account for the results alleged to have been produced upon any known chemical or philosophical principles; and at my request, he reduced this statement to writing. He was not asked, and did not assume, to endorse the Keely motor, and your assertion that he did so is purely gratuitous, and places him in a false position before the public. With this report thus prepared, I proceeded again to New York, submitted it to the parties with whom I had contracted, stated to them that, while I did not understand the ultimate philosophical principle involved in the production of this vapor, I was convinced that it was produced precisely as asserted by the inventor; that I stood ready to return to them their money previously advanced, if they desired to withdraw from the enterprise. They did not so desire, but on the contrary paid to me the balance ($7,000) of the $10,000 subscribed, which money was subsequently from time to time disbursed for the construction of apparatus connected with the invention. (1) My original contract with these parties gave to them an option of $40,000 more of the stock of the company at its par value. Prior to the agreement out of which this company had its origin, the individuals then holding contracts under Mr. Keely had themselves entered into a contract with some parties looking to the disposal of rights in the New England States, which contract became obligatory upon this, the Keely Motor Company. Under and by virtue of the several contracts, the contracting parties were entitled to an exhibition of the production and practical application of this power. This has been given to them, and was witnessed by about 30 gentlemen, among whom were many men of long and extensive experience in the construction and operation of machinery, such as steam engines, air-compressing machinery, electrical apparatus, etc. As the result of such exhibition, the parties respectfully have, unurged, paid to the treasurer of this company an aggregate, with the ten thousand dollars referred to, of one hundred thousand dollars. This company, with the single exception above referred to, has not sold or offered for sale a dollar of its stock; neither has it desired to give any publicity to its business, until it shall be ready to introduce to the public its machine.

Of the money which has thus been paid into its treasury, Mr. Keely was entitled, in his individual right, to the sum of fifty thousand dollars. This, however, he yielded to the company, stating that he did not desire to make a dollar of profit out of his invention until patents had been obtained, and he had established, to the satisfaction of the world, the validity of his assertions. After having long been living in most humble circumstances and working under great disadvantages, a comfortable house and a convenient workshop have, without his solicitation, been purchased for him, and he is now giving his undivided time to the completion of his structures. That he is endeavoring to "wriggle money out of silly people" or out of any one, I believe to be a monstrous calumny. The money which has been paid into the treasury of the company, it is the declared policy of the company to retain intact for the completion of its various structures now in progress, and for the procuration of letters patent throughout the world. As for myself, I have given to the development of this invention and to the affairs of this company my almost undivided time for a period of several months, having the meanwhile to beg the indulgence of clients for whom I have the charge of important causes, and have not been compensated to the extent of a dollar: my declared policy having been to attest by my actions the confidence that I have professed, in the genuineness and value of Mr. Keely's inventions, resting content to await that moderate degree of fame and of fortune which shall probably be mine, if the correctness of my judgment shall be vindicated in the future. So much, personally, as to Mr. Keely and his "confederates." (2) Now what about the invention?

In my report of November 10, I undertook to narrate as precisely as I could facts which I had observed. I state therein substance, and I now reiterate that I saw:

First: The apparatus, of which I at the time had an accurate sectional drawing made from the machine, subjected to such tests as I believe would have satisfied any intelligent mind, as the tests did satisfy the minds of the eleven persons present, that there was nothing in the apparatus but air at atmospheric pressure.

Second: I saw the inventor blow from his lungs, for the period of, say, 30 seconds, into a nozzle upon the "generator;" then I saw him connect this nozzle by a small rubber tube with the nozzle of his hydrant, and introduce water direct from the hydrant through this rubber tube into the "generator" until say five gallons of water had been thus introduced under a pressure, as indicated by a gage applied to the hydrant, of 26½ pounds, the communication with the hydrant being then cut off.

Third: A connection being then made between the generator and a register of force, by a tube of one tenth inch bore (the register of force consisting of a piston of one square inch area, pressed down in a cylinder by a lever of the third order, and weighted so as, according to the calculations of Mr. Rutherford and Mr. Bell, to require upwards of 1,430 lbs. to the square inch to raise the lever.) I saw Mr. Keely, by a very simple manipulation of his generator, requiring no more force than a child could exert, make an "expulsion," as he terms it, of his vapor, and with it raise this weighted lever; and this he repeatedly did.

Fourth: I saw him, in the same manner, make expulsions *filling a chamber of 3½ gallons capacity*, with his vapor, at a pressure proved to be a fraction less than 2,000 *lbs. to the square inch.* This operation I saw repeated several times, and saw the produced vapor conducted through a tube of the dimensions aforesaid upon, *not* "a dollar toy engine," but one which did not cost less than two hundred and fifty dollars to construct, which was run at a speed of several hundred revolutions a minute, developing no inconsiderable power. (3) These expulsions were made in an inappreciable period of time, unaccompanied by noise or the use of heat, and without appreciable production of heat.

Now, what I assert is stated not as matter of *opinion*, but of *fact*. You may deny the fact and assert that I falsify. If so, I retort that you are ruthless traducers of character, and will hold you personally responsible for defamation. Again, you may, with propriety, assert that I am mistaken. To this, I will reply that what I saw was witnessed by ten other gentlemen, who will at any time attest to my accuracy, and three of whom, at least, were of equal ability with yourself. Again, you may accept the truth of the facts and undertake to account for the results upon other hypotheses than as claimed by the inventor, and to disparage their importance. You have in your article of the 26th inst. undertaken to account therefor. While I have not space to review your attempted solution of the matter, I will simply say that, if the writer of your article had seen and examined Keely's generator, and another, not seeing it, had written what appears in your columns, your editor would have said he was a fool. I simply say he is mistaken. Again, I have repeatedly seen, in Mr. Keely's workshop, a receiver with a capacity of twenty-six gallons, containing his vapor at a pressure of 10,000 lbs. to the square inch: I have seen this vapor conducted through a tube of one-tenth inch bore to an engine which was propelled by it at a speed of about 1,500 revolutions a minute, developing a power of certainly 10 horses. This fact I can corroborate by the testimony of scores of persons: among them some of your best known and most influential citizens. You think that we confound "pressure with power." We do not. We understand, probably as well as you do, the distinction between "pressure" and *vis viva*. You may say, accepting the fact, that it is condensed air. If so, please enlighten us as to the means whereby it could be so condensed. You may say that it is a gaseous product from chemical action; remarking that this vapor is totally negative in its properties and pure as mountion air, please inform us from what chemical substances it may in your opinion have been produced. I append hereto some communications addressed to me on this subject.

In conclusion, I would repeat that the Company I represent is a private corporation. It does not offer, nor has it offered, its shares in the open market, nor can it be held responsible for the action of individuals who, having acquired, may have again offered its shares, which was, however, their undoubted right. It will not, in "thirty days," though I believe it will before many months have expired, exhibit to the world that which it claims to have. In the meantime, it has not sought nor does it now seek notoriety; but the invention on which it is based having, through newspaper correspondents, been publicly discussed, we must expect, and do not shrink from, fair and legitimate criticism; and if you