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ELECTRIC LIGHTING.

It has long been known that the electric light, in point of brilliancy, beauty, and safety, far transcends all other known means of artificial illumination; but its great cost, together with the skill required to manipulate it, has, until within a short time, hindered its use except in the lecture room or laboratory. Of late years, however, machines have been devised that convert dynamic energy, with very little loss, directly into electric energy, affording, for the purpose of lighting, an inexpensive source of electricity, so that the luxury of the electric light is not only brought within reach of many, but is actually made much cheaper than any other means of illumination where light of equal power is required.

The illustration given below represents a machine shop lighted with one of these splendid lights. The apparatus used is the invention of Hiram S. Maxim, M.E., of this city.

The machine in the foreground is a dynamo-magneto-machine, which converts dynamic energy, as derived from a suitable motive power, into electrical energy, by the agency of magnets. This machine requires 1½ horse power to drive it. It weighs 300 lbs., and produces a light of from 1,200 to 2,000 sperm candles, according to speed. The magnets are similar in form to those used by Dr. Siemens, of London, but the armature, or revolving portion, is of a new design, which is said to be free from many objections common to other machines. The only points where any considerable wear takes place on these machines is in the commutator, in which a stationary copper brush takes the current from the revolving part.

In some machines this portion has been built into the machine, so that when it is worn the whole machine would require rebuilding in case of repair. Mr. Maxim has constructed his machine so that the removal of a nut loosens the parts subjected to wear, so that they may be replaced in a few minutes, and at a trifling cost.

This dynamo-machine is simple and requires no more attention than a fan blower or emery wheel. It may be placed in any convenient locality, and the wires for conveying the current may run almost any distance to the light-apparatus.

In this machine no acids or chemicals are used. A bundle of iron and copper revolving between two electro-magnets generates at first a slight current, which reacts upon the magnets and upon itself until a very powerful current results. It may be said that a dynamo-machine forces or induces a current of electricity through a wire very much as a fan blower forces a current of air through a pipe. Connect the outlet and inlet of a fan blower, and a current of air will circulate in proportion to the speed at which the fan is run. Connect a wire from the positive to the negative of a dynamo-machine, and a current of electricity is set up, which is very nearly in proportion to the speed of the machine. If the wire should be cut the current would cease, the same as the current of air would in the blower if a valve was closed in the pipe. On breaking the circuit the power required to run the dynamo-machine would fall off from 1½ horse power to about ⅛ horse power, which is sufficient to overcome the friction. While the machine is running, touch the ends of the wires, and at once the current is re-established. Draw the wires apart slowly, and a brilliant flame of the incandescent vapors of the metal of the wire is seen, but the wire soon melts or burns away. Attach to the wires two pieces of carbon, such as is used for battery purposes, bring them together and separate them, and a beautiful white flame will appear. This is called the voltaic arc.

It will soon be seen that one of the pieces of carbon at the spot impinged by the arc becomes intensely heated, and gives off a light fully as brilliant as sunlight, and that this very brilliant carbon is wasted away much faster than the other. This (the hot one) is called the positive carbon, and is attached to the positive wire.

To maintain the light the carbons must be moved together, so as to keep the distance between them, across which the arc plays, always the same. To keep the arc always in the same position both carbons must be advanced at a rate of speed equal to their consumption. The apparatus for accomplishing this purpose is called a regulator or lamp. Many of these have been made, but few have answered the expectations of their inventors.

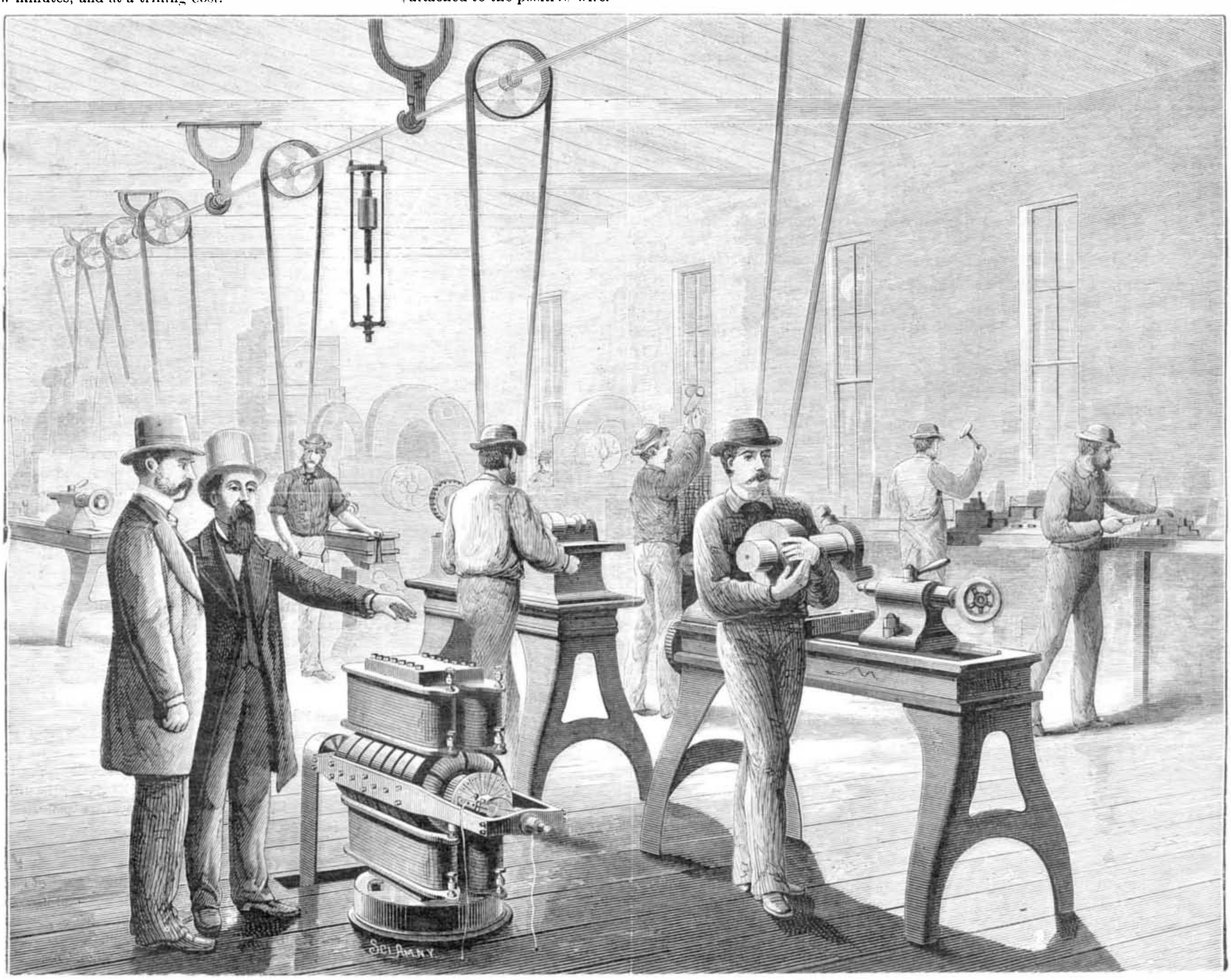
We shall refer to some recent improvements that seem to operate remarkably well.

Fig. 2, page 178, represents a vertical central section of a lamp lately produced by H. S. Maxim. Fig. 3 is a perspective view of the same, and Fig. 4 a detail. A is the positive carbon carrier, and B the negative.

The operation of this lamp is as follows: The negative carbon, which may be 6 inches long, being secured in the lower holder, B, the top holder may be drawn up, as the pinion that gears into its rack is free to turn in that direction without driving the train of gears. A carbon 11 inches long may now be inserted in the top holder, and its point brought in line with the lower carbon by moving the lever on the back side of the carrier.

The wires being connected to the binding post (one on each side of the lamp), the thumb nut, G, being turned will allow the weight of the positive carrier to rotate the train of gearing, and by winding up a cord to draw the negative upward until the combined movement of both causes the points of the two carbons to meet. This will establish an electrical contact, and the current will at once commence to pass, the electro-magnet in the bottom of the lamp will become excited and draw downward the two armatures, one of which draws down one end of the cord that supports the negative carbon, and the other locks the gearing. The separation of

[*Continued on page 178.*]



NEW ELECTRIC LIGHT APPARATUS.—BY H. S. MAXIM, M. E.

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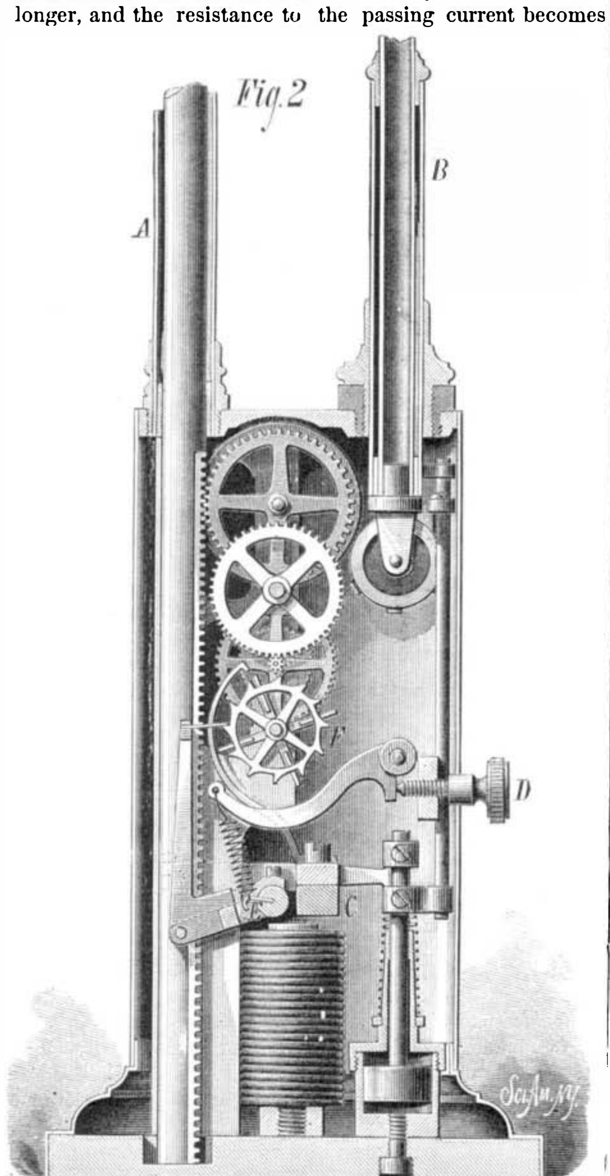
the carbons by this downward movement of the negative establishes the voltaic arc, when the light comes out in all its splendor. As the carbons waste away the arc becomes longer, and the resistance to the passing current becomes



greater, its power to excite the electro-magnet correspondingly decreasing. The armature, E, is drawn away from the magnet by a retractile spring, the tension of which is adjusted by thumb screw, D. When the magnetism is so much reduced that the pull of the spring is greater than the pull of the magnet, the spring will force the armatures upward and remove the detent from the ratchet wheel, F, thus allowing the train of gears to move so that the carbons slowly approach each other until a point is reached where the arc is shortened sufficiently to again bring the magnet up to its original strength, when it will again pull down the armature and lock the gearing. A too rapid movement of the parts is prevented by a small fan, shown in Fig. 4. When the carbons are drawn apart to a considerable distance and then allowed to approach, this fan will revolve with great speed, and its wings will be spread by centrifugal action to their fullest extent; but when the carbons touch, and the electrical current is established, its speed is much reduced as the larger armature, C, is drawn down, and it remains in that position while the circuit is complete. The armature has an attachment which is brought within the field of the extended wings, but it cannot reach them when they are closed. The fan, when engaged by the attachment, can revolve only a quarter turn at a time and at a very slow speed.

When the ratchet, F, on the fan shaft is unlocked it can revolve rapidly only when the current is broken, and when it is released to feed the carbons to an already established arc it can only turn at a speed a little faster than the actual consumption of the carbons. Should the arc be broken, or the light be extinguished from a high wind or other cause, the large armature, C, will be liberated, and by bringing the lower carbon against the upper carbon it re-establishes the arc instantly. A too rapid movement is prevented by a controlling chamber or dash pot in the bottom of the lamp. All of the comparatively heavy work of separating the carbons and re-establishing the current is done by the armature, C, while the smaller armature, E, has only to lock and unlock the train of gearing.

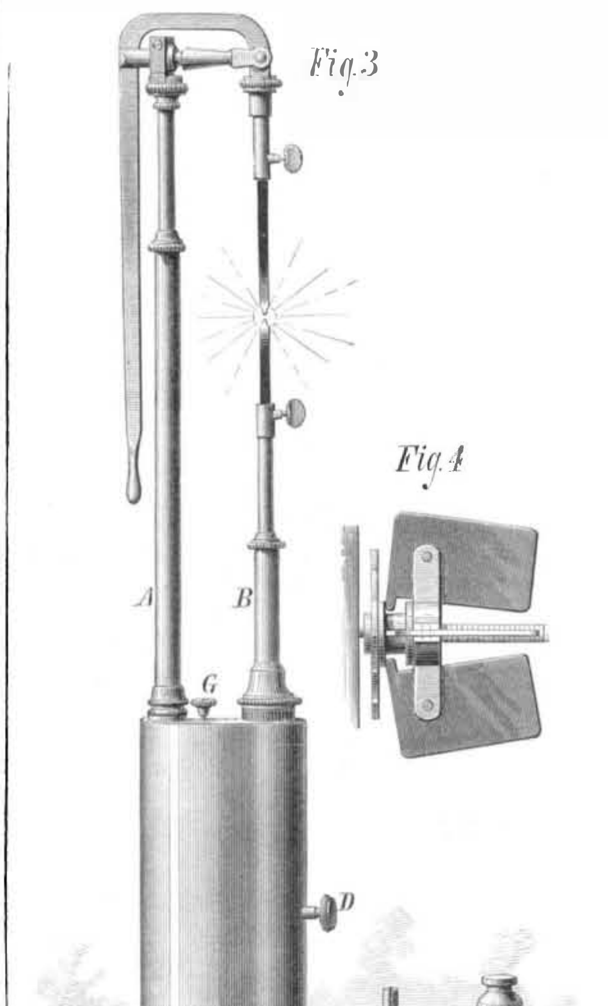
As the distance to be traveled is very slight, and the work to be done so light, but very little change in the electro-motive force of the current is required to stop or start the feeding of the carbons. The tension of the spring that opposes the magnetism can be adjusted from the outside of the case to balance its pressure against a current of any strength. Where great nicety and steadiness are required, this lamp seems well adapted to meet all requirements. It is small and compact, and appears a very substantial and beautiful piece of mechanism.

Fig. 5 is a side elevation of a less expensive kind of lamp devised by the same inventor. In this lamp both carbon holders are supported by a cord. As the upper or positive holder descends it draws the cord over a pulley and raises the negative just one half the distance traveled by the positive. When the wires are properly connected and the carbons are in position, the top holder may be allowed to run down until the two carbons meet. This establishes the circuit and excites the axial magnet in the bottom of the case, when the core is drawn into the helix, and the two carbons, through the medium of levers, are drawn apart until the magnetism and tension of the spring balance each other, and as the carbon is burned away the arc is lengthened, the magnetism reduced, when the core is drawn out of the spool, thus feeding the carbons together as they are consumed until the parts have reached a position where the ratchet on the lower lever is beyond the reach of the pawl, then the core descends and the ratchet revolves, when the carbons take a new position, and the feeding goes on as before. The ratchet wheel is prevented from turning more than one tooth at a time by a spring at the end of the lower lever. The pull of the rack is opposed to the spring, and when the pull is reduced by the disengagement of a ratchet tooth the lever, and with it the ratchet, are forced downward, and the succeeding tooth is caught on the pawl. The core on which the magnetism operates is connected with the rack by compound levers, so that by changing the position of the connecting link the leverage can be readily adjusted.

Adjustments may also be made with the thumb nut on the top of the case, which is attached to a retractile spring. While this lamp is not so susceptible of a very fine adjustment, still for some purposes it is better than the more expensive one just described. In places where the speed of the dynamo-machine varies much, or where the machine is of poor quality, it is better than the regular clockwork lamp.

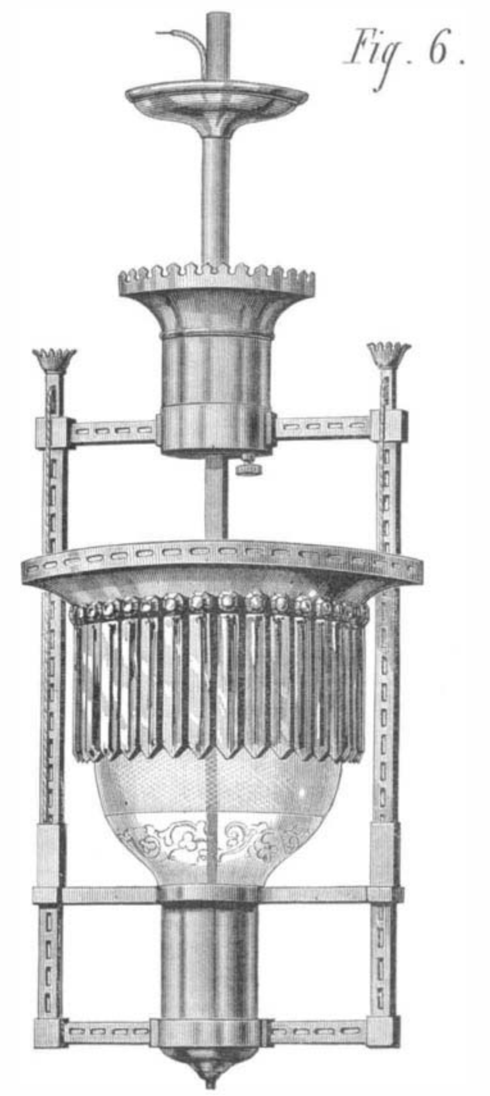
The hanging lamp shown in the large engraving has no clock work. It is very simple in design, and is intended as a cheap lamp for common use; it could not be used in a reflector as only one carbon feeds, consequently the focus is continually changing its position.

A new lamp which is quite different from anything before made is shown in Fig. 4. This lamp is in two parts, connected by vertical tubes. The upper portion has a device for feeding the carbons, and the lower portion contains a device for separating them. The focus or source of light is always at the same place, as the two carbons feed exactly in proportion to the rapidity with which they are consumed. This lamp will accommodate itself to widely varying currents. Should a slackening of the speed allow the carbons to come

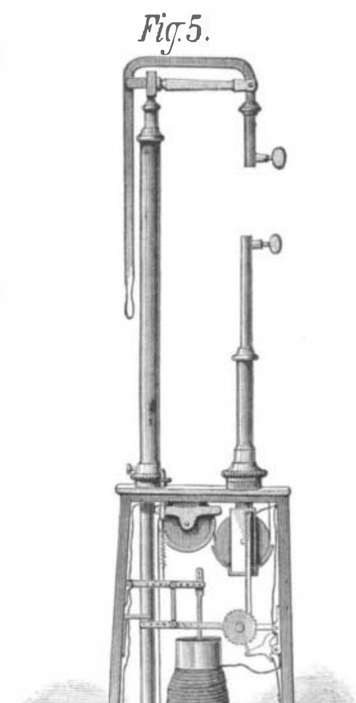


completely together they would at once draw apart on the increase of speed, and they will do this any number of times in succession. Or the current may be broken and established any number of times without disarrangement of the parts. This feeding has positive movement, and is so nicely balanced that a very slight change in the length of the arc allows the carbons to feed, and should the current be broken, the lower carbon by a very rapid movement re-establishes it before the heat of the carbons is perceptibly diminished, and before the magnetism of the machine is discharged.

The light from the naked carbon points is dazzling to the eyes, and casts very distinct shadows. The light is of wonderful intensity. To diffuse the light without reducing it very much, and to make the small point appear as large as possible, have been the aim of the inventor in constructing this lamp. Above the focus is a silvered reflector of suitable shape to throw the beams that would be wasted above in a horizontal



or downward direction, and from this reflector two rows of prisms are suspended. One half of the prisms are arranged with their flat side to the light, and the other half have their angular side toward the light. Below the focus is a bowl shaped glass, having a zone ground just wide enough to be always between the eye of a near observer and the luminous arc. The point from which the light is emitted appears from a distance diamond shaped and quite large. Thus modified the light can be looked at with perfect ease, while its brilliancy does not seem to be at all impaired, the ground glass portion of the globe only being between the eye and the luminous point. The prisms and glass bowl inclose the light and protect it from the wind. The bowl is suspended by two cords that pass over pulleys and are attached to the reflector. By pulling the bowl downward the reflector is raised up, and thus opening a space through which the carbons may be viewed. A pair of carbons $\frac{3}{8}$ x $\frac{3}{8}$ inch in these lamps last about three hours, and afford a very steady light. Carbons $\frac{5}{16}$ x $1\frac{1}{4}$ inch last about 10 hours.



Electric light may be utilized in two ways—either by powerful foci illuminating at great distances, or by less intense foci giving a more diffused light suitable for all kinds of night work, thus including lighthouse service, fortifications, maritime service, shores, armies in action, and for manufactories, show rooms, for open air use, for large workshops, railroad depots and yards, wharf work, steamboats, mines, theaters, large halls, reading rooms, streets, squares, and many other places. For these purposes electric light is superior to all others and much cheaper. Mechanical workshops have been among the first to make use of the electric light, also dyers and sugar refiners, who need a very pure and white light, and spinning mills and foundries have adopted it. Electric light is analogous to sunlight, all colors appearing the same at night as by daylight. Any further information may be obtained from the United States Electric Lighting Company, Room M, Equitable Building, New York city.