ON PHOTOGRAPHING THE NEBULA IN ORION.*

By Professor Henry Draper.

The gaseous nebulæ are bodies of interest because they may be regarded as representing an early stage in the genesis of stellar or solar systems. Matter appears to exist in them in a simple form, as indicated by their simple spectrum of three or four lines. It is desirable, therefore, to ascertain what changes occur in the nebulæ, and determine, if possible, the laws regulating their internal movements. Drawings by hand have been made of some of the nebulæ, and especially of the nebula in Orion, for upwards of 200 years. But drawings are open to the objection that fancy or bias may distort the picture, and it is therefore difficult to depend on the result, and to compare the drawing of one man with that of another. To apply photography to depicting the nebulæ is difficult, because these bodies are very faint, and, of course, owing to the earth's motion and other causes they seem not to be at rest. They require a large telescope of special construction, and it must be driven by clock-work with the greatest precision. All such difficulties as those arising from refraction, flexure of the telescope tube, slip of loose bearings, atmospheric tremor, wind, irregularities of clock-work, foggy or yellow state of the air, have to be encountered. The photographic exposure needed is nearly an hour, and a slip or movement of a very small fraction of an inch is easily seen in the photograph when it is subjected to a magnifier.

The means I have used to obtain the picture are as follows: A triple achromatic objective of 11 inches aperture made by Clark & Sons, according to the plan of Mr. Rutherford, for correcting the rays especially for photography. This telescope is mounted on an equatorial stand and driven by a clock that I made myself. The photographic plates are gelatino-bromide, and are about eight times as sensitive as the wet collodion formerly employed.

As to the picture itself the nebula is very distinct in its bright portions. The stars of the *Trapezium* and some others are so greatly over exposed that under the magnifying power employed they assume a large size, partly from atmospheric tremor and partly from other causes. It is probable that much more of the nebula will be obtained in pictures taken in the clear winter weather. This photograph was made at the end of September when there was some fog in the air; but nevertheless, the original shows traces of the outlying streamers seen in the drawings of other observers. A series of photographs taken at various times of the winter season and in different years will give us the means of determining with some precision what changes, if any, are taking place in this body.

ELECTRO-MOTIVE FORCE OF THE BRUSH DYNAMO-ELECTRIC MACHINE.*

Professor Henry Morton.

Some recent experiments, which I made in determining the electro-motive force of the Brush dynamo-electric machine, and various instruments for the accurate measurement of electric currents of great strength, show that each pair of coils on the armature of the machine develops a fluctuating electro-motive force, the projection of which gives a kind of oval curve around the centre of a diagram.

When these curves for each pair of coils are combined, it is found, that they show a kind of eight-lobed figure with intersecting lines in certain places. These intersections, if compared with the positions of the commutator, are found to coincide exactly with the points at which rupture of circuit occurs, and thus show that each pair of coils is thrown out, not at the point where its force is least, but at that at which its electro-motive force is equal to that from which it breaks; thus suppressing a spark, but only at a certain sacrifice of theoretical efficiency.

* Read before the National Academy of Sciences, N. Y., 1880.

APPLICATION OF THE PHOTOPHONE TO THE STUDY OF THE NOISES TAKING PLACE ON THE SURFACE OF THE SUN.

On visiting the Observatory of Meudon, at the invitation of M. Janssen, Mr. Graham Bell examined with much care the large photographs which are being made there for the study of the solar surface. M. Janssen having informed him that he detected movements of a prodigious rapidity in the photospheric matter, Mr. Bell had the idea of employing the photophone for the reproduction of the sounds which these movements must necessarily produce on the surface of the sun. M. Janssen approved of the idea, and requested Mr. Bell to attempt its realization at Meudon, placing all the instruments of the observatory at his disposal. The weather being very fine on Saturday last (October 30), Mr. Bell came to Meudon to attempt the experiment. A large solar image of 0.65 metre in diameter was examined with the selenium cylinder. The phenomena were not sufficiently decided to be regarded as successful, but Mr. Bell does not despair of succeeding on further examination. M. Janssen suggested that the chance of success would be much greater if in place of directly interrogating the solar image where the variations are produced, though responding to considerable changes on the sun's surface, are not sufficiently rapid even in the most powerful instruments to cause the production of sounds in the photophone, a series of solar photographs of one and the same spot, taken at sufficient intervals to obtain well-marked variations in the condition of the spot, might be passed with a suitable rapidity before an object glass, which would give conjugated images upon the selenium apparatus. This would be a means of condensing into a time as brief as could be desired the variations which in solar images are much too slow to give rise to a sound. M. Janssen has placed himself at Mr. Bell's disposal to provide him with solar photographs suitable for carrying out this idea, and the latter has sent M. Janssen the photophonic apparatus requisite. It has appeared to M. Janssen that the idea of reproducing on earth the sounds caused by great phenomena on the surface of the sun was so important that the author's priority should be at once secured.

LECTURE PHOTOPHONE.

A simple form of Photophone, which is sufficient to show the principle of the instrument, and may be used for lecture purposes, has been arranged by Mr. Shelford Bidwell, and exhibited before the Physical Society of London.

The reflector for receiving the light is discarded, and the beam focussed on the selenium by the lens.

The two lenses used cost only about six dollars, and the beam is sent fourteen feet.

The selenium cell was made by spreading melted selenium over sheets of mica, and then crystallized by heat. For mica Professor Bell recommended microscopic glass.

The resistance of the cell was 14000 ohms in the dark and 6500 in the light. Speech was distinctly transmitted by this apparatus.