CONSTITUTION OF THE SUN AS REVEALED BY PHOTOGRAPHY.

By M. JANSSEN.*

FROM the moment in which we entered upon the study of celestial photography, on the occasion of the transit of Venus, we have always thought and maintained that photography appeared to us called to play a leading part in astronomical observations.

This opinion has just received a first confirmation in so far as solar photography is concerned. We have succeeded in obtaining, at the Observatory of Meudon, prints of the sun disclosing important facts on this star which have hitherto escaped optical observations. I cannot here enter into details; I will only say that, following certain theoretical considerations, and the study of the results hitherto obtained, I have been led to combine enlargement of the diameters of the images with diminution of the time of the action of the light in order to combat the photographic irradiation.

The solar images have been successively brought to a diameter of 12, 15, 20, and 30 centimeters. At the same time the duration of the exposure has been reduced in the last experiments to about $\frac{1}{3000}$ of a second, this time having reference to the direct action of the sun without the intervention of a refracting medium.

Under these conditions, and taking the most minute precautions to get images of the greatest possible purity, solar images have been obtained having nothing in common with previous results.

While the older images, apart from spots and faculae, showed no real detail of the sun's surface, the new photographs show this surface as entirely formed by a fine granulation, the elements of which are very varied in form, in size, in relative position, in clearness, according to the regions, etc. This image, each point of which has been formed in $\frac{1}{3000}$ of a second, would require several months to be studied in all its details.

The size of the granular elements is very varied; grains are to be found from some tenths of a second to three and four seconds in diameter.

This granulation shows itself everywhere, and does not seem, as far as we have gone, to present a different constitution toward the sun's poles. We shall have, however, to return to this point.

But the most remarkable result, and one which is due to the aid of photography, is the discovery of the photo-spherical network.

In fact, the careful examination of these photographs shows that the photosphere has not a uniform constitution in all its parts, but that it is divided into a series of figures more or less distant from one another, and presenting a peculiar constitution.

These figures have generally rounded contours, on approximately rectilinear and rambling polygons. The dimensions of these figures are very variable—they have sometimes a diameter of a minute or more. While in the intervals between the figures of which we are speaking the grains are clear, well defined, although of very variable size, in the interior the grains look as if half effaced, drawn out, strained; most frequently, indeed, they have disappeared, to give place to trains of matter which replace the granulation. This would seem to show that in these places the matter of the photosphere is subjected to violent movements which have disturbed the granular elements.

I will not touch at present on the consequences of this fact, which throws light on the forms of solar activity, and shows, as I said some time since, that this activity in the photosphere is always very great, although no spot may show itself on its surface.

The network of the photosphere could not be discovered by the optical means which are used in ocular observation of the sun. In fact, to determine its existence on the prints, lenses must be employed which enable us to cover a certain extent of the photographic image. Then, if the enlargement be sufficient, if the print be quite pure, and especially if it has received the proper pose, we see that the granulation has not everywhere the same clearness; that the parts with well-formed grains are delineated as currents which circulate in such a manner as to circumscribe spaces in which the phenomena present the appearance which we have described. Thus, to determine this fact, it is necessary, as we said, to cover a considerable portion of the solar disk, a thing impossible to realize when we view the sun with a very powerful instrument, the field of which is very limited from the fact of its power. Under these conditions we can, indeed, determine that portions exist in which the granulation ceases to be clear or even visible; but we cannot suspect that this fact is connected with a general system.

Already the examination of photographs during a few months' discloses differences in the constitution of the photo-spherical network—differences which will give us information on the variations in the forms of solar activity.

I add this very important fact, established with certainty by the photographs, that of the existence of very dark nebulous tracks, showing themselves in the regions of regular granulation, and which indicate that the photospherical layer must have a very slight thickness.

Solar photography is thus placed, from this time, under conditions in which it can reveal to us most important facts on the constitution of the sun. It is a new method which is opening before us, and the efforts of which we can join to those of spectrum analysis and the older optical methods to solve the great problems which the nature of the sun raises, problems which touch in so many points those of the constitution of the universe.

IMPROVED CARBON PROCESS.

HERR HONIKEL, of Leipzig, has, according to the *Wochenblatt*, proposed the following amendment of the carbon process:—Starting from the assumption that the shadows and half tones of all carbon prints are uncommonly rich in details, while the lights and high lights are extremely poor, Herr Honikel proposes that instead of mixing black or dark coloring matter, as has hitherto been the custom, with the gelatine destined to form the pigment tissue, white pigments should be used, and the sensitive tissue exposed under a positive and developed, and transferred to black or colored paper. Besides the more beautiful appearance claimed for such pictures, this method is said to possess the advantage of indefinitely increasing sensibility. According to Herr Honikel the sensitiveness of white pigment tissue is from twenty to twenty-five times as great as that of ordinary carbon tissue. And yet another advantage claimed is that by means of white pigment tissue it is possible to produce direct enlargements upon paper with the camera. It is

* Read before the French Photographic Society.

VARLEY'S NEW ELECTRO-MAGNETIC MACHINE.

scarcely necessary to remind our older readers that the late Mr. William Blair devoted much attention to this kind of pigment printing, an account of it having been published by him nearly ten years ago.

VARNISH FOR MELAINOTYPES.

THE *Photographisches Wochenblatt* gives the following directions for the black backing of ferrotypes or melainotypes:—Cut the iron plate to the proper size and heat it to about 80° R. Then brush upon both sides of the plate the following varnish:

Alcohol	100 grains.
Yellow gum lac.	10 "
Sandarac	5 "

The mixture should be slightly warmed for half an hour in a glass vessel, and the clear part decanted off. The black varnish, with which one side of the varnished plate is to be coated, consists of—

Chloroform	80 grains.
Asphalt	80 "
Canada balsam	20 "

When in the course of a few days the varnish has become perfectly dry the plates may be used, but it is as well to dip each of the four edges into the above solution, a sufficient quantity of which for the purpose has been poured into a groove made in a piece of wood. The object of this is to prevent the varnish from slipping off the edges of the plate and thus permitting the iron to come into contact with the silver bath and spoiling it. Before collodionizing rub the plate with a tuft of cotton wool to remove all dust. The most suitable collodion is lithium collodion, which contains a little free acid. The developer is—

Water	500 grains.
Glacial acetic acid	30 "
Alcohol	30 "
Sulphuric acid	30 "

Intensify and fix as usual.

VARLEY'S NEW ELECTRO-MAGNETIC MACHINE.

These improvements have been designed by MR. C. F. VARLEY, of London, Eng.

In magneto-electric machines constructed according to the invention, actual or nearly actual contact is maintained between the armatures and poles of the inducing magnets. The magnets themselves, together with the intermediate cores surrounded by helices, form a complete ring, link, or circuit of iron or iron and steel or other magnetic substances. These permanent or electro-inducing magnets have their respective north and south poles continuously or nearly continuously closed, notwithstanding the movement of the armature or armatures, but the armature or armatures (when rotated or moved to and fro along the iron or link) effect the commutation, or, in other words, alter the direction of the magnetic conduction through the inducing cores surrounded by electric conductors, the effect of which commutation or reversal of magnetism is to generate electricity in the conductors forming the helices. In arranging a machine on these principles in the simplest and most elementary form, two horseshoe magnets are placed opposite to one another, and between their poles are two soft iron cores on which coils of covered wire are wound. The two north poles of the magnets are in contact with the two ends of one of the cores, and the two south poles are similarly placed in relation to the other core. Together with these, which are fixed parts of the apparatus, an armature is employed, to which a reciprocating motion is communicated, which places it first in contact or nearly so with the two poles of one magnet, and then transfers it to a corresponding position in respect to the other magnet. The faces of the magnets and of the armature may advantageously be grooved to increase the area of the surfaces in contact or close proximity. The armature may also advantageously be made double, so that the poles of the magnets may be received between its two parts. The attraction of the magnet for the two parts of the armature will then balance each other, and by a screw adjustment the surfaces of the armature may be brought very close to the surfaces of the magnets without giving rise to friction. The dimensions of the armature should be such that it may close with one pair of poles before leaving the other pair of poles. In place of a reciprocating armature a rotating armature may be employed, so formed as to connect the north pole of one magnet with the south pole of the other, and as it rotates to couple the poles alternately.

By another arrangement, six or it might be any other even number of horseshoe magnets are arranged radially around a circle, and with, say, the north poles of all the magnets uppermost. As in the former case, the similar poles of the magnets are connected by means of soft iron cores wound with covered wire forming the circuit in which the currents are generated. These, which are the stationary parts of the apparatus, are all preferably carried upon a gun metal cylinder or ring, within which a corresponding

plug or frame rotates; this plug or frame carries armatures, and as the plug revolves these couple together the poles of each magnet in succession. In some cases, to produce currents for telegraphs and other uses, Mr. Varley gives motion to the armature by a finger-key when it is desired to transmit a current. In arrangements of this nature the armature is of small size and the magnets have pole pieces or horns approaching within a short distance the one of the other, leaving only sufficient space for the armature to move between them. For some purposes he mounts the armature on a tuning-fork, and so obtains electric pulsations in unison with the fork. Other vibrators may be substituted for the fork. In Fig. 1, M, are horseshoe magnets—permanent magnets are represented, but electro-magnets are also available. Between the magnets and in contact with them are two cores of soft iron wound with coils of insulated wire, C; they form part of the circuit or circuits in which the electricity generated by the apparatus is transmitted. N, S, mark the poles of the magnets. O are guides made of gun metal in which the rod, D, is free to slide to and fro; it has upon it the armature of soft iron marked A. A reciprocating movement may be communicated to the armature between the guides, O, by connecting the rod, D, directly or indirectly with a steam engine or other motor. It will be observed that in this arrangement no reversal of the magnetism in the armature, A, takes place. Fig. 2 is a section showing the armature grooved to increase the area of the surfaces in close proximity, when so desired; but in some cases Mr. Varley forms the armature in two parts—one above and the other below the poles of the magnets, with a gun metal block between them.

Fig. 3 represents an arrangement in which a number of armatures are mounted upon a rotating disk of gun metal, and they are so placed that as the disk rotates they close the poles of the two magnets alternately. The armature is mounted upon a rotating axis, D, and as it revolves the magnetism in the armature, A, is reversed in each rotation. The armature may carry a coil, in which case electricity will be generated in the circuit of which this coil forms part. An ordinary rotating commutator may be included in the circuit, and the electricity can then be employed to excite the magnets, M, M, when electro-magnets are employed. Mr. Varley describes several other methods of arranging the apparatus for special purposes, which, however, it is not necessary to reproduce.

The electrostatic multiplier referred to as the second part of the invention comprises a series of insulated studs or conductors which act as potential carriers, and enable the tension, which on first starting may be so minute as to be imperceptible, to be augmented as described in the prior patent referred to, but in addition to which he now employs surfaces or disks of a dielectric substance, such as a plate or cylinder of glass or vulcanized caoutchouc, etc., together with inductive surfaces placed on the reverse side to the collecting and discharging combs or contact pieces, by which means a succession of sparks or electrostatic discharges can be maintained. The charging-up or accumulation of the electrostatic potential is effected automatically, and, as well as the former part of the invention, is self-charging. During the operation of charging-up, contact making springs or contact pieces are employed to make contact with the carriers. As soon as a charge of a certain potential has been accumulated these springs are no longer required, and they are removed or thrown out of action.

The electrostatic multiplier, as Mr. Varley prefers to construct it, consists of a vulcanite disk mounted upon an axis carried upon insulating standards, and capable of being rapidly rotated. On the face of the disk strips of tin foil are fixed radially and at equal distances apart. In front of the disk, and diametrically opposite the one to the other, are the two collecting combs by which the electricity passes from the face of the disk to the conductors of the machine. As the disk revolves the strips of tin foil pass in succession in proximity to the collecting combs. Also in close proximity to the disk, but on the other side of it, are two pieces of wood mounted on insulating standards and serving as inductors; they are about the same width or somewhat wider than the collecting combs. They are of curved form, each inductor covering about a quadrant of the operative part of the disk or that which passes near the points of the collecting combs, and upon which part on one side of the disk are the strips of tin foil. The inductors are so fixed upon their insulating supports that the leading end or commencement of the inductor is immediately opposite to the collecting comb, but on the other side of the disk. For the purpose of charging the inductors there are other combs similar to the collecting combs and similarly placed, but removed from them by an angular distance of ninety degrees, so that they are opposite to the ends of the inductors but on the other side of the disk. These combs are placed in metallic connection with the inductors, each to each. To render the machine self-charging, the last mentioned combs also carry springs or wire brushes, which make metallic contact with studs upon the face of the disk and in metallic contact with the tin foil strips upon it, each to each. As soon as the machine is at work these springs or brushes can be lifted out of contact by means of silken threads or other