Fall of temperature at Madras, by nights :—

1\. Entirely clear sky (1·000). 25 nights.

| ° |
|---|
| 4·5 |
| 7·1 |
| 8·5 |
| 7·7 |
| 7·6 |
| 11·2 |
| 9·5 |
| 9·5 |
| 9·1 |
| 6·9 |
| 9·6 |
| 9·6 |
| 12·2 |
| 8·1 |
| 9·4 |
| 6·6 |
| 8·2 |
| 4·9 |
| 6·5 |
| 8·7 |
| 8·2 |
| 7·5 |
| 10·6 |
| 9·4 |
| 6·5 |
| 25 ) 207·6 |
| 8·3 |

2\. Partially clouded sky (·915). 22 nights.

| ° | Percentage of clear sky. |
|---|---|
| 4·8 | ·900 |
| 6·2 | |
| 5·9 | |
| 8·4 | |
| 4·6 | ·910 |
| 5·0 | |
| 7·5 | |
| 7·6 | |
| 5·3 | |
| 5·4 | |
| 5·8 | |
| 8·5 | |
| 3·6 | ·920 |
| 7·2 | |
| 7·6 | |
| 5·0 | |
| 6·7 | |
| 5·7 | ·930 |
| 4·2 | |
| 6·4 | |
| 4·9 | |
| 6·3 | |
| 22 ) 132·6 | |
| 6·0 | ·915 Mean. |

At Fort Franklin, Sir John Richardson found that the maximum of solar radiation was obtained in the *spring* and at noon. Mr. Forbes accounted for this by the fact that the sun's rays were reflected from the *snow*, and thus the bulb of the thermometers received reflected as well as direct rays of sunshine.

## II. "On the Conversion of Dynamical into Electrical Force without the aid of Permanent Magnetism." By C. W. Siemens, F.R.S. Received February 4, 1867.

Since the great discovery of magnetic electricity by Faraday in 1830, electricians have had recourse to mechanical force for the production of their most powerful effects; but the power of the magneto-electrical machine seems to depend in an equal measure upon the *force expended* on the one hand, and upon *permanent magnetism* on the other.

An experiment, however, has been lately suggested to me by my brother, Dr. Werner Siemens of Berlin, which proves that permanent magnetism is not requisite in order to convert *mechanical* into *electrical* force; and the result obtained by this experiment is remarkable, not only because it demonstrates this hitherto unrecognized fact, but also because it provides a simple means of producing very powerful electrical effects.

The apparatus employed in this experiment is an electro-magnetic machine consisting of one or more horseshoes of soft iron surrounded with insulated wire in the usual manner, of a rotating keeper of soft iron surrounded also with an insulated wire, and of a commutator connecting the respective coils in the manner of a magneto-electrical machine. If a galvanic battery were connected with this arrangement, rotation of the keeper in a given direction would ensue. If the battery were excluded from the circuit and rotation imparted to the keeper in the opposite direction to that resulting from the galvanic current, there would be no electrical effect produced, supposing the electro-magnets were absolutely free of magnetism; but by inserting a battery of a single cell in the circuit, a certain magnetic condition would be set up, causing similar electro-magnetic poles to be forcibly approached to each other, and dissimilar poles to be forcibly severed, alternately, the rotation being contrary in direction to that which would be produced by the exciting current.

Each forcible approach of similar poles must augment the magnetic tension and increase consequently the power of the circulating current; the resistance of the keeper to the rotation must also increase at every step until it reaches a maximum, imposed by the available force and the conductivity of the wires employed.

The cooperation of the battery is only necessary for a moment of time after the rotation has commenced, in order to introduce the magnetic action, which will thereupon continue to accumulate without its aid.

With the rotation the current ceases; and if, upon restarting the machine, the battery is connected with the circuit for a moment of time with its poles reversed, then the direction of the continuous current produced by the machine will also be the reverse of what it was before.

Instead of employing a battery to commence the accumulative action of the machine, it suffices to touch the soft iron bars employed with a permanent magnet, or to dip the former into a position parallel to the magnetic axis of the earth, in order to produce the same phenomenon as before. Practically it is not even necessary to give any external impulse upon restarting the machine, the residuary magnetism of the electro-magnetic arrangements employed being found sufficient for that purpose.

The mechanical arrangement best suited for the production of these currents is that originally proposed by Dr. Werner Siemens in 1857* consisting of a cylindrical keeper hollowed at two sides for the reception of insulated wire wound longitudinally, which is made to rotate between the poles of a series of permanent magnets, which latter are at present replaced by

* See Du Moncel 'Sur l'Electricité,' 1862, page 248.

electro-magnets. On imparting rotation to the armature of such an arrangement, the mechanical resistance is found to increase rapidly, to such an extent that either the driving-strap commences to slip or the insulated wires constituting the coils are heated to the extent of igniting their insulating silk covering.

It is thus possible to produce mechanically the most powerful electrical or calorific effects without the aid of steel magnets, which latter are open to the practical objection of losing their permanent magnetism in use.

## III. "On the Augmentation of the Power of a Magnet by the reaction thereon of Currents induced by the Magnet itself." By CHARLES WHEATSTONE, F.R.S. Received February 14, 1867.

The magneto-electric machines which have been hitherto described are actuated either by a permanent magnet or by an electro-magnet deriving its power from a rheomotor placed in the circuit of its coil. In the present note I intend to show that an electro-magnet, if it possess at the commencement the slightest polarity, may become a powerful magnet by the gradually augmenting currents which itself originates.

The following is a description of the form and dimensions of the electro-magnet I have employed. The construction, it will be seen, is the same as that of the electro-magnetic part of Mr. Wilde's machine.

The core of the electro-magnet is formed of a plate of soft iron 15 inches in length and $\frac{1}{2}$ an inch in breadth, bent at the middle of its length into a horseshoe form. Round it is coiled in the direction of its breadth, 640 feet of insulated copper wire $\frac{1}{12}$ of an inch in diameter. The armature, which is according to Siemens's ingenious construction, consists of a rotating cylinder of soft iron $8\frac{1}{2}$ inches in length, grooved at two opposite sides so as to allow the wire to be coiled upon it longitudinally; the length of the wire thus coiled is 80 feet, and its diameter is the same as that of the electro-magnet coil.

When this electro-magnet is excited by any rheomotor the current from which is in a constant direction, during the rotation of the armature currents are generated in its coil during each semirevolution, which are alternately in opposite directions; these alternate currents may be transmitted unchanged to another part of the circuit, or by means of a rheotrope be converted to the same direction.

If now, while the circuit of the armature remains completed, the rheomotor be removed from the electro-magnet, on causing the armature to revolve, however rapidly, it will be found by the interposition of a galvanometer, or any other test, that but very slight effects take place. Though these effects become stronger in proportion to the residual magnetism left in the electro-magnet from the previous action of a current, they never attain any considerable amount.

But if the wires of the two circuits be so joined as to form a single cir-