switchboard itself has a capacity for 9,600 subscribers' lines and more than 15,000 stations.

After Mr. Rennard's interesting remarks were concluded the members of the society were taken through the central office in groups guided by details from the chief engineer's staff. So interested were the members in viewing the installation that they remained until a late hour enjoying a most interesting and profitable evening.

THE POLAR RAYS OF THE CORONA.

By MRS. WALTER MAUNDER.

THE corona of 1901 was of the most pronounced minimum type, its form was simpler than any of which astronomers have had experience since 1889. This circumstance, though it may seem to detract from its beauty and interest in some respects, is not without its advantages, as the relations of many of its details can be more distinctly followed and their significance better appreciated.

Especially is this the case with regard to the structures immediately round the two poles of the sun's axis. At times of maximum, the great synclinal rays are found, not merely in the neighborhood of the sun's equator, but all round the limb, and the polar rays are obscured by the more conspicuous type of formation. But in an eclipse like that of last May, the polar regions are left absolutely free except for the beautiful and regular tufts of light which have earned for themselves the appropriate name of "plumes" or "panaches." These are then seen there in utmost distinctness, and can be studied to greatest advantage. No doubt structures similar in general character may exist in every region of the corona, both at minimum and maximum, but in the equatorial regions the greater brightness of the great synclinal curves, and the complexity shown by the regions of the corona close to the sun's limb, prevent the "plumes" from being easily recognized.

Restricting our attention for the present to the rays round the southern pole, they present something like the following appearance. Starting from the great southeast synclinal group, we find that the first polar rays are drawn over into a curvature which nearly, though not precisely, conforms to the southern outline of that formation. As we approach the pole the rays are less and less curved, till at the pole itself, and in its immediate neighborhood, we find them as straight as if they were ruled. And this change of shape is not confined to the bright rays. Between the bright rays there are dark streaks—whether we regard them as mere rifts or interspaces, or as actually dark rays, having an objective existence, as being, in other words, an absorption and not a mere contrast effect—showing precisely the same excessive curving near the southeast synclinal group, and straightening gradually as they approach the pole until they become there as truly rectilinear as the bright rays among which they are found. Proceeding from the pole toward the west, we find in like manner that the curvature of the rays increases the further we get from the pole, although we do not get the same extreme bending noticed on the east. But it is noteworthy that the southwest equatorial wing is more diffused than the southeast; its outline is not so sharp and well defined, and the curve of that outline is much gentler, except at one particular point with which I am not at present concerned.

The dark rifts or rays interspersed between the bright polar rays deserve special attention. Many of these appear to be, and probably are, mere contrast effects, interspaces between the bright rays. But others seem to me to be of quite a different order. Thus on the east of the pole we find two bright rays, the curvatures of which lead them apart from each other the further they recede from the sun. The dark space between them therefore broadens the further we go from the limb. But within this space we find an intensely black line; not a contrast effect, for it borders neither of the bright rays, it does not broaden as it recedes from the sun, but is equally narrow throughout, and its curvature corresponds to that of neither of the bright rays between which it runs. More remarkable still it can be traced further from the sun than the bright rays. A similar remark applies to another ray even longer and darker than the first, that springs almost exactly from the sun's pole.

The polar rays toward the west appear to show some evidence that they are not in the same plane. To the extreme west two short bright rays of considerable curvature appear to be distinctly nearer to the spectator than a pair of straight rays which make a considerable angle with the solar axis. The more westerly of the pair would indeed seem to be partly hidden by the curved rays; the more southerly in its turn appears to conceal the lower portion of three straight rays, which show a slight divergence from the solar axis. Elsewhere in the corona of 1901 there were similar indications, none very strongly marked, of a certain amount of relief. The general effect of this corona, as of all coronæ, is of that of an essentially plane phenomenon. The impression produced is that of a superficies, not of a solid; of a body having extension in two dimensions, not in three.

Yet we know for a certainty that the material composing the corona must be distributed in all three dimensions; taking one eclipse with another it must on the average be equally extended in all solar longitudes. We are looking down upon the sun day by day through a depth of the corona which on the average corresponds to its mean depth as seen in the tangential plane.

This consideration is so certain that it has led to the system of polar rays being regarded as in fact a sub-polar ring, the pole itself being bare. But at a distance from it of about 20 deg. or 25 deg. a number of rays rise from the surface and all of them bend over toward the sun's equator. On this theory, those rays which lay very nearly in the line of sight would necessarily appear to us to be straight or nearly straight, through the effect of foreshortening, and would be seen by projection in the apparent neighborhood of the pole. It has been further suggested that this ring of rays would be a phenomenon essentially similar to our terrestrial auroræ, the long coruscations of which have frequently impressed themselves upon

observers as resembling in appearance these polar rays of the corona. But indeed this latter suggestion is a very superficial one, and entirely ignores the difference between the positions of the spectator in the two cases. In the case of a terrestrial aurora we may indeed see the rays shooting up from low down in the north, high across our zenith, but we have no guide by which we can tell as to whether those rays are really rising or falling in our atmosphere, or as to whether, which is far more probable, they are moving practically at one given level; their apparent rise or fall being simply the effect of perspective. So far as our knowledge goes a terrestrial aurora, watched from the moon, would seem to be essentially a surface phenomenon; as entirely so as the streaks which radiate from Tycho or Copernicus appear to be to us.

The difficulty which we have in regarding the polar rays as situated in a ring at about 65 deg. of solar latitude lies here; that in such a case they should obviously be much more crowded together as we approach the greatest apparent distance east and west from the pole, while near the pole they should be considerably shorter and fainter, and much more sparsely scattered. In other words, not only would there be a marked flattening of the corona itself at the two poles, but the polar rays would show such flattening among themselves. But in general these features are just what are not seen. The straight rays close to the pole are in general at least as long and as bright as those nearest the synclinal groups, and they are nearly, if not quite, as closely packed. Yet a careful examination of the region before us does show a certain crowding toward the east, while close to the great dark ray at the pole a broad but short bright ray is clearly seen, which may very well have its rise in a latitude some 15 deg. or 20 deg. from the pole, either on the side of the sun nearer to us, or on that more remote.

The indications of relief in the corona, which the present plate affords, slight though they may be, are of importance, as they tend to remind us that the corona, in spite of that essentially flat appearance which it generally presents, must in reality have a great extension in the line of sight. It is a fact of which we need to be reminded, since it is so easy to forget it, and it has often been ignored in discussions upon its structure and nature. And indeed it seems very difficult to reconcile it with some features of its actual appearance. The dark rays, for instance, whether we regard them as mere interspaces between bright formations, or as having a distinct and separate objective existence, are exceeding hard to account for in a structure in relief. Then, again, in the coronæ of 1900 and

FLEXIBLE RULERS FOR DRAWING CURVES.

of 1901, and we might add also in the more complicated one of 1898, the great mass of the corona was comprised in a very few striking formations of the character known as synclinal groups. In 1900, three of these were recognized; in the other two years, four. On all three occasions these structures had the most enormous extension, reaching on the average a distance of about three solar diameters from the center of the sun. It is clearly not conceivable either that the structures which were visible were exactly where they appeared to be, in a plane at right angles to the line of sight, or that the moon concealed from us at the most more than two or three structures of similar character and extent. The picture, therefore, that is conjured up to our mind of what would be visible to us, could we look down upon the sun and see the corona on all sides at once and in full relief, is that of about half a dozen or so of these monstrous excrescences distributed irregularly round the sun; while about one-tenth of the solar surface, that immediately surrounding the two poles, would be given up to a few "plumes," few, that is to say, relatively to the area engrossed by them.—Knowledge.

APPARATUS FOR DRAWING CURVES.

We illustrate herewith, from *La Nature*, three types of flexible rulers for drawing curves, the invention of a Mr. Brooks, of London.

One of these is made entirely of celluloid, and is provided laterally with five small rings upon which to rest the fingers when the ruler is placed vertically in order to make a drawing. It will be seen that, owing to these rings, it is possible with one hand to keep the ruler at any degree of curvature whatever, while the other hand is manipulating the drawing pen or pencil (Fig. 1).

Fig. 2. shows a similar but somewhat more complicated ruler, which is here a flexible band of steel, to which, through rings, are laterally attached a series of flat links, the relative position of which determines the curves of the ruler. The joints of these links work by hard friction, so that after any curve whatever has been given the ruler the latter keeps it until the effort necessary to modify it is made. There is thus obtained a genuine templet that permits of drawing two symmetrical curves, one on each side of the same axis.

The third type of apparatus (Fig. 3) is still more complicated. Here the ruler is in most cases of wood, because it is of larger size and does not need to be so flexible. Through joints it is attached at a series

of points to square metal rods that are capable of sliding in metal sockets, so as to form more or less marked concavities or convexities in the strip of wood. The sockets, moreover, are fixed upon a straight metal rod that forms, as it were, the frame of the instrument, and permits of drawing a curve on either side of a horizontal axis. As in the preceding case the apparatus may be reversed for the drawing of a symmetrical curve.

RAILWAY MOTOR CAR SERVICE IN EUROPE.

UNDER date of January 1, Thornwell Haynes, United States Consul at Rouen, writes as follows regarding Railway Automobiles in Europe:

Railway automobiles are beginning to be considerably used in Europe: (1) As early and late postal trains; (2) on branch lines and others where passengers are few; (3) on trunk lines where it is often difficult to secure convenient secondary trains; (4) in industrial centers and city suburbs. Furthermore, the automobile railway train can be attached for a certain distance to an express and detached at the station where the road branches.

There is an economy in the personnel of the train, in the expense of traction, in material, capital, and maintenance, and an additional traffic because of the increased number of stations made possible by the facility of stopping and starting. Up to the present time, the carriages constructed are steam and electric.

Of the former, I have noticed mention of the following: The Belgian State Railway has constructed carriages 46 feet long weighing 50 tons, with a capacity of 53 passengers. They can go at the rate of 18½ miles an hour, or a maximum rate of 34 miles an hour. Two men are generally in control; sometimes three. There are also employed in Belgium two Rowan coaches for tramway service in the suburbs of Antwerp. They have 46 places, weigh when charged 4000 pounds and have a speed of 31 miles. The boiler is vertical, with inclined tubes. It is the same automobile used on the lines of the Paris Omnibus Company. The Russian State Railway (Nicolas line) employs two steam coaches. These are constructed with two stories having 20 places for first-class, 20 for second-class, and 40 for third-class passengers. The management necessitates three men, and the maximum speed is 14 miles an hour. They burn naphtha, and the boilers have horizontal tubes. The Northern Railway of France has put on its lines a postal steam automobile, with room for 12 persons in the back part of the coach.

The following trials have recently been made in Europe with the electric automobile:

The Italian Mediterranean Railway has placed automobiles on the line from Milan to Monza. Each carriage has room for 90 passengers, of whom 16 can be seated. It goes at a rate of 27 miles, and is recharged after each 50 miles. The French Northern Railway Company, at the same time when the steam automobile mentioned above was constructed, built an electric automobile weighing 20 tons, having room for 12 people, a speed of 30 miles, and being capable of going 74 miles without recharging. The Belgian State Railway has put in service 5 carriages for tram service without baggage. Each of these has 78 places, weighs 51 tons, and can make from 62 to 93 miles, with stoppages every 3 miles, at a speed of 19 miles an hour.

CALCAREOUS CLAY AGGLOMERATES PREPARED BY M. MEURER.

M. MEURER describes a rational method for obtaining silico-calcareous bricks of good quality. This consists in the following operations:

1. Drying and heating of sand employed.
2. Working up pulverized quicklime with hot sand, (quenching by addition of hot water under pressure) finely divided and in quantity chemically sufficient to obtain hydration.
3. Second addition of hot water, distributed and proportioned in the warm mixture so as to aid the molding.
4. Molding by the press, in the course of which the hygroscopic water disappears completely by evaporation.
5. Hardening of the product obtained by keeping it in steam, saturated or superheated at high pressure.

This invention realizes a scientific and rational manufacture. It is a process which involves no uncertainty, nothing unexpected, and which allows us to obtain industrially at a low price, certain products, at the same time that it allows the employment of a restricted mechanical material.

The two substances employed are sand and lime. Now M. Girard, the well-known chemist, has discovered that crude clay, like sand, undergoes the action of lime in steam under pressure.

Indeed, by acting on a mixture of lime, clay and sand, M. Girard has ascertained that the clay is combined with lime to such a point that it is completely transformed, and on analysis, after treatment, only hydrosilicates of lime, of aluminium and of iron perfectly soluble in chlorhydric acid, are found.—Translated from *La Revue des Produits Chimiques*.

METHOD OF KILLING ANIMALS AT PARIS POUND.

A LETHAL chamber for the destruction of lost dogs has been provided for the Paris pound. Thirty condemned dogs are placed in a cage, which is rolled onto a platform, which, by hydraulic force, sinks about six feet into the earth and is hermetically closed. Carbonic-acid gas is turned on and in the space of forty seconds every dog dies without a struggle. By the old system—the use of common gas—the dogs suffered for sometimes two and three minutes.

In the London pounds, an admixture of carbonic-acid gas and chloroform is used, but it was decided here that as carbonic-acid gas is one of the most powerful anesthetics known, the chloroform was superfluous. The cost of this lethal chamber was almost 10,000 francs (\$1,930).

In the pounds of some of the cities in the United States, electricity is used for the destruction of the dogs. While this causes instant death, only one dog can, as I understand it, be killed at a time.