[International Review.]

THE CONSTITUTION OF THE SUN.

BY PROFESSOR C. A. YOUNG.

Number II.

THE PHOTOSPHERE.

As to the nature of the photosphere, or visible surface of the sun, all the observable phenomena, with hardly an exception, concur in representing it as a sheet of luminous cloud: its peculiar granulated structure, the swift mobility of its constituent filaments, and the remarkable appearances, presented by the spots and faculæ, are all consistent with this idea and readily explained by it. And if, as is most likely, according to what has been said, the main body of the sun is in fact a huge globe of mingled vapors and gases at such a temperature that even the enormous force of solar gravity can only reduce them to a density a little greater than that of water, it is perfectly easy to account for the existence of such a cloud sheet: it is simply a necessary consequence of the cooling of these vapors at the outer surface of the globe, where they come in contact with the cold of space. Under such circumstances condensation must result, for just the same reasons and in the same manner as that which produces the water and snow clouds of our own atmosphere: minute drops or flakes must be formed, not of water and ice indeed, but of the materials which we know to exist upon the sun, and must descend in fiery rain and hail into the central depths to be again reëvaporated. And as the descending matter is continually replaced by fresh supplies from below, there must result a vertical circulation of ascending streams and jets of vapor contesting the supremacy with down-pouring cataracts and sheets of the products of condensation; and in consequence the upper surface of the cloud layer must be in a state of continual and intense disturbance, as observation directly shows.

For it is found that the solar surface, when examined with a powerful telescope, is by no means uniformly bright, but mottled with a peculiar texture which has been very variously described, but may well enough be accounted for by supposing it to be formed of columnar clouds, floating vertically in the atmosphere of vapors out of which they are formed. Here and there the surface is marked by brilliant streaks known as the faculæ, most conspicuous near the edge of the sun's disk, which on account of the absorption of the solar atmosphere is much less brilliant than the center. They are simply photospheric clouds, whose summits rise above the general level of the surface, and sometimes form visible projections on the limb. But the most singular objects, and the most interesting, are the spots, whose origin and phenomena have as yet, we think, failed to receive any completely satisfactory explanation. They are dark blotches of exceedingly irregular form, and consist essentially of two parts, a central "umbra," as it is called, surrounded by a lighter fringe known as the "penumbra." The umbra contains usually one or more rounded spots much darker than the rest, and known as "nuclei;" even the darkest nucleus, however, is dark only by contrast with the intenser light around; for when, by means of a peculiar eyepiece, invented by Mr. Dawes, who first discovered these nuclei, we examine the umbra, excluding all light from the surrounding regions, it is found that even the darkest points are far too bright for the unprotected eye; and by the help of Professor Langley's polarizing eyepiece the color is seen to be a purple tint, closely matching that portion of the spectrum near the fixed line, H.

That the spots are hollows, having a depth varying in different cases from two to ten thousand miles, may be considered as an established fact, admitted now almost without dissent. The spectrum of the umbra of a spot is found to differ from that of the neighboring portions of the solar surface, first, in a general darkening of the whole; second, in a widening and deepening of many of the dark lines, with, on the other hand, a thinning and sometimes even an actual reversal of others; and third, in the presence of certain dark bands, sharply terminated on one edge, but shading gradually on the other. Now all these phenomena are just what might be expected in a cavity filled to a great depth by the nearly transparent gases which elsewhere form a thin layer over the sun's surface.

Spectroscopic observations on the chromosphere also show that around the spot there is an unusual and violent up-rush of hydrogen and other materials from the central depths.

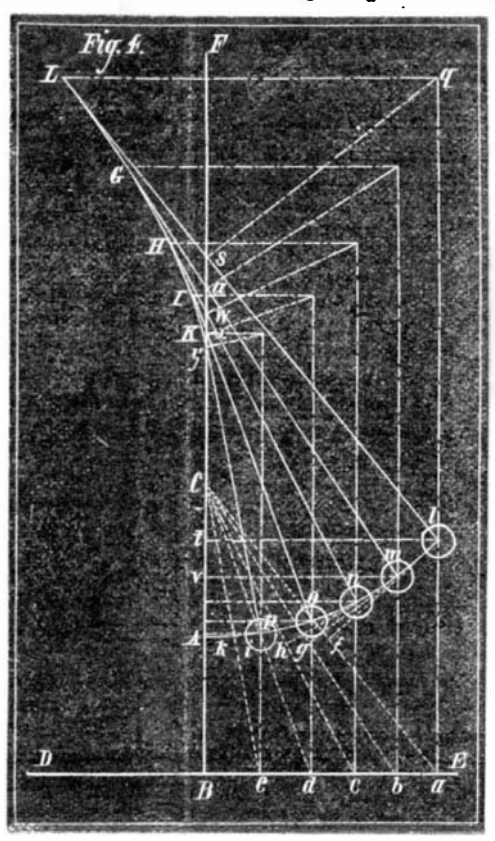
There is a well marked periodicity in the frequency and violence of our magnetic storms and their accompanying auroras, which exactly corresponds to that of the solar spots.

PENDULUM GOVERNORS.

Number II

A governor in which the hight of the balls is always the same, whatever their position, is said to be isochronous. In such a governor, the balls can only maintain the middle position, corresponding to the ordinary load on the engine, when the latter is at its proper speed, any change of speed causing the governor to act upon the regulator in such a manner as to correct the variation at once, if sufficiently powerful. In order to fulfil this condition, the centers of the balls, as they change their positions, must describe arcs of parabolas, as illustrated in Fig. 4, the curve, *t m n o p* A, being a parabola. It will be seen that, as the ball changes its position, so does the point at which the center of the ball rod cuts the center of the spindle, so that the vertical hights from center of ball to these points are always the same. In this form of parabolic governor, the end of the governor rod is made of flexible steel, and is hung to the end of a curved check, L G H I K, which is called the evolute of the parabola. The construction of the parabola and its evolute are shown in Fig. 4. The weight of balls, length of arms, and resistance to be overcome are first ascertained; and from these, the hight of the balls can be calculated when the engine is at speed. Then draw two lines, B F, D E, at right angles to each other.

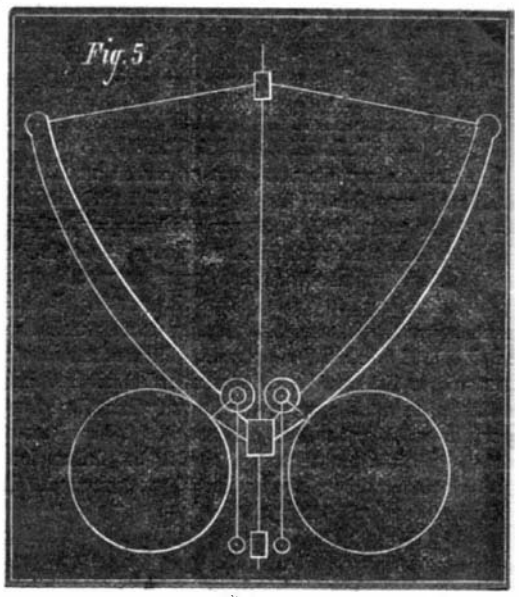
Fig. 4.



Make B C equal to the calculated hights. From C, draw any number of lines, C *e*, C *d*, etc., to D E, and, at each point of intersection, erect a perpendicular to D E. From the middle point, *k*, of C *e*, draw a perpendicular to C *e*; the point, *p*, in which it meets the perpendicular through *e*, is one point of the parabola. Bisect each of the other lines, C *d*, C *e*, etc., by perpendiculars, and the points in which these perpendiculars cut the perpendiculars drawn through *d*, *e*, etc., will be other points of the parabola. From each point so determined, as from *l*, draw a line, as *l s*, parallel to the line drawn through C, to determine the given point. From each point, as *s*, in which this line cuts B F, erect a perpendicular, as *s q*, and from the point in which it cuts the perpendicular, as *a q*, through the given point of the parabola, draw a line, as L *q*, parallel to D E, till it meets the line, as *l s*, first drawn. In this way, points L, G, H, I, K, of the evolute of the parabola, are determined.

Another manner of making the balls move in parabolic

Fig. 5



arcs is shown in Fig. 5, the balls sliding up along parabolic guides, as they change their position.

It has been shown that the weight of the balls does not affect their position, if the governor has no resistance to overcome beyond the weight of its own parts. In practice, however, a governor acts upon the controlling mechanism, and should have its balls proportioned so as to exert the requisite force. The necessary weight is thus calculated: Measure the distance of the point of suspension of each ball from its center. If there is a sliding weight, measure also the distance from its center to each point from which it is suspended. Ascertain the resistance of the controlling mechanism in pounds, and measure the length of the connections by which the governor overcomes this resistance, from their points of suspension to their points of attachment with the controlling mechanism.

1. Multiply each weight or resistance by the length of its connection, and divide by the length of the ball rod; add these quantities together, and divide them by 2.

2. Assume the greatest speed of governor that will occur under variation of load on the engine, subtract the proper speed of governor from this number, and divide by proper speed.

3. Divide the quantity obtained by the first part of the rule by the second quantity. The result will be the weight of the two governor balls.

This rule is somewhat complex, and it may be simplified by applying it to an example.

The ball rods of a governor are each 12 inches in length; there is a weight of 30 pounds connected to the spindle by a lever 9 inches in length; the resistance of the controlling mechanism is 20 pounds, and the rods connecting this mechanism with the governor are each 1½ inches long. The governor is connected with the engine so as to make 300 revolutions per minute when the engine is at speed, and the greatest number of revolutions per minute under variations of speed is to be 350. What is the proper weight for each ball?

1. Multiplying the weight on the spindle of 30 pounds by 9 and dividing by 12, we obtain 22·5 pounds as the equivalent weight, if its connection were of the same length as those of the balls. Similarly, the equivalent resistance of the controlling mechanism is 15 multiplied by 1½ and divided by 12, or 2·5 pounds. The sum of these weights is 25 pounds; and dividing by 2, we obtain 12·5.

2. The difference between the greatest number of revolutions of the governor per minute and the proper number is 50, and this, divided by 300, is 0·167, nearly.

3. Dividing 12·5 by 0·167, we obtain 74·85+ pounds, so that the weight of each ball should be about 37·5 pounds.

It will be evident, from what has preceded, that a pendulum governor which is very sensitive cannot be very powerful, nor one which is very powerful be very sensitive; and that, in order to obtain great power, it will be necessary to use very heavy balls. Our readers have, doubtless, observed that those governors which give the best satisfaction are arranged with a view to sensitiveness, the controlling mechanism being actuated by the application of a very slight force. It is probable that governors of any design will be subject to similar conditions, since a great resistance in general requires considerable force to overcome it.

We have been at great pains to simplify the rules contained in this article, and we think our readers, by applying them to a few examples, will readily understand them. The principles stated are of interest and value to all who are engaged in the construction of governors.

Correspondence.

The Patent Office Tea Set.

To the Editor of the Scientific American:

In answer to your inquiry as to what has been done in reference to the illegal presentation to Commissioner Leggett, I would say that it was stated on good authority that the Assistant Secretary submitted the question to the Attorney General for his opinion, and that it was finally concluded to drop the matter, and do nothing about it.

That it was a plain, open violation of the law is clear, and is admitted by the more honest of those who participated in it. The leading ones—those who headed the subscription and gave the most, some of whom are soon to come before the Senate for confirmation—fearing the effect of their illegal act, now seek to evade it by denying that they gave anything. The ground on which they do this is that, although they subscribed, they did not pay their subscriptions until after the 1st of November, which was some time after the plate was purchased and presented. Possibly, in order to avoid the effect, they may not have paid it yet; but that the present Commissioner headed the list with $50, and the Assistant Commissioner followed with $25, or more, is not denied, and cannot be, truthfully. This, to say the least, is a most cowardly and mean attempt to crawl out and leave blame to fall on the subordinates, nearly all of whom subscribed under compulsion: merely to retain the goodwill of those in authority, or to come in, and thereby to retain their places or secure promotion.

Again, they urge that they did not violate the law, because the subscription, although made early in October, was dated November 1, so as to have it appear that it took place after the Commissioner was out of office. This only makes the matter worse, because it shows on its face a knowledge of the law, and a deliberate attempt to evade its plain provisions.

Again: they urge that it was at best but a technical violation, because, although legally Leggett's resignation did not take effect until the 1st of November, still practically he was already out of office. The trouble with this is that it is not true, for not only did he remain until after the presentation (October 19, I think it was), but the Office records show that he acted as Commissioner and made decisions after that—at least so I am informed and believe. It has also been stated that this matter of the presentation originated with the lady employees. This is not true, and it is all the more unmanly for these parties to seek to shift the responsibility from their own shoulders to those of the women. A certain woman did originate, or at least carry out, the plan of presenting the cane; but the tea set presentation originated with, and was carried out by, the male employees. A certain examiner, who hoped and expected to be made Assistant Commissioner, was the main mover in the matter, and personally circulated the subscription paper.

Not only was the whole proceeding a palpable and wilful violation of the law, but they were so told at the time, by some who refused to subscribe, for that among other reasons. The whole matter, both in the transaction itself and in the neglect to enforce the penalty of the law by the Secretary, is but a fair illustration of the contempt for the law manifested of late by the Patent Office officials. JAMES.

GREAT BRITAIN has formally accepted the invitation of the United States to contribute to the Centennial.

THERE is no mode so effectual to impress ideas on the mind as that of experiment aided by reflection.