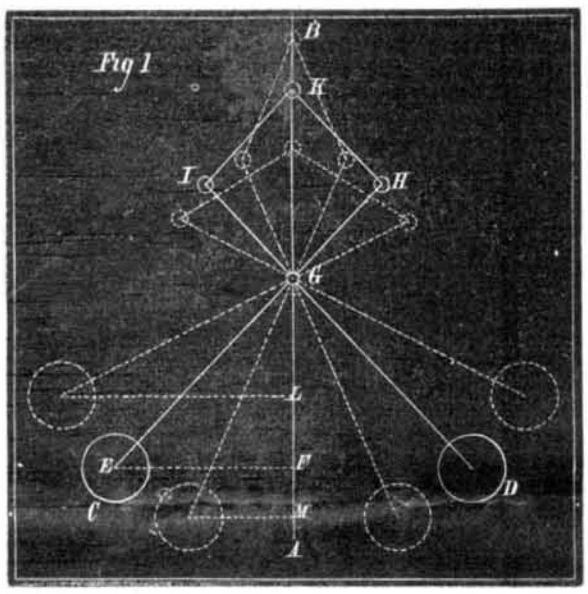
PENDULUM GOVERNORS.

Number I.

The essential features of the ordinary pendulum governor consist of a vertical spindle, which is made to revolve by suitable connections with the machine which it is to regulate: the spindle carrying, on opposite sides, a pair of arms, to which heavy weights are attached, forming revolving pendulums, which vary their positions at different speeds, and so control the machine. Such a governor is represented in Fig. 1, A B being the revolving spindle, C D, the balls attached to the spindle by the rods, E G, D G, forming the pendulums, which, as they assume different positions, act on the collar, K, moving up or down the spindle, being connected to this collar by the rods, G I, I K, G H, H K. A lever, not shown in the engraving, is ordinarily attached to the collar K, and thus operates mechanism which regulates the speed of the prime mover to which the governor is connected. The subject of steam engine governors is treated in nearly every work on the steam engine, and in numerous elementary treatises on natural philosophy, rules being given for proportioning the parts. In general, however, these rules, being founded on theoretical considerations which do not obtain in practice, are of very little value in designing governors. In works where the subject is presented in detail, the reasoning is often too abstruse for the general reader, and we propose, in these articles, to give the principal facts connected with the theory and construction of pendulum governors, in as simple a manner as possible.

A revolving pendulum, such as is shown in Fig. 1, assumes different positions if made to rotate at different speeds; and



supposing that there is no friction in the joints of the rods, and no other resistance to be overcome except the weight of its parts, the position assumed depends entirely upon the number of revolutions in a given time, no matter what may be the weight of the balls. In Fig. 1, the distance, F G, or the vertical hight of the point, G, above the centers of the balls, is commonly called the hight of the pendulum; and a revolving pendulum, under the conditions supposed above, makes just half as many revolutions in a given time as a common pendulum of the same hight makes vibrations. Thus, if the hight, F G, were 3·91 + inches, a common pendulum of the same hight would make about 60 vibrations in a minute, and the revolving pendulum would make 30 revolutions in the same time. In general, the hight of a revolving pendulum, in inches, when overcoming no resistance but that of its own weight, is equal to 35,208 divided by the square of number of revolutions per minute. If, for instance, the number of revolutions per minute is 100, the hight will be 35,208 divided by 10,000, or about 3½ inches.

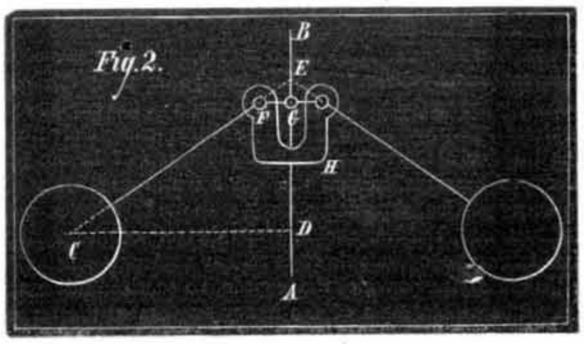
Strictly speaking, the hight of a pendulum revolving without resistance is slightly altered by the weight and centrifugal force of the connecting arms; but as governors are usually constructed, the weight of these parts is so small, in comparison with the weight of the balls, that the correction is unimportant in practice.

Below are given the hights, calculated by the foregoing rule, for different speeds:

Revolutions per minute.	Hight in inches.	Revolutions per minute.	Hight in inches.
10	352·08	275	0·4646
20	88·02	300	0·3912
30	39·12	350	0·2873
40	22·01	400	0·2201
50	14·08	450	0·1739
60	9·78	500	0·1408
70	7·184	550	0·1164
80	5·501	600	0·0978
90	4·347	650	0·08333
100	3·521	700	0·07184
125	2·253	750	0·06259
150	1·564	800	0·05501
175	1·150	850	0·04873
200	0·8802	900	0·04347
225	0·6955	950	0·03901
250	0·5633	1000	0·03521

A simple inspection of this table will suffice to show that the conditions under which these hights were calculated, do not occur in practice. For instance, it is not unusual to run a governor at a speed of 250 revolutions a minute; but our readers must have observed that in such a case the vertical distance from centers of balls to point of suspension is always more than $\frac{6}{10}$ of an inch, which is about the hight given by the table. The reason for this, and the proper correction for the hight, will be found in another part of this paper.

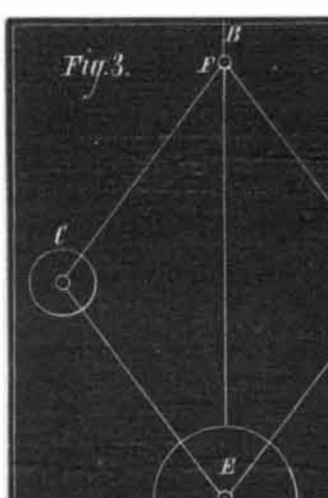
Referring again to Fig. 1, suppose that the full lines represent the position of the balls when the engine is running at the proper speed under the usual work, the lower dotted lines, the position at which the greatest opening of the regulator is effected, and the upper dotted lines, the position corresponding to the greatest slowing effect. These positions of the balls correspond to different speeds of the governor spindle, and consequently to fluctuations of speed in the engine,



which gives motion to the spindle. Suppose, for instance, that some work is suddenly removed from the engine; it will commence to run faster, and must increase its speed considerably before the governor can effect the regulation, since the required position of the balls corresponds to an increased speed. A sudden increase of work put upon the engine produces a contrary effect, the engine being slowed down considerably below its proper speed before the necessary regulation can be made. All that such a governor can do, then, under great variations of load in the engine, is to keep checking and increasing the speed, which will continually vary in inverse proportion to the load. This difficulty is partially obviated, in many forms of governor, by arranging the controlling mechanism so that a slight change in the position of the balls will produce a consierable movement of the regulator. The general idea is shown in Fig. 2, where the ball arms are not jointed to the center of the spindle, and are connected to the regulating collar, K, by direct levers, which are very short in comparison with the length of the arms. In estimating the hight of the balls of such a governor, it is to be measured from E, where the center lines of the ball arms produced cut the center of the spindle.

An inspection of the table of hights will show that, where a governor is run at a high number of revolutions, considerable variation in the speed only affects the hight in a slight degree. Hence, in addition to a direct and effective connection, it is generally a good plan to give the governor a high speed.

A steam engine governor, when connected with the regulator, encounters some resistance in changing its position, and this resistance keeps the balls at a greater hight than that given in the table. For the purpose of obtaining a considerably greater hight of balls, when running at a high rate of speed, many governors have weights or springs attached to them. The most prominent governors of this form are: Porter's, in which a heavy weight revolving on the spindle is attached to the balls by rods, and Pickering's, in which the balls are attached to the spindle by stiff springs; but our readers must have noticed weights on many ordinary governors, connected with the spindles by levers. The general principle of all these arrangements is represented in Fig. 3,



which is an illustration of the simplest form of Porter governor. The weight, E, is connected to the governor balls by rods, E C, E D, of the same length as the ball rods, C F, D F. In such an arrangement, if there is no other resistance than that of the weight of the parts, the hight of the balls corresponding to any speed of governor, can be found as follows:

Add twice the weight on the spindle to the weight of both balls, and divide that sum by the weight of both balls; multiply the quantity so obtained by the number in the preceding table.

For example, suppose that the weight of the two balls is 100 pounds, and the weight on the spindle is 500 pounds, the hight corresponding to any given speed is 11 times the hight in the table. It is evident from this that such a governor is much more sensitive than one in which no resistance is encountered, since the position of the balls changes much more rapidly with a given variation of speed.

Electrical Countries.

Certain interesting phenomena have recently been noticed by the Hayden Expedition in the mountains of Colorado, showing the high electrical state of the elevated position known as Station 9, Uncompahgre Peak, during the passage of a storm. Although the indications of the change in the weather could be seen at a distance, the electricity at the point of observation did not become plentiful until a characteristic buzzing was heard. Painful sensations followed, and at the back of the head and at the elbows a sharp pricking, like that of needles or a sharp knife, was felt. By this time the party came to the conclusion that they were standing on dangerous ground. Those standing on the very summit of the peak and along the sharp ridges leading from it experienced the severest shocks. After beating a hasty retreat, and remaining on the sides of the mountain to continue observations, it was noticed that after each discharge or flash of lightning a short rest ensued until a sufficient quantity of electricity had again accumulated. Those nearest the point struck would feel a heavy shock pass through them. These same phenomena were noticed during three days of continuous storms. At many places the rocks were glazed where the electric current had passed. The formation of tubes in sand from the same cause is well known.

A French meteorologist, M. Fournet, has suggested that it would be an interesting question for Science to determine whether certain countries or regions are in a higher electrical condition than others, and whether meteorological reactions do not result from the unequal distribution of the electricity. Similar phenomena to those detailed above have been noted upon the elevated plateaus of Mexico, and nearly a century ago Volney recorded remarkable noises occurring during thunderstorms in the neighborhood of Philadelphia. In South America, at Popayan, province of Granada, Boussingault says that thunder is heard every day and electrical phenomena are common. The extreme dryness of the Andine table lands also favors similar effects, and it is said that in the Chilian desert involuntary erection of the hair upon animals, as well as the appearance of sparks leaping from clouds to soil, is common. Dr. Livingstone notes that during the spring, a period of great dryness, the African deserts are traversed by a warm north wind so highly charged with electricity that the plumes of the ostrich stand upright, and that sparks are produced by the mere attrition of the garments.

In India, at certain localities, telegraphic wires are maintained with great trouble. It is stated that during storms of exceeding violence the conductors become charged almost to melting. Professor Loomis has observed abundant electricity in the atmosphere about New York city, especially during winter. We have repeatedly remarked the high electrical condition of the hair on cold nights, and also that the mere act of walking on a soft carpet in a heated room will cause a crackling sound under the foot.

From all the various examples which have been collected of this curious condition, it would appear that the abundant presence of electricity is not due necessarily to heat of the season, since in this country it is never more strongly manifested than after a cold northwest wind; nor are indications in any other region more clear than in the dry and icy air of Siberia. It would appear that reservoirs of electricity exist in the most widely separated parts of the globe. If it be admitted in accordance with the opinions of Fournet, Maury, and Admiral Fitzroy, that the ordinary winds are in relation with these great electrical sources, further and more extended observations upon them would be in the interest of meteorological progress. If, for example, the electricity of each great atmospheric current, tropical or polar, is regularly positive or negative, it may be, as Fitzroy suggests, believed that the changes of weather which supervene, at the moment when one electrical current succeeds the other, have on a small scale a certain analogy to the changing of the trade winds. Fournet remarks upon a natural relation of these phenomena with the meteorites produced during storms. These views are, however, mainly conjectural, so that there remains a large field for definite research.

Reform Needed at the Patent Office.

Unless there is an early and decided change in the practice of the Patent Office in its treatment of inventors, the institution will lose its character for usefulness. The annual report shows the enormous number of 7,500 applications for patents rejected last year, while probably as many more were delayed and their claims emasculated. We hope that the rejected applicants will all write to their members of Congress in complaint, and ask for official enquiry. The press is beginning to take the matter up. *The Technologist* says: "Commissioner Thacher will most promote the welfare of the Patent Office, and the rights of inventors, by putting his foot firmly down upon this uncalled-for practice of standing in the light of inventors, instead of giving to their applications the full, fair, and impartial consideration to which, in law, justice, and equity, they are entitled."

Blood Coloring Matter Free From Iron.

MM. Paquelin and Jolly announce that they have obtained the hematic pigment in a state of perfect purity and free from iron. Hematosine, as it is termed, burns without ash, similar to resinous substances. It is insoluble in pure water, and dissolves in small proportion in ammoniacal water, to which it gives a light yellow tinge. It is altered by potash and caustic soda solutions, to which it gives a brown color, and is lightly soluble in alcohol. The solvents of hematosine are ether, chloroform, benzine, and bisulphide of carbon. With these bodies the weak solution is amber-colored; when concentrated, red.