Scientific Museum.

Demonstration of the Rotation of the Earth.

BY PROF. HORSFORD.

In the great experiment of Foucault, the motion of the pendulum at the pole is not difficult to conceive. The plane in which oscillation takes place, not revolving with the earth in its motion from east to west, the pendulum will, at each returning sweep, approach an observer from a new point; or in other words, the plane of oscillation will revolve, and in twenty-four hours will have accomplished a revolution around the earth's axis.

The motion of the pendulum at the equator is easily presented. By the law of inertia, the absolute direction of the plane of oscillation will be, throughout the revolution of the earth, that in which the motion of the pendulum commenced. If it coincide with the equator, at the outset, it will continue to do so. If it it be at right angles to the equator, the same rule will apply. Any given direction will be maintained till the pendulum comes to rest. The plane of oscillation will not revolve around its own vertical.

The motion of the pendulum at a point between the pole and the equator, is less easily explained.

It is influenced by so many varying conditions that a strictly true mechanical conception of it may be impossible. As yet, the more gifted mathematicians have not attempted to present it in a detailed form suited to the general comprehension. While we wait for the patient and more thorough investigation, it may not be unwise to avail ourselves of such illustrations as may be approximately correct, and possibly prepare for more profound and accurate views when they shall be offered.

With these considerations the following is submitted:

The accompanying diagram represents the earth. A K is the axis; G H its equator, and D E L the meridian of latitude of Boston. B D G and B E H are two meridians of longitude 15 degrees apart, and D A and E A are tangents to these meridians, at the points D and E.

A pendulum at the pole making its first oscillation in the meridian B E H, at the end of an hour would vibrate in the meridian B D G. The plane of oscillation would in this time have swept over 15 degrees—the 24th part of 360 degrees; an angle equal to D C E, which measures the inclination of the two meridians to each other.

A pendulum at D, in the latitude of Boston, for example, oscillating in the meridian G D B, at the end of an hour would have moved with the earth in its revolution to E; but preserving the original direction of its oscillation, in would not vibrate in the meridian H E B but in the direction E F, parallel to D A.

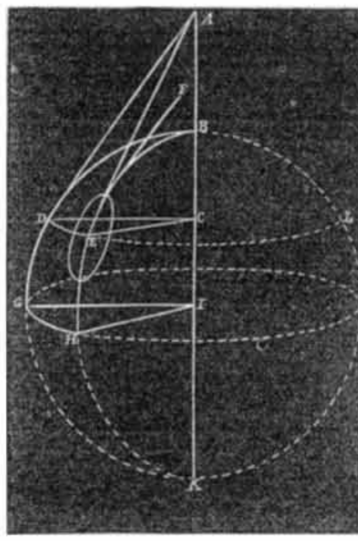
Strictly speaking this direction at the second meridian is not absolutely the initial direction. The straight lines may nevertheless be regarded as giving the sensibly correct path of the pendulum.

This direction makes with the tangent of the meridian the angle A E F—the portion of 360 degrees through which the plane of oscillation revolves in the latitude of Boston in one hour. 360 degrees, divided by this angle, will give the number of hours required for a complete revolution. If the angle be less than 15 degrees, the revolution of the plane of oscillation will require *more* than 24 hours.

Now although not strictly true, the three lines A E, A D and F E, may be regarded as lying in the same plane and the angle D A E as being therefore equal to its alternate angle A E F. But the angle D A E is less than the angle D C E, but because of the triangles D A E and D C E having the same base, D A E has the greater altitude. A E F being equal to D A E, A E F is less than D C E. But D C E is fifteen degrees, the inclination of the two meridians to each other. 360 divided by this quantity, which is less than 15, will give a quotient greater than 24.

The lower the latitude, that is, the nearer the line D E is to the equator, the less will be the angle D A E and of course the angle A E F, and the greater will be the quotient arising from the division of 360 by this angle. At the equator where the tangents to the meridian no longer converge but are parallel, the angle will be reduced to zero, and the quotient become infinity.

The path of the pendulum in latitudes between the pole and the equator may be thus illustrated:



Upon a globe a foot or more in diameter having upon it the hour parallels, small circular discs having a straight dark line through the centre (gum-tickets such as are used for price-marking by merchants, answer the purpose well) may be attached in the following manner:

In the latitude of Boston, for example, attach the first ticket with the straight line north and south. This line will represent the sensible path of a pendulum made to vibrate north and south in this latitude. Place the second ticket upon the next meridian eastward, the line upon it being parallel to that on the first ticket. This line will represent the sensible path of the pendulum at the end of the first hour's vibration. The third ticket is to be placed on the third meridian, its line being parallel to that on the second, and so on around the globe, the straight line on each succeeding ticket being parallel to that on its predecessor. The straight lines will give the path of the pendulum as it passes each succeeding meridian.

It will be observed on attaching the 24th ticket, that the line which represents the path of the pendulum at the commencement of the 24th hour of its vibration, is not parallel to that on the first ticket. The line will not have completed a revolution around its centre. Now with a pencil continue the parallel lines across the tickets already attached, each succeeding line being, as before, parallel to its predecessor, and it will be found that about twelve of the tickets, an hou. apart, will have been crossed before a north and south line will be drawn. In other words, it will appear that about 36 hours are required in this latitude for the plane of oscillation to complete a revolution about its own axis.

A large orange and wafers crossed by a straight pencil mark, may be substituted for the globe and gum-tickets, and the general illustration very well given.

[We have received a great number of communications on this subject, the majority of them against the correctness of the pendulum experiment. These, we must say, exhibit more skepticism than experimental knowledge. We have received a few able articles not denying the veracity of the pendulum experiment, but cautioning against too hasty conclusions respecting its complete and perfect demonstration of the question. One of these from A. M., Matteawan, N. Y., exhibits a very extensive acquaintance with science, and gives the details of a number of experiments made with a pendulum 11 feet, long which was made to carry a fine pencil on its lower point, so as to trace, in an easy manner, its lines of vibration on a sheet of paper. These tracings we have now before us, and they are beautiful elipsis, increasing from nearly a straight line described by the two first vibrations. He says we must beware of hasty conclusions, "as slight causes produce great deviations."

We have received a communication on the subject from Mr. John Wise, the celebrated hero of a hundred balloon ascensions. He does not controvert Foucault's deductions but counsels, like the other, caution in respect to hasty conclusions, which may be attributable to other causes than the earth's rotation. In his ascension he noticed that all bodies which he dropped gyrated, and the balloon itself partook of the same motion. In his aerial voyage, June 1841, he observed a peculiar motion in the balloon, which on a former occasion had attracted some attention. This was a pulsatory movement of the balloon while it revolved on its vertical axis. He thinks the pendulum not decisive in itself of the earth's rotation.

There is a mechanical drawback in the way of the perfect action of the pendulum, viz., the extreme difficulty of causing it to vibrate truly in one plane, so as to prevent it moving in a narrow elipse. When it moves in an elipse, the arc is considerable, as the direction of the major axis is continually changing. This is described in Herschel's Astronomy. The sources of error are numerous and not easily guarded against. To every person who has not fully examined the subject, the question at once presents itself to the mind "how can it be possible that the earth's rotation can be shown by the disc placed in the floor of a house, by a pendulum suspended above it in the roof, when the point of suspension, the floor, and the whole house revolve with the earth." This is true, but here is an experiment—it is a fact, and how is the rotation movement of the disc to be accounted for. Only for the pendulum this would not be noticed. The pendulum is the finger of the philosopher, "behold our planet wheeling on its axis." In commencing to reason on the subject, we must say, "the pendulum moves continually in the same plane, in the arc of its first vibration." If friction is left out of the question, this is supposable. If we suppose our earth to be represented by a huge ball with a horizontal spindle passing through it, and revolving in bearings, we can easily perceive, that a pendulum erected on a standard at its middle could not point out its rotary motion on a disc placed on the surface of the ball below it; but if we place the spindle of the globe vertically and put up the pendulum on its standard at the upper end, and set it vibrating over the axis of the ball, we can see at once that a disc of paper marked E. W. N. S. would show the pendulum to be describing lines N. S. E. W. during the revolution of the ball. This then, is the pendulum experiment. It is therefore clear that at the equator, the pendulum experiment cannot demonstrate the earth's rotation, and it is equally clear that at all the intermediate points between the equator and the pole, according to the latitude of the place, the pendulum experiment will exhibit more or less clearly the earth's rotation, in other words, it will take longer and longer time to show the earth's revolution, as we approach to the equator, where no revolution is exhibited.

The arrangements made for going through a series of experiments by Prof. Horsford, in the Bunker Hill Monument, are the most complete of any yet got up either in Europe or our own country. The result of these we have no doubt, will be presented through our columns, and the character and qualifications of him who superintends them, will make them a future standard of reference to all philosophers.

We perceive by our foreign exchanges, that a gentleman at Dundee, Scotland, who has tried the pendulum experiment, states that it does not show the rotation of the earth, but that it tends to the magnetic meridian. He states, also, that a scientific friend has come to a similar conclusion.

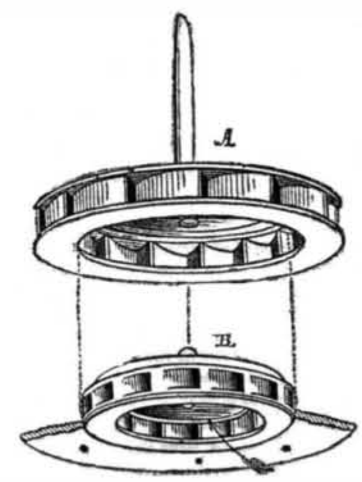
Capt. Judkins, of the steamship Asia, addressed a letter to the Liverpool Times, stating that a report had been circulated about his betting on the passage of his ship Asia which he pronounces to be without foundation.

For the Scientific American.
Hydraulics.

(Continued from page 296.)

The accompanying engraving represents a wheel which has been published in the "American Miller," under the name of Henry Vandewater's Patent. Thinking that it must have some extraordinary merit to entitle it to a patent, as it has been somewhat loudly applauded, we searched for the claim and have found it to be as follows:—

FIG. 53.



"To Henry Vandewater, Philadelphia, Pa. Patented Sept. 19, 1848. (Page 1,051 Patent Office Rep., 1848; Claim 5,785).—What I claim as my invention is the entire shape, construction, and operation of the gate, with the method of moving it and regulating the supply of water by the lever, *d*." Fig. 53 is a perspective view of the wheel as it has been set before the public. A represents the buckets; B the inside of the case,—but what in this wheel enables it to go by a new name, is not easily explained. We suppose there are many wheels in our country named after this or that man who has a patent on some part connected with the wheel, but not on the wheel itself. It is not fair to blind-fold the public in respect to inventions of any kind. Here is a common re-action wheel named after an inventor who made an improvement on the *gate*.