THE ROTATION OF THE EARTH.

Every schoolboy nowadays is taught something of the physical nature of the earth on which we live, and any one who should venture to say that the earth does not revolve on its axis, but remains stationary while the heavens revolve around it, would be treated as a Rip Van Winkle, and even children would smile at his ignorance. But if he should ask for proof of his error, what percentage of the general public could supply it? In this matter the great majority of mankind walk by faith and not by sight, for the rotation of the earth is not obvious to the eye. Indeed, what is obvious to the eye is rather in favour of our hypothetical Didymus, for each day we see the sun rising in the East in the morning, passing across the heavens and setting in the West in the evening, while the stars in the same way appear to revolve round our earth. It is true that this phenomenon, when intelligently considered, is seen to be compatible with a theory of rotation of the earth on its own axis, but it does not give a conclusive proof, and for this we must seek elsewhere. Some might be satisfied that this theory is correct on the ground of its greater probability and rationality, as, while the other and older hypothesis, if correct, would involve the conception of tremendous velocities of travel of the sun, and still more of the stars, in their orbits round the earth, the modern hypothesis only demands a peripheral velocity at the earth's equator of a little more than 500 yards per second. Still, is there any means, we are led to ask, by which the rotation of the earth can be made manifest to the eye?

We owe to a French physicist, M. Leon Foucault, a very beautiful and simple experiment which proves conclusively the truth of the theory of the earth's rotation. This experiment has been recently repeated by French astronomers and physicists in the Pantheon at Paris, the scene of Foucault's classical demonstration fifty years ago.

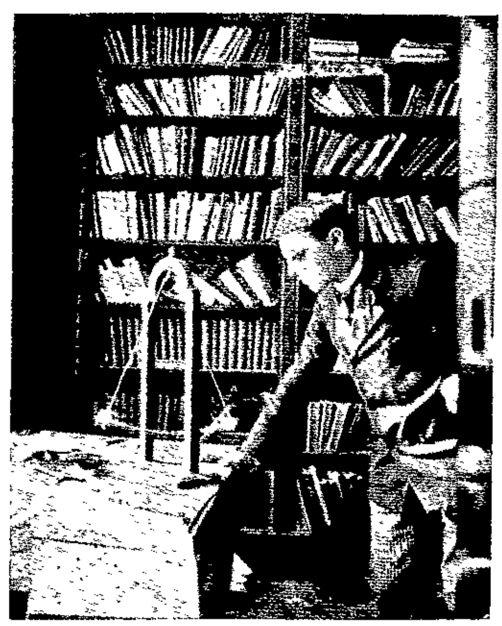
The apparatus for the experiment may be readily obtained by all, as it consists of nothing more than a simple pendulum. Let a small pendulum—a lead ball hung by a fine steel wire—be suspended from the summit of a wooden frame similar to that seen in the photograph, and place the frame upon a smooth table. Now set the pendulum swinging in any fixed direction, and while it is swinging, give to the frame-work a slow movement of rotation round a vertical axis. What happens? It will be seen that the pendulum does not follow the motion of the frame, as might be expected, but continues to swing in its original plane of vibration, or in a plane parallel to it if the point of suspension has been moved relatively to the table while the frame was being rotated. If the frame is turned through a considerable angle from the position it occupies in the photograph, the pendulum will still remain swinging in one fixed direction, namely, towards the window opposite the observer.

Foucault started with this little experiment in order to illustrate the fundamental principle that the plane of oscillation of a simple pendulum remains constant in direction and then by a slight modification of the experiment he applied this principle to test whether the earth is in rotation or not. Draw a line on the table above which the pendulum has been suspended, and let this line pass directly under the point of suspension of the pendulum. Set the pendulum to swing in a vertical plane containing this line, so that the bob of the pendulum, when it begins to swing, passes backwards and forwards along this line and close to it. Now if the earth does not rotate, but remains fixed in space, this line on the table must remain fixed in direction, and as we have seen that the direction of oscillation of the pendulum also remains fixed, we should expect to find that the pendulum would never deviate from this line which it followed at the outset. On the other hand, if the earth does rotate, then the direction of a line such as that we have drawn is constantly changing in space. So far as surrounding objects on the earth are concerned, no change of direction is evident, for these are all subject to the same movement; but if the line was drawn originally to point to a particular fixed star, in a short time it will no longer point to that star but to another part of the heavens. Assuming then that this relative motion is due to the rotation of the earth on its own axis, we see that the line is actually changing its direction from moment to moment. But the pendulum does not change its direction and there should therefore be an apparent deviation of its line of oscillation from the line on the table which it originally followed. We should expect to find after a time that, instead of following the line on the table, the pendulum would swing in a direction crossing that line at an angle.

Under the two hypotheses, then, we must expect quite different results in this experiment. What actually happens? Foucault showed that the pendulum gradually deviates from the original line, and that if instead of one line we place on the table a large chart marked like a compass card, with its centre directly under the point of suspension of the pendulum, the direction of oscillation of the pendulum will appear to change gradually from one line to the next till it has completely "boxed the compass" and has returned to its original line. The actual time taken for a complete circuit depends upon the position of the place of observation upon the earth's surface. If the experiment were made exactly over the North or South Pole, the period of revolution would be exactly twenty-four hours, and the pendulum, passing through an angle of 15° each hour, might be used as a clock; but in latitudes such as those of London and Paris, the period is increased by the fact that the vertical at these places after a time ceases to coincide with the central position of the swinging pendulum, but makes an angle with it. At Paris, where Foucault made his experiments, the period of revolution is about thirty-two hours. At the Equator, if we swing the pendulum in the Equatorial plane, then the rotation of the earth does not alter the direction of this plane, and therefore the pendulum should not show any deviation, as observed in higher latitudes. This has been tested by experiment at Quito, only a quarter of a degree from the Equator, and the pendulum showed no deviation. Thus we have clear and striking proof that the earth does rotate, a proof that appeals to the eye and is not difficult to understand.

Foucault's original pendulum was only 6½ ft. long, and with this he conclusively proved his case. But for the purposes of better demonstration he began to look out for opportunities of using long pendulums, as he thereby could obtain very slow and steady oscillations. At the Paris Observatory he was able to repeat his experiment with a pendulum 11 metres long (13 yards approximately), but finally in 1857 he was invited by Napoleon III. to make use of the dome of the Pantheon. Here he gave his classical demonstration with a pendulum having a bob weighing 28 kilogrammes suspended by a thin steel wire 67 metres long. In the recent repetition of this experiment under the auspices of the Astronomical Society of France, the weight and length of the pendulum used were the same as those of Foucault's pendulum, and the conditions of the experiment were made to resemble those of 1857 as much as possible. The table was marked with lines to show angular deviation, and was used some time ago at the Pantheon. The period of a pendulum of this length is over 16 seconds for the complete double swing, and with this slow movement it was possible to observe the deviation even between two consecutive oscillations. By sprinkling sand on the table at a distance of 4 metres from the centre, and providing the bob of the pendulum with a spike at the bottom, the observers could measure the progress of the pendulum per minute or per hour along the circumference of this circle, and the actual measurements were found to agree very closely with the theoretical values.

The simplicity of Foucault's experiment should be an inducement to many to try it for themselves, and teachers may provide a most instructive lesson for their pupils by having an apparatus constructed suitable for class-room use. The little frame with short pendulum to demonstrate the fundamental principle, a longer pendulum consisting of a lead ball of 2 or 3 lbs. weight suspended by thin steel piano wire, say 6 ft. in length, or more if there is room, from a suitable suspending device, and a graduated dial to place under the bob for the better observation of the deviation—these are the only essentials. Recently a young French engineer, M. Cannevel, has furnished a complete outfit for the experiment in a small cabinet measuring 8 in. x 6 in. x 2½ in.



FOUCAULT'S PENDULUM FOR DETERMINING THE ROTATION OF THE EARTH.

Business Notes.

Keith, Hutcheson & Wilson (James Stephen Keith, John Hutcheson, and Thomas Wilson) ship chandlers, riggers and sailmakers, Wellington, have dissolved partnership, J. S. Keith retiring.

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Edward Anderson & Co. Ltd. (private company) have been registered with a capital of £25,000, in 5000 shares of £5 each. Objects: To acquire and carry on the business of china and glassware merchants. Subscribers, with number of shares each:—Edward Anderson, 4,980 shares fully paid up; Elizabeth Anna Anderson, 20. Registered office, Wellington.

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J. A. Nash & Co. Ltd. (private company) have been registered with a capital of £8,950, in 1790 shares of £5 each. Objects: To acquire the business of J. A. Nash & Co., of Wellington, and Manawatu Hardware Co., at Palmerston North. Subscribers, with number of shares each:—James Alfred Nash, 704; Henty Stratford Porteous, 142; John Samuel Watchorn, 472; Leonard Sutton, 472.

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Taranaki Oil and Freehold Co. Ltd. have been registered with a nominal capital of £15,000 in £1 shares. Subscribers for five shares each:—William Thomas Jennings, M.H.R., Francis Peacock Corkill, George William Browne, Michael Jones, William Thomas Gardner, James Hawkins, and Thomas Kingwell Skinner. Registered office, Devon street, New Plymouth; secretary, John Spencer Selwyn Medley.

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Ellis Motor Co. Ltd. have been registered with a capital of £4,000, in 4000 shares of £1 each. Objects: To acquire from Peter Ellis, of Wellington, engineer, the rights of a rotary engine invented by him. Subscribers, with number of shares each:—Samuel Bolton, 100; A. H. Pringle, 100; Herbert P. Rawson, 50; G. Hutchinson, 25; John Highet, 50; Graham S. Pringle, 50; W. P. Pringle, 50; and others. Registered office, Wellington.

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Robertson & Co. Ltd. (private company) have been registered with a capital of £15,000 in 15000 shares of £1 each. Objects: To take over the engineering business of Robertson & Co., Phœnix Foundry, Wellington. Subscribers, with number of shares each:—David Robertson, 14,992; James Alex. Robertson, 1; Hannah Robertson, 1; Jane Virtue, 1; Helen Newson, 1; Marjory Bannatyne, 1; Thomas Young, 2; William D. Robertson, 1; Registered office, Wellington.

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Taranaki Petroleum Co. Ltd. have been registered with a capital of £120,000, in £1 shares. Objects: To acquire from the liquidator the business, assets, etc., of "The Moturoa Petroleum Co., Ltd." for 56,000 ordinary shares credited as fully paid up. Subscribers for five shares each:—Daniel Berry, Murdoch Fraser, George Charles Fair, John Walter Wilson, William Humphries, Michael James Jones, and John Rollo. Registered office, Egmont street, New Plymouth; secretary, David Laing.

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New Zealand Automatic Gate Co. Ltd. have been registered with a capital of £4,500, divided into 4,500 shares of £1 each, of which 1500 are considered fully paid up. Objects: To purchase from S. S. Hartley a New Zealand patent for "improvements in and relating to farm gates." Subscribers, with number of shares each:—Charles B. Pharazyn, 100; James B. Campbell, 50; H. Harcourt, 50; George F. M'Lean, 50; Peter H. Miller, 50; S. S. Hartley, 50; W. E. Hughes, 25; Registered office, Wellington.

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