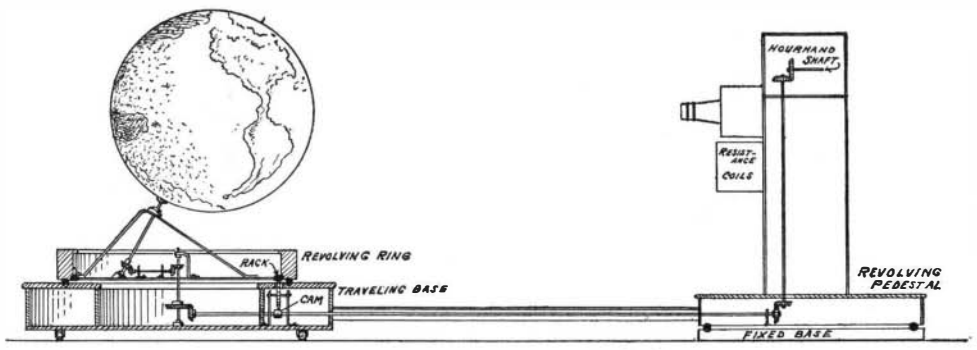
A HUGE PLANETARIUM.

BY GEORGE SHERWOOD HODGINS.

A wonderful object lesson on the movements of the earth may be had by any visitor at the American Museum of Natural History in New York. The relations of the earth and sun are represented by a model erected under the supervision of Dr. H. C. Bumpus, director of the museum. The mechanical details have been very carefully worked out by Mr. H. F. Beers, an expert mechanician on the museum staff. The globe representing the earth is about four feet in diameter, made of paper, and turning on its axis once in 24 hours. The sun is represented by an electrically lighted stereopticon lamp of 3,000 candle-power, which throws a divergent beam of white light upon the side of the globe turned toward it. The lamp is placed on a revolving stand in the center of the hall, and the 92,700,000 miles which separate earth and sun are here reduced to a distance of about 14 feet.

The light, hollow paper sphere, showing land and sea, is carried on a steel shaft supported by an iron frame, which rests upon a revolving wooden ring. This ring, turning on a ball race, rests on a traveling base, mounted on castors which roll upon the floor. The motive power for the miniature world is a Howard steeple clock, such as is used in churches. The clock is inclosed in a glass case, the pendulum swinging in a cabinet below. The cabinet stands on a circular wooden pedestal, and like the revolving wooden ring below the globe, the pedestal rotates on a ball race. The clock cabinet also carries the stereopticon lamp, so that lamp and clock rotate together on the fixed base. The work done by the clock is probably less than that which would be required in moving the eight hands of a tower clock. The minute-hand shaft is not used, and this clock steadily turns only the shaft usually employed to drive the hour hands. As the globe is required to revolve but once in 24 hours, a pair of gear wheels is interposed so that the hour-hand shaft moves as it would for a clock having 24 hours shown on the dial.



Section through the planetarium.

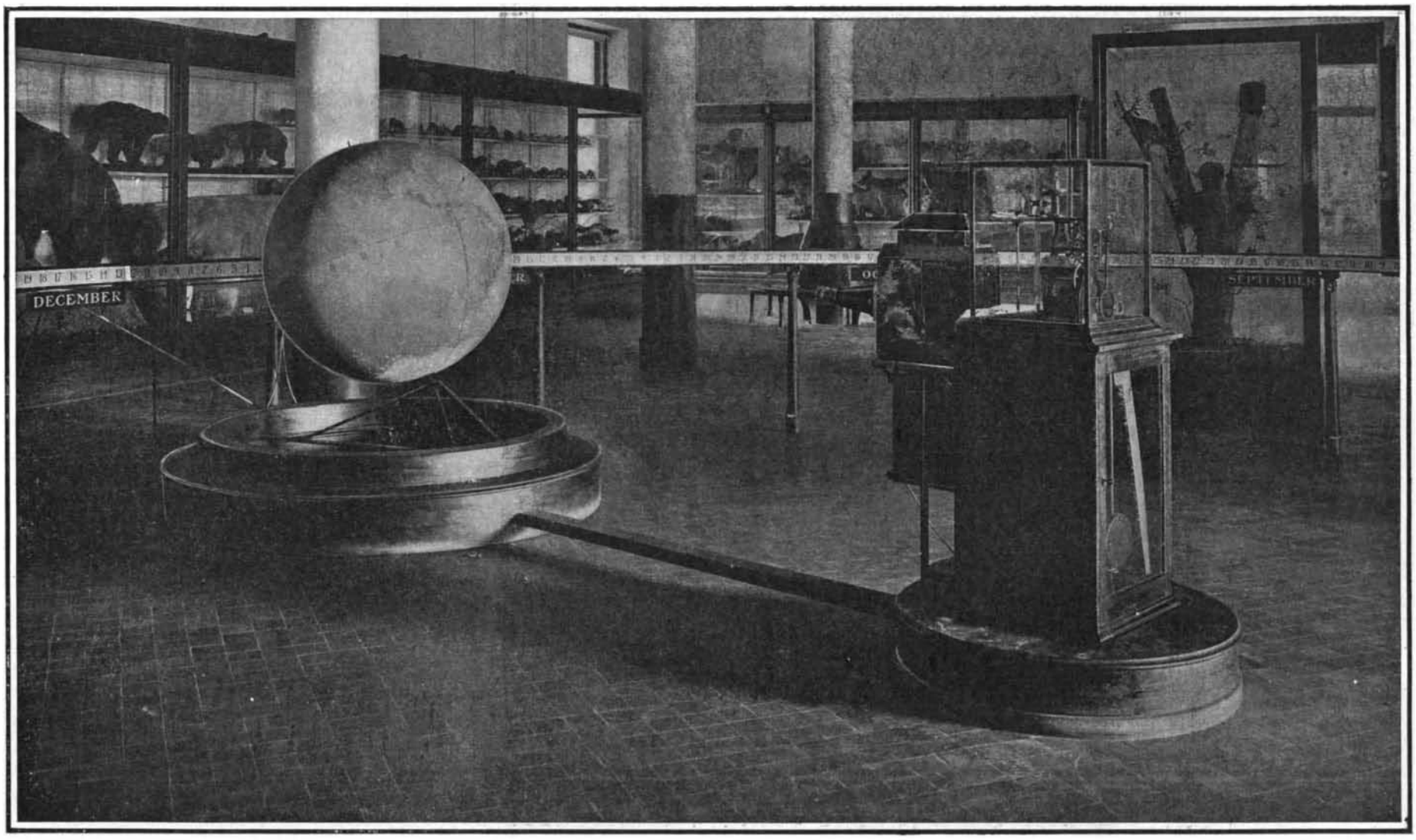
No dial is used, however, and the slowly driven hour-hand shaft terminates in a 45 deg. bevel gear, just behind the lamp. This bevel wheel meshes with a similar gear on the upper end of a vertical shaft, which shaft therefore turns in unison with the hour-hand shaft of the clock. At the bottom of the vertical shaft, a pair of 45 deg. bevel gears transmit similar motion to a long horizontal shaft, laid in the hollow of a 4-inch channel iron, which connects the revolving pedestal of the clock with the traveling base below the globe. In the center of the traveling base a third pair of 45-deg. bevel gears give the motion of the horizontal shaft to a short upright shaft, and a fourth pair of 45-deg. bevel gears at the top of the upright shaft transfer the motion to a short horizontal shaft. All these shafts are carried on bicycle ball bearings. The connection between the short horizontal shaft and the axis of the globe is made by a pair of specially cut bevel gears, so that while the axis of the globe receives its motion from the clock, through the intermediate shafts and gears, the specially cut bevel wheels preserve an angle of 23 deg. 27 min. from the vertical, for the axis of the globe. The complementary angle 66 deg. 33 min. at which the axis of our earth is inclined to the ecliptic, or plane of its orbit about the sun, is thus maintained. The axis of the globe is placed, like that of the earth, so that it points toward the pole-star in the heavens. The globe is therefore made to turn upon its axis once in 24 hours, and with the same axial tilt as that of our planet, and with its poles directed as are those of Mother Earth.

The divergent beam of light from the lamp bathes one-half of the globe in bright light, while the other is enveloped in the comparative gloom of the hall. Thus the recurrence of day and night is made plain to the beholder. The equator of the globe is divided into twenty-four spaces with fractional divisions for half and quarter hours, and the shadow from a wire in front of the lens of the lamp draws a meridianal line upon the globe. This shows the advance of "high noon" in the center of the illuminated surface, as the globe turns continuously from west to east, as does the earth. During the time the earth is making one complete revolution on its axis, it is swinging on in its vast journey around the sun. The rate of this motion has been calculated by astronomers as about 18 miles a second.

If the earth did not revolve around the sun, one complete axial revolution would be made in 23 hours and 56 minutes. In other words, the meridian passing through New York would be back again under the central beam of light from the sun in 4 minutes short of 24 hours, and the corresponding meridian on the globe would coincide with the shadow line from the lens, in just that time. The earth, however, has in one day been carried forward more than a million miles in its path around the sun, and the meridian of New York is therefore behind the central beam from the sun by about 4,320 miles, and 4 minutes more are required to bring this meridian under the central beam, indicated by the shadow line, and so completes one revolution which we call day and night. The period of 24 hours is called the solar day, while the shorter period is the sidereal day.

The constantly north-pointing direction of the earth's axis is also represented and maintained by the globe through a cleverly devised arrangement. On the underside of the revolving wooden ring below the globe, a circular rack is fastened, and a suitably proportioned spur wheel gears with the rack. On the long horizontal shaft in the channel iron, there is fixed a cam or dog, which revolves with the long shaft. The cam has one tooth, which engages with the spur wheel at every revolution of the long shaft. The contact of cam and spur wheel gearing with the rack, moves the wooden ring, which supports the globe, the distance necessary to preserve the position of the axis of the globe always pointing north.

The requisite movement of the traveling base is made each day by the museum attendants. The advance of the base represents the orbital motion of the earth in one day. On the model this amounts to 3 inches. All round the planetarium there is a protecting handrail. On the inner face of the handrail a series of divisions is marked off, each corresponding to a day. The whole circle of the handrail approximately indicates the earth's path around the sun. The top of the handrail is divided into 360 spaces representing the degrees of a circle. If there were only 360 days in the year, the divisions for days and degrees would correspond. There are 365 days in the year and 360 deg. in a circle. The divisions representing the days are each smaller than the space occupied by a degree. This slight discrepancy between each of them increases as the circle of the handrail is followed round. At the end of the year the accumulated difference is practically equal to a quarter of a division representing a day, and thus the spectator has ocular demonstration of what leap year means, by the adding of one day to every fourth year.



THE GREAT PLANETARIUM OF THE AMERICAN MUSEUM OF NATURAL HISTORY.