

**THE MAGIC SPHERE—AN ILLUSION APPARATUS IN WHICH CURIOUS OPTICAL EFFECTS ARE PRODUCED BY CENTRIFUGAL FORCE.**

BY DR. ALFRED GRADENWITZ.

The paradox that we actually see things right-side up, although our eyes are constructed to see them upside down, has never been satisfactorily explained. Anatomical reasons are sometimes given. It is suggested that the optic nerves, which transmit the visual impression to the brain, cross each other, and that the inverted image of the retina will therefore be seen vertically. It seems that in all these explanations the theorist confuses the *subjective* visual impression and the merely *objective* optical phenomenon, viz., the production of an image on the retina.

That upright vision is quite independent of the position of the image on the retina, may be inferred from the fact that on inclining the head, we still see objects in their proper positions, although the positions of the images on the retina are changed. The question naturally arises: By what standard, conscious or unconscious, does the eye judge in gaging the upright position of things independently of the position of the head? Is there perhaps some organ which acts like a carpenter's plumb-line or spirit-level and indicates the direction of a given line?

Sir Hiram Maxim has given some thought to this problem. His views were seriously influenced by a chance observation. One day, when he was tired from a long railway journey, he noticed, on looking at an incandescent lamp, and then closing his eyes, that a distinct image of the filament still remained, which is a well-known optical phenomenon. After turning his head to the right about 45 deg. still

looking steadily at the lamp for about half a minute, he closed his eyes and placed his head in a vertical position. He then found that the image of the filament was inclined 45 deg. in the other direction. He now turned his head to the left, and again looked steadily at the lamp. On closing his eyes and placing his head in a vertical position, he distinctly saw two images of the filament crossing each other at about 90 deg. (Fig. 1.) This proved to his mind that the position of the head and the angle of the image on the retina had nothing whatever to do with seeing things right-side up. Not only this, but it showed at the same time that we judge the position of objects on the retina by comparing them with some organ which is a part of the mechanism of seeing, and which is controlled by the attraction of gravitation, as are the instruments used by the carpenter and builder above referred to.

The next experiment was to ascertain if this organ could be influenced by any force other than gravitation. If we place a spirit-level on the edge of a

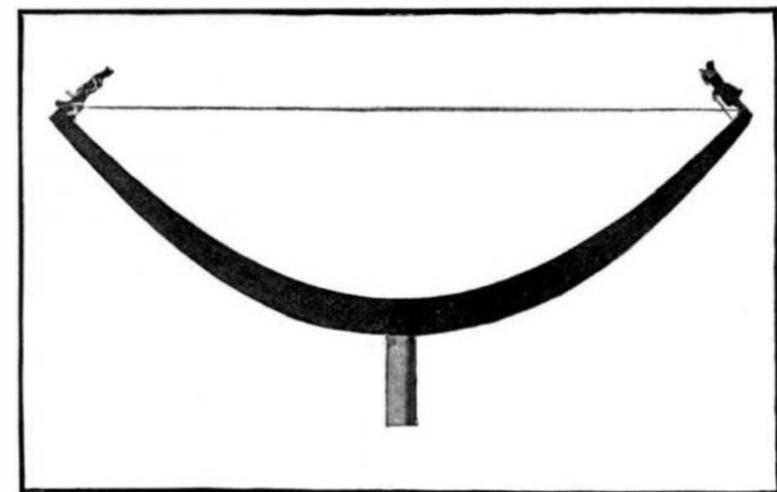


Fig. 3.—Section of a parabolic floor. To the woman the only level part of the floor is apparently the spot on which she is standing. To her the man on the other side appears to be projecting horizontally from a vertical surface. The man cherishes the same illusion about the woman.

slowly revolving table, the liquid is thrown outward and the air bubble inward; if we hang a plumb-line to a rotating arm, it will be thrown outward by centrifugal force to an extent governed by the speed of rotation. The line will never be vertical except when the arm is stationary. Are the organs of sight similarly influenced by centrifugal force? Actual experiments have demonstrated that they are. It was found that if a person were placed in a receptacle, which was

caused to travel in a large circle until the centrifugal force was just equal to the force of gravity, objects really vertical appeared to be tilted to one side, thus establishing a new standard line which the organs of sight use for comparing all objects seen. (Fig. 2.)

Suppose that we have a large circular room, 30 feet in diameter; suppose that we spin this room on a vertical axis fourteen times each minute. If a man should stand at the extreme outer edge of the room, he would be pulled outward with a force exactly equal to the force of gravity. If the floor on which he stands is dead level, it will appear to him to be tilted upward 45 deg. and that he is standing on the lowest edge; if he stands on a platform which is really tilted 45 deg. above the horizontal, it will appear to him dead level, while the rest of the floor, which in reality is level, will be tilted upward. Under these conditions the pressure of his feet against the platform will be increased 40 per cent.

It is evident under these conditions that it is only at the extreme edge of the floor that the maximum effect is produced. Centrifugal force diminishes as one moves toward the center.

Fig. 3 shows the approximate shape of the floor that must be used in order that the centrifugal force and gravity may balance each other, no matter on what

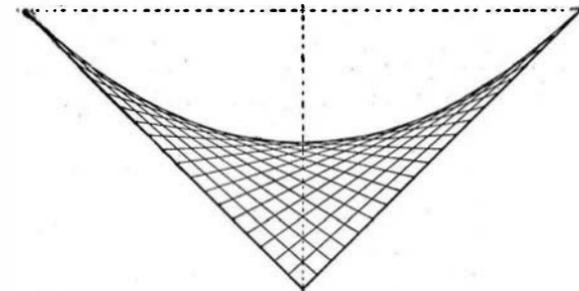


Fig. 4.—In order that every part of the rotating floor should appear dead level to those standing on it, it must be so curved that the centrifugal force and the force of gravity will exactly balance each other. This drawing shows the exact shape of the floor and the manner of describing the correct parabolic curve.

part of the floor one stands. Its shape is a parabola. If two people stand on opposite sides of this parabolic floor, it will appear to each that the floor immediately under his feet is dead level and all the rest of the floor tilted upward, while the person standing on the opposite side appears to be walking on a vertical surface. Fig. 4 shows the exact shape of a parabolic floor 30 feet in diameter and making fourteen turns a minute. It will be observed that the extreme outer edge is 45 deg. above the horizontal.

If a person is placed on a rotating platform inside of a stationary room, he will become dizzy; and conversely, if a man is placed on a stationary platform and the room revolved about him, he will become dizzy in exactly the same degree. Look in a revolving mirror, and you will become dizzy. Hence, our rotating parabolic floor must be mounted in a room that rotates with it. No dizziness will then result. The most convenient way to do this is to place the rotating parabolic floor inside of a large rotating sphere, which may be entered through the center at the bottom. In order to give the sphere an attractive appearance, the outside is mapped off and painted like a large terrestrial globe.

Our front-page illustration shows a vertical central section of the sphere with the pedestal on which it is mounted and the driving gear. The entrance and the stairways may be either covered over or provided with a rail, which is not shown in the drawing.

Some very curious and interesting phenomena will be manifest with this apparatus. While in rotation, the floor immediately under your feet will always appear level. Walk from one side to the other, and the whole apparatus will seem to tilt over exactly as if it were floating in water, and as if you were infinitely heavy and everyone else infinitely light. You can walk with perfect freedom in a circumferential direction, but if you walk quickly in a diametrical direction, you will be apparently pushed to one side. You will find it most difficult to walk in a straight line except very slowly. A cyclist riding in the direction of revolution adds his own centrifugal force to that of the apparatus. He is able, therefore, to ride off this parabolic floor and upon the inner walls of the sphere. To those standing on the extreme edge of the parabolic floor, he is seen riding up the walls of the room across the ceiling and down on the other side. If mirrors are placed above the floor, the whole interior of the sphere seems filled with people, feet pointing outward and heads inward. It is believed that this system is well

adapted for a skating-rink. Mounted on roller skates, you could perform some most extraordinary feats with very little effort. It is said that no roller skates can ever be made in which the coefficient of friction is so small as it is with the ice skate; but with this system, by increasing and diminishing the speed periodically, say four times a minute, the friction would disappear altogether, the motive power doing all the work and the skater nothing. In a skating-rink the floor would of course be larger and flatter, and the rotation much slower.

[Interesting as the principle upon which the Magic Sphere is conceived undoubtedly is, we may be permitted to disagree with portions of the author's explanation. Above all, we question the existence of any gravitational sense-organ. A man placed at the outer edge of a rotating table and subjected to a centrifugal force which just balances the force of gravitation would, in moving toward

the center of the table, incline his body forward, so that the force of gravity would be permitted to gain the ascendancy. He does this in response to the mechanical requirements of his position. In that inclined position he would not experience much difficulty in walking despite the author's contention. Furthermore, objects would appear tilted because he is himself tilted, because he refers the position of other objects to himself, and not because of any hypothetical gravitational sense. We believe that the author has failed to take cognizance of this involuntary inclination of the body when subjected to the action of centrifugal force in explaining the paradoxes of the Magic Sphere. Similar phenomena are observed on ordinary railway trains traveling on curves at high speed, when the outer rail is appreciably elevated above the inner rail. Because we assume that the car is vertical, houses, trees, and telegraph posts seem askew as we whirl around the curve. We form part of the train, we refer the external objects to ourselves, and hence we see them inclined. We are always subject to the action of gravitation and we always compare external objects with the vertical line that passes from our heads through our bodies.—Ed.]

An invention which will be of inestimable value to the blind has been effected by Mr. W. G. McLaren, of Edinburgh, whereby the ordinary, laborious, and expensive process of punching the Braille letters is superseded. He has also perfected a process of printing the embossed Braille letters on aluminium sheets instead of paper. The sheets are far easier to read than the best paper books, especially by those who have become blind late in life, or whose fingers are not very sensitive. They are also practically inde-



Fig. 5.—This picture shows how the rotating parabolic floor will appear to an observer standing on its outer edge. The cyclists are apparently riding on a vertical surface.

structible. The thickness of the sheets is 0.004 inch, and a book of twenty royal quarto pages can be produced for \$1.25 per copy. By means of the McLaren printing process, a ten-page paper in Braille type can be sold for two cents per copy. Hitherto the production of books and papers for the blind has been so prohibitive as to be beyond the reach of all except the privileged few.

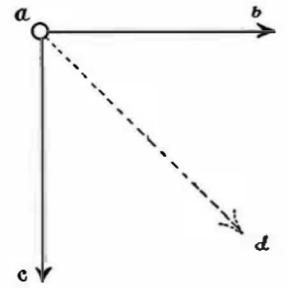


Fig. 2.—Suppose a man weighing 100 pounds, standing at the point a. Gravitation will pull him toward c with a force of 100 pounds. Suppose that this man is also subjected to a centrifugal force of 100 pounds which tends to pull him toward b. He will as a result move in the direction a d with a force of about 141 pounds. To him the dotted line will appear vertical.

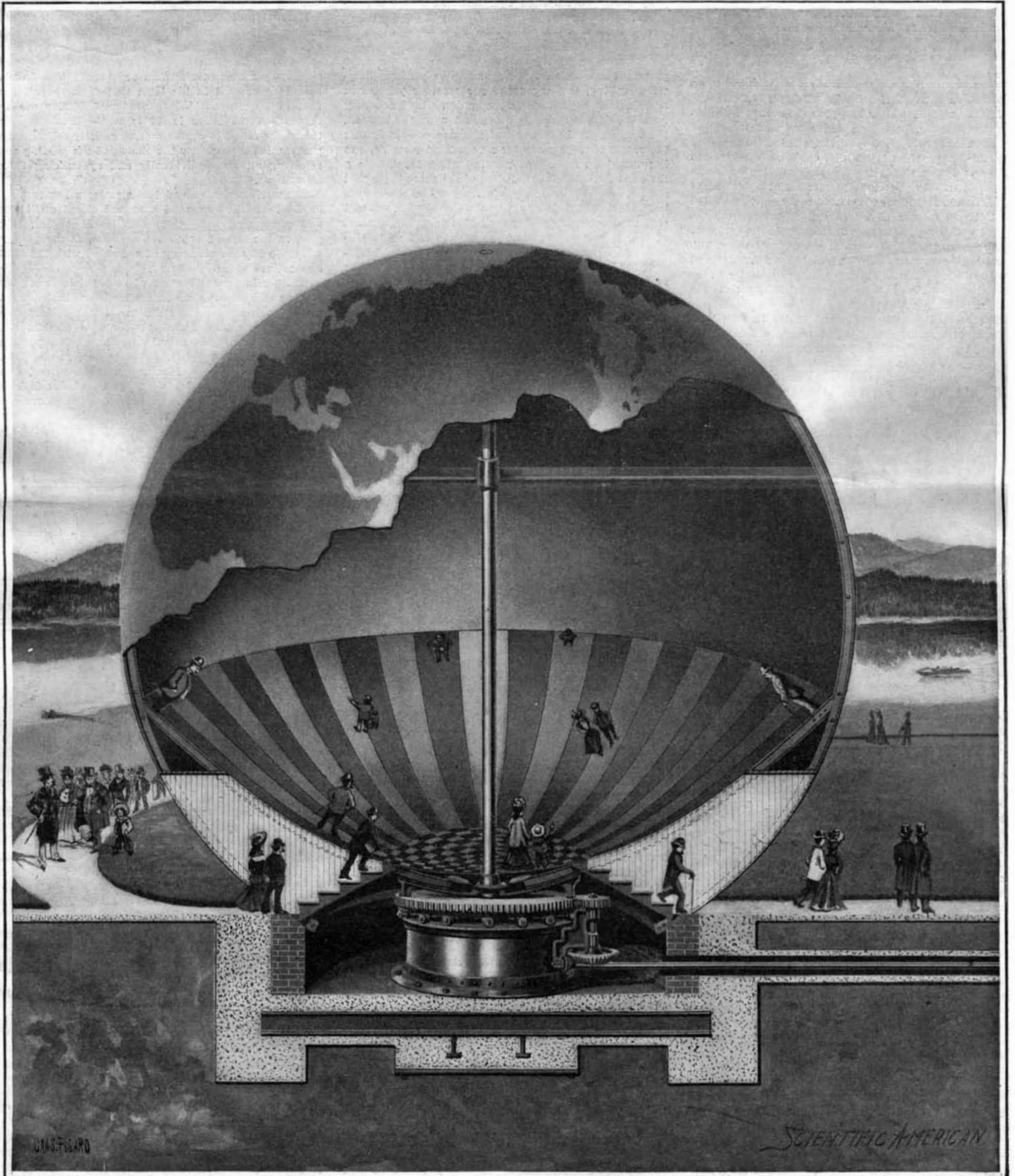
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A Parabolic Floor is Rotated at Such a Speed that the Centrifugal Force About Equals the Attraction of Gravitation. As a Result a Man Standing on the Outer Edge Will Imagine that He Alone is on a Dead Level and that the Persons on the Opposite Side Are Walking on a Vertical Surface. If he Moves Across, It Will Seem to Him as if the Entire Apparatus Were Rolling Over With Him Like a Ball Floating on Water. He will Seem Infinitely Heavy; Everybody Else Infinitely Light. Circumferential Walking is Easy; Diametrical Walking Difficult.

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