

## THE USE OF THE GYROSCOPE IN THE BALANCING AND STEERING OF AEROPLANES.\*

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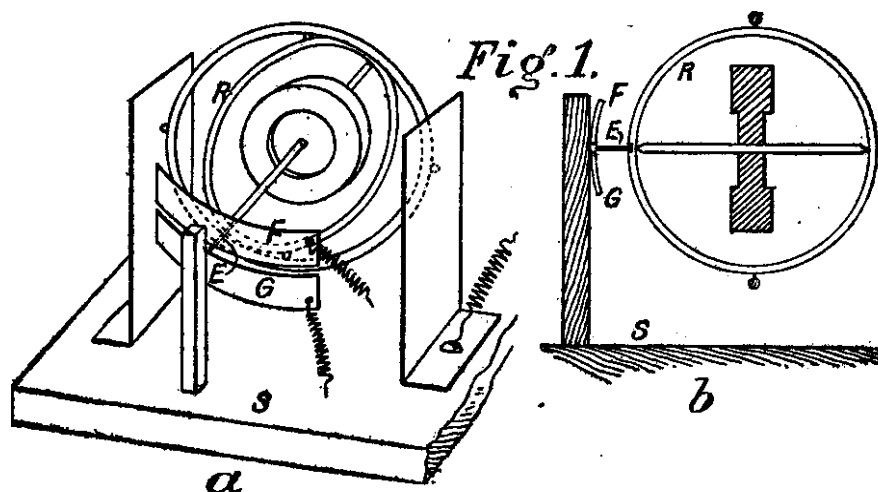
An important point in aerial navigation that has not received much attention is the balancing of aeroplanes. The importance is obvious when one considers that the successful flier will undoubtedly embody the aeroplane principle; and that balancing must be automatic, if the apparatus is to be perfectly safe.

Balancing is, of course, automatic in the case of the bird; and the method employed by the bird may possibly be imitated. The organs by which equilibrium is maintained are known as the semi-circular canals. They are small, hair-like tubes, filled with fluid, in the bone of the skull, lying in three planes at right angles, each tube controlling, through delicate nerve-ends, the movements of the bird in its respective plane. Although it is not possible to reproduce artificially these complex structures, use can be made of a device which operates practically in the same way.

Everyone knows that a spinning top tends, with considerable force, to spin in one plane. This suggests a method of preventing an airship, with two equal wings as supporting planes, from turning in any direction, by using three gyroscopes at right angles to each other.

To illustrate how the governing action may take place, suppose Fig. 1a represents one of these gyroscopes. It is run continuously by electro-magnets (not shown) and is

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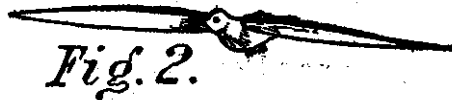


supported by gimbals so that it always maintains a horizontal position, no matter how the surface  $S$ , is tilted. The surface,  $S$ , ordinarily is fixed to the airship so that it is inclined in the same direction and to the same extent as the airship. To this surface is secured an upright post, supporting two copper strips,  $F$  and  $G$ , of the form shown in the figure. Suppose further, that we solder a fine wire,  $E$ , to the ring,  $R$ , which holds the gyroscope, and have the length of wire such that it can just graze  $F$  or  $G$ . Fig. 1b, showing a section of the gyroscope through its axis, will make this clearer. Normally, the state of affairs is that shown in Fig. 1b. The airship is not inclined; therefore  $S$  is horizontal, and the tip of the fine wire mentioned above lies in the narrow space between  $F$  and  $G$ , touching neither strip. If, however, the airship tilts to one side,  $S$  no longer remains horizontal, although the gyroscope remains so. Thus  $F$  and  $G$  have a motion either up or down, relative to the gyroscope axis, and hence relative to the fine wire. Under these conditions, this fine wire touches  $F$  or  $G$ , and we may suppose that, by so doing, it establishes electrical contact through magnets

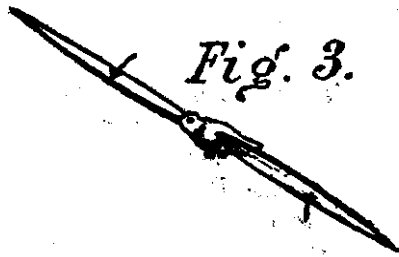
which tilt the forward edge of one wing in such a manner as to restore the airship to its original, horizontal, plane. All three gyroscopes are mounted upon *S*, which may be tilted by hand, if desired, in any direction.

It remains to show how this controlling apparatus may be applied. The device almost universally adopted for steering has hitherto been some sort of rudder; but from observations on the common chimney swift—a bird that seldom makes use of a tail—the writer has come to the conclusion that the successful flier, at high speeds, will require no rudder whatever. To indicate why this is probably so, let us suppose an unexpected current of air tends to overturn the swift. He simply moves the forward edge of one wing upward, and the forward edge of the other slightly downward. Fig. 2 shows the normal flight; Fig. 3, the turning movement. Thus he transforms his whole body into a sort of screw propeller. Remembering that his velocity is great, we can see that, by this action, he brings to bear an almost irresistible force tending to turn him back to his horizontal position.

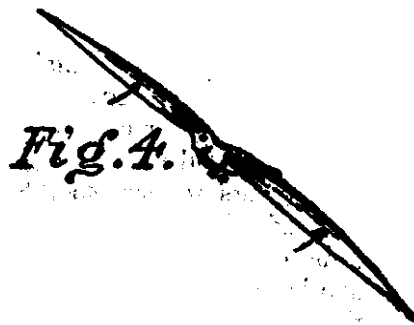
Suppose, again, that the swift wishes to change the direction of his flight. He must first tilt his body at an angle, such



*Fig. 2.*



*Fig. 3.*



*Fig. 4.*

that the wing on the side he wishes to turn, points downward; then the forward edge of this wing is tilted upward until the forward edges of both wings are tilted at the same angle. Reference to Fig. 4 will make this clearer. In this position the bird describes a curved path (in Fig. 4 the center of curvature of this path lies to the right of the figure) and travels in a straight path again only when the reverse of the whole operation is performed. Thus it may be seen how the swift has perfect control of the angle his body makes with the horizontal.

With the apparatus previously described, steering becomes a simple matter. Ordinarily the surface, *S*, moves with the airship, but in steering, it is inclined for a short time, by hand, in the required direction. As a result, the whole aeroplane is tilted. A curved path is then described, just as in the case of the swift's flight, until the aeroplane is turned back to its original position by a reverse operation. Thus it seems very probable that, for reasonable speeds, aeroplanes may be balanced automatically, and hence operated with comparative safety.