Aug. 20, 1935. W. A. REICHEL ET AL 2,011,775

COMPASS COMPENSATOR

Filed Nov. 7, 1934

Fig. 1

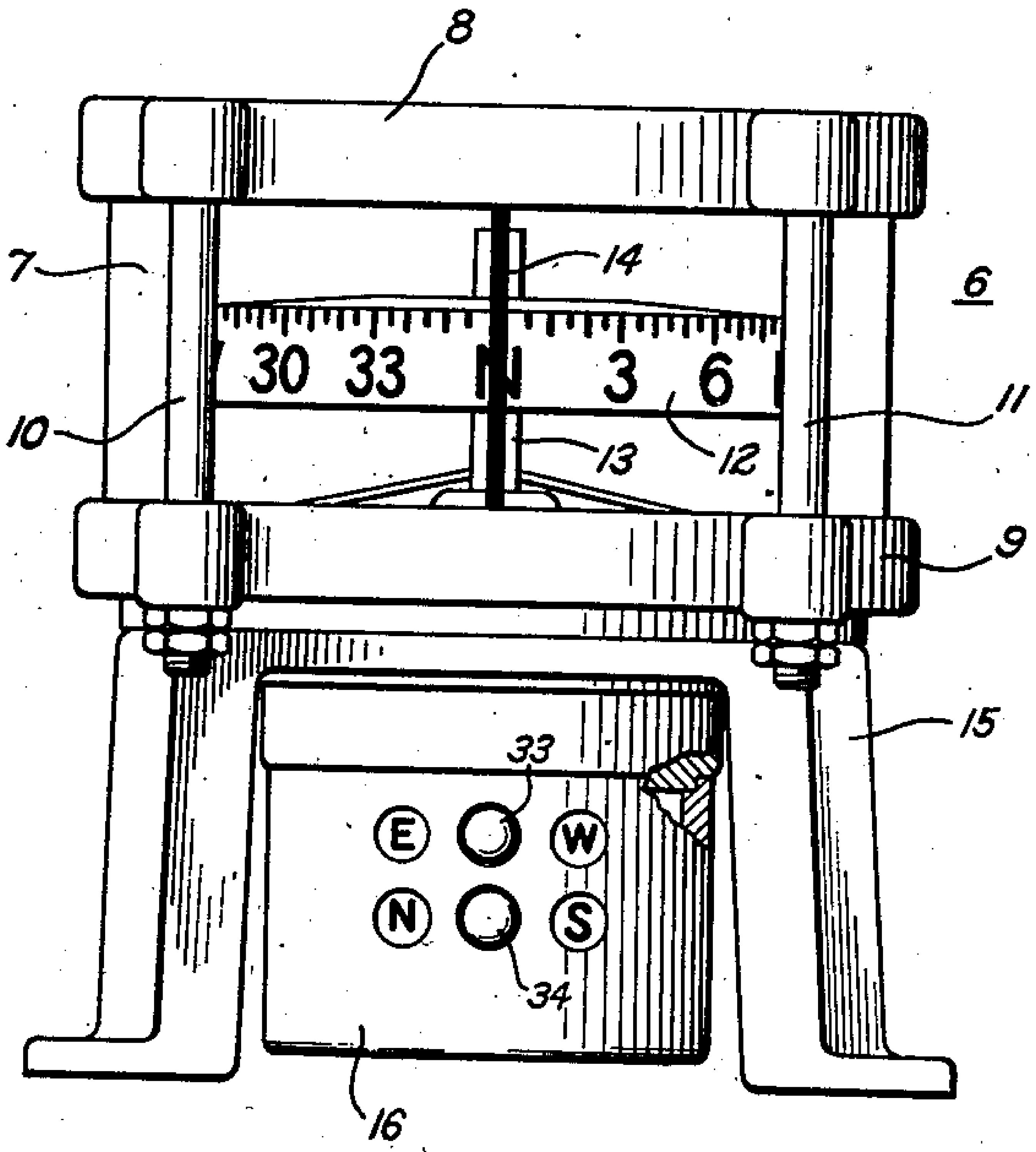


Fig. 4

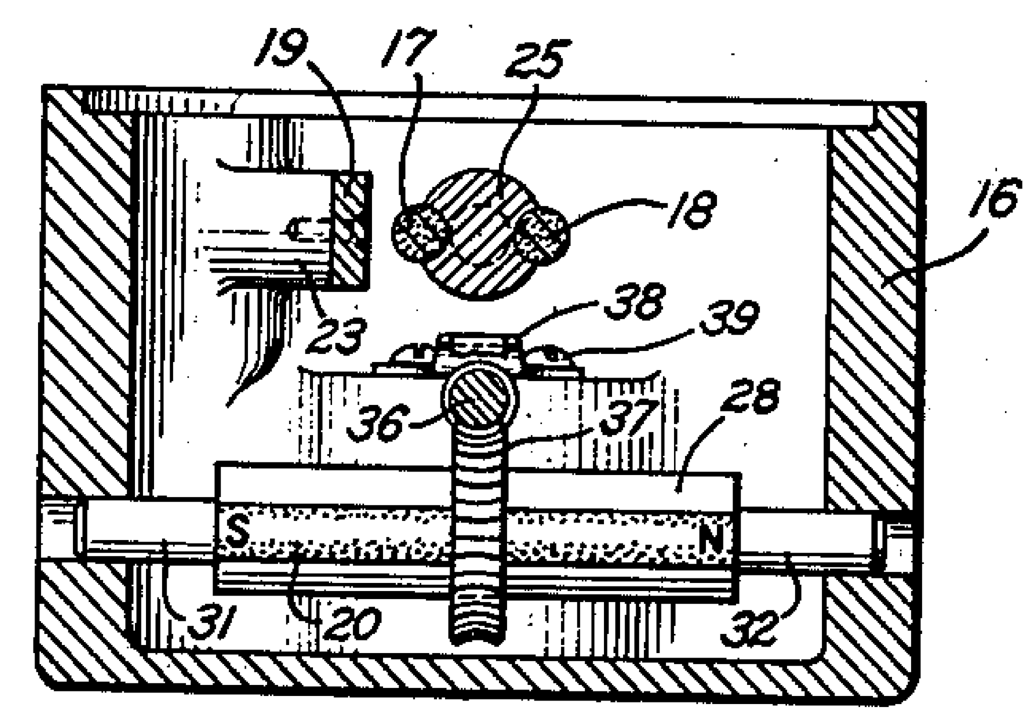


Fig. 3

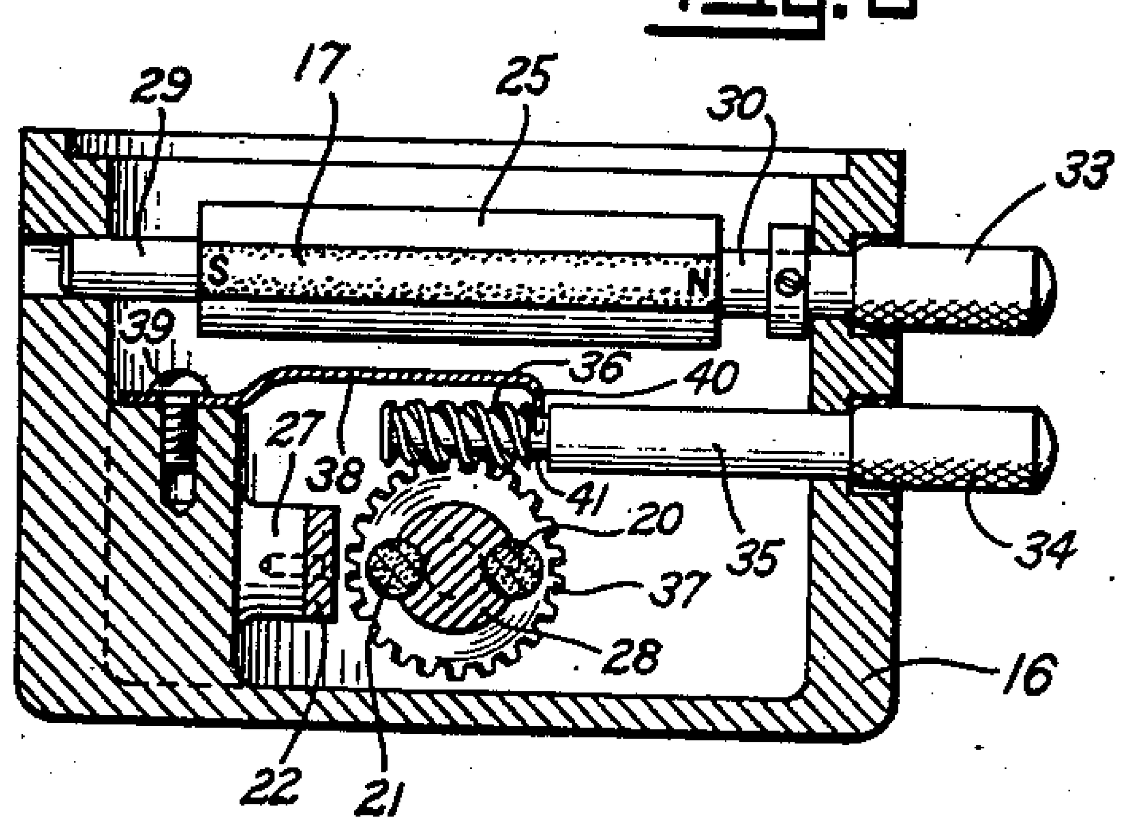


Fig. 2

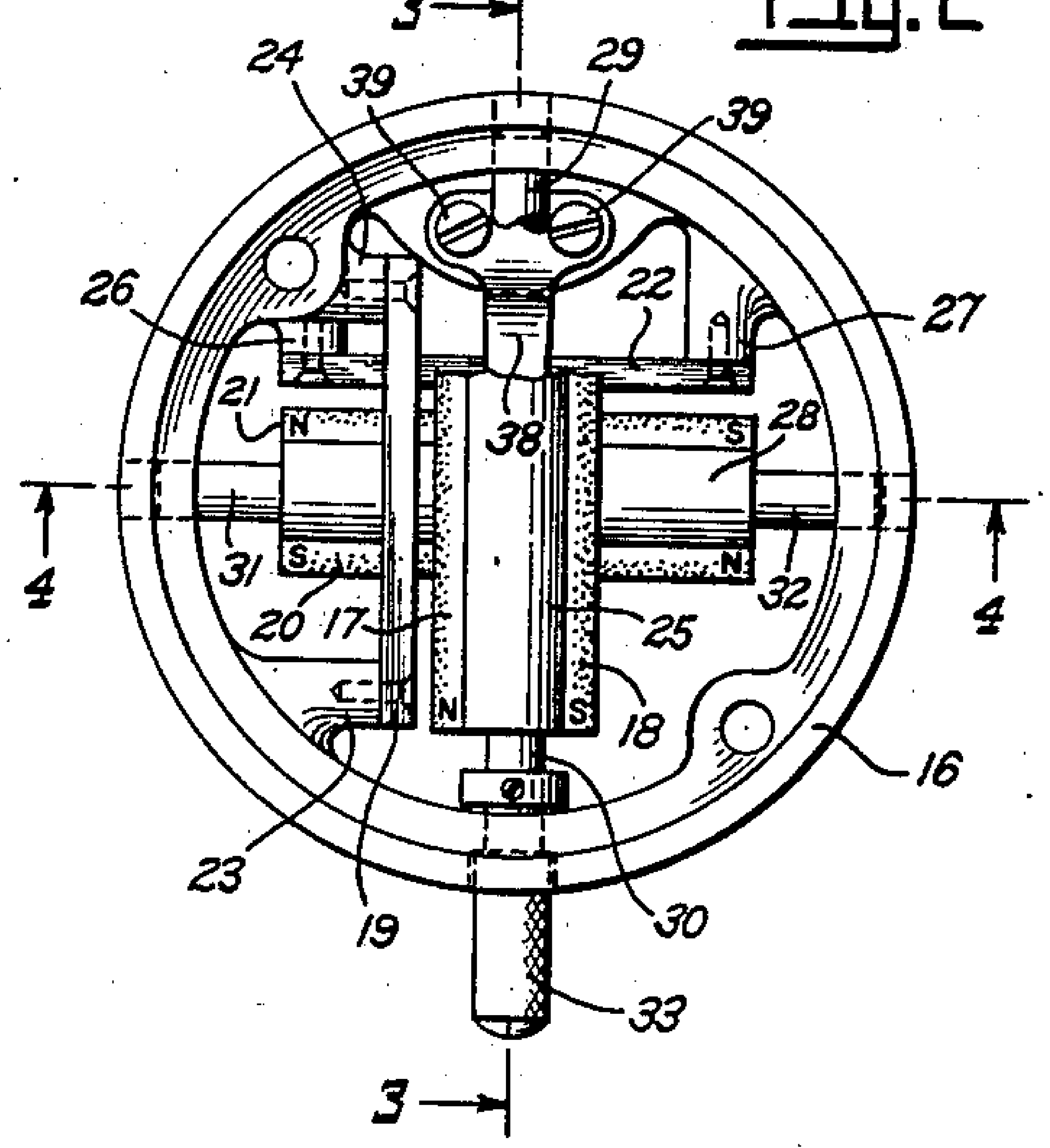
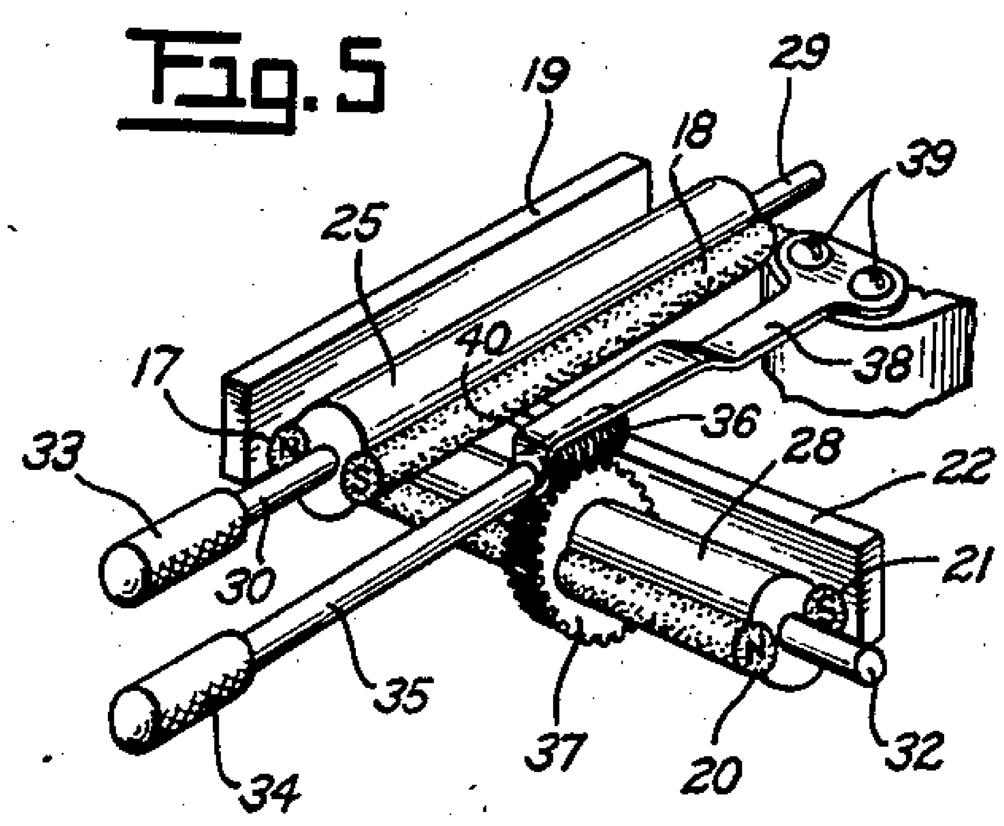


Fig. 5



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COMPASS COMPENSATOR

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5 Claims. (Cl. 33—225)

The present invention relates to compensating devices for compasses employed upon moving bodies such, for example, as ships and aircraft.

One of the objects of the invention is to provide a novel, simple, reliable and improved device of the above type for compensating for the errors introduced into the indication of a compass due to the presence of permanently magnetized bodies in the vicinity of the compass.

Another object is to provide a novel compensating device for magnetic compasses, embodying permanent magnets arranged and operated in a novel manner, and a shield of suitable magnetic material associated therewith whereby the compensating effect of said magnets on the compass may be readily adjusted.

The above and other objects and advantages of the invention will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawing wherein one embodiment of the invention is illustrated. It is to be expressly understood, however, that the drawing is for the purposes of illustration and description only and is not to be construed as defining the limits of the invention, reference being had to the appended claims for this purpose.

The invention consists substantially in the construction, combination, location and relative arrangement of parts for obtaining the results desired in accordance with the foregoing objects, as will be more fully hereinafter set forth in the specification, as shown in the drawing by way of example, and as finally pointed out in the claims.

In the drawing where'n like reference characters refer to like parts throughout the several views:

Fig. 1 is a view, in elevation, of a compass showing the location of the compensating device thereon;

Fig. 2 is a plan view of the compensating mechanism removed from the compass;

Fig. 3 is a vertical section taken on line 3—3 of Fig. 2;

Fig. 4 is another vertical section taken on line 4—4 of Fig. 2, and

Fig. 5 is a perspective view of the elements of the compensating device comprising an embodiment of the invention.

It is well known that regardless of the direction of a magnetic force, its horizontal component may be resolved into two components at right angles to each other, the disturbing effect of which upon the indication of a compass may be compensated, i. e., reduced to zero, by means of auxiliary magnetic forces respectively equal to and in opposite directions to the components of the disturbing force. In accordance with the present invention, there is provided a simple and reliable device that will, at all times, provide for the introduction of compensating component magnetic forces exactly at right angles to each other and of the desired magnitude.

For purposes of illustration, the invention is shown in the drawing as embodied in a compass structure of the side-reading type such as is generally employed on air-craft. It is to be understood, however, that the invention is not limited in its application to aircraft compasses but is generally applicable to other types of compasses such, for example, as the well-known mariners' compass or the earth inductor compass.

From a general aspect, the invention comprises a unit constituted by a pair of auxiliary magnets situated in cooperative relationship with the direction-sensitive element of a compass, a member of suitable magnetic material such as soft iron, "permalloy" or "hypernick" positioned adjacent said auxiliary magnets longitudinally thereof and parallel thereto, and means for mounting said magnets so that they may be simultaneously revolved as a unit about an axis parallel to the adjacent member of magnetic material which functions as a shield for varying the effect of the auxiliary magnets upon the compass as they are revolved. The member of magnetic material will hereinafter be referred to as an armature.

More specifically, the invention comprises a pair of compensating units of the above type mounted at right angles to each other for the purpose of introducing compensating component forces in two mutually perpendicular directions and of the desired magnitude.

Referring now to the drawing and more particularly to Fig. 1 thereof, there is shown, by way of example, a compass 6 comprising a cylindrical glass bowl 7 clamped between an upper plate 8 and a lower plate 9 by suitable means such, for example, as a plurality of circumferentially arranged bolts, two of which are shown at 10 and 11. Within the glass bowl 7 there is pivotally mounted a direction-sensitive element of the compass, i. e., the compass card 12 which carries the card magnets (not shown) therebeneath. A central vertical post 13 which is provided at its upper end with a suitable jewel bearing (not shown) serves to support the compass card 12 in a substantially horizontal position and provides for rotation of the card about a vertical axis defined by the central axis of the post 13.

The bowl 7 is generally filled with a suitable damping liquid such, for example, as kerosene, varnolene or alcohol, and since said bowl is transparent, the card 12 may be readily observed therethrough from any side thereof. A stationary reference mark 14, familiarly known as a lubber's line, is secured within the bowl to the lower plate 9 and in front of the card 12 so that the characters or compass graduations upon the card 12, with which the lubber's line appears to coincide, indicate the direction in which the moving body upon which the compass is carried is headed. The entire compass structure is carried by a suitable bracket 15 for mounting said compass on the moving body in an upright position.

Beneath the compass is carried a housing or casing 16, preferably cylindrical, within which the compensating device embodying the present invention is located. The housing 16 is removably secured to the upper part of the bracket 15 substantially centrally of the bowl 7 and concentrically with the vertical axis of the compass, by any suitable means (not shown) for the purpose of facilitating the removal of the compensating mechanism for repair or replacement.

Referring now to Figs. 2 to 5, inclusive, the compensating mechanism comprises, in the form shown, two units mounted at right angles to each other in substantially parallel horizontal planes, one of the compensating units, the upper one, for example, as viewed in Figs. 3, 4, and 5, consists of a pair of parallel, oppositely disposed bar magnets 17 and 18 so that their unlike poles are adjacent each other, and an armature 19 of substantially the same length as the bar magnets and positioned adjacent said magnets longitudinally thereof and parallel thereto, while the unit at right angles to the first unit comprises a pair of parallel, oppositely disposed bar magnets 20 and 21, and an armature 22 of substantially the same length as said magnets and positioned adjacent thereto longitudinally thereof and parallel thereto.

The armature 19 is secured to some suitable support such, for example, as a pair of bosses 23 and 24 formed integrally with the casing 16 at the upper part thereof and projecting toward the magnets 17 and 18 so that said armature 19 is relatively close to said magnets. The magnets 17 and 18 are carried preferably by a cylindrical member 25 of non-magnetic material such, for example, as brass, and on diametrically opposite sides thereof, said magnets being partially embedded in said non-magnetic member 25 longitudinally thereof and preferably being of substantially the same length as said member.

The armature 22 is carried by a support also constituted by a pair of bosses 26 and 27 formed integrally with the casing 16 at the lower part thereof and projecting toward the magnets 20 and 21, said magnets being carried by a cylindrical member 28 and also disposed on diametrically opposite sides of said member, the latter being of non-magnetic material like member 25.

In order to provide for revolving the magnets 17 and 18 and the magnets 20 and 21 with respect to their associated armatures 19 and 22, respectively, about horizontal axes parallel to the armatures, the cylindrical members 25 and 28 are respectively carried by stub shafts 29, 30 and 31, 32 secured to or formed integrally with said members 25 and 28, the stub shaft 29, 30 being journaled in the upper part of the casing 16 and the stub shaft 31, 32 being journaled in the lower part of said casing, as shown in Figs. 3 and 4. Thus, it will be seen that the magnets 17 and 18 are revolvable about the axis of the member 25, which axis is common to both of the magnets, is in substantially the same plane with said magnets and is parallel to the armature 19 and to the magnetic axes of said magnets, while the magnets 20, 21 are revolvable about the axis of the member 28, which axis is parallel to the magnetic axes of said magnets and to the armature 22 and is in substantially the same plane with said magnets.

Means are now provided for revolving the pairs of magnets 17, 18 and 20, 21 about their respective axes of revolution at right angles to each other and with respect to their associated armatures 19 and 22 for the purpose of introducing compensating component forces at right angles to each other and of the desired magnitude so that the errors introduced into the indication of the compass 6 due to the presence of permanently magnetized bodies in the vicinity thereof may be reduced to zero. In the form shown, said means comprise a pair of knobs 33 and 34 which extend outside of the casing 16, the knob 33 being secured to or formed integrally with the stub shaft 30 and the knob 34 being secured to or formed integrally with a shaft 35 parallel to the stub shaft 30. By rotation of the knob 33, the non-magnetic member 25 is rotated about its axis directly inasmuch as the knob 33 is connected directly to the stub shaft 30 and is coaxial with the member 25. Since, however, the member 28 is at right angles to the axis of the knob 34 and the shaft 35, the latter is provided at the end thereof with a worm 36 which meshes with a worm gear 37 carried by the non-magnetic member 28 substantially mid-way between the ends thereof so that the magnets 20, 21 may be revolved about the axis of member 28 from a direction at right angles to said axis, thereby enabling the adjustment of the magnets 17, 18 and of the magnets 20, 21 from the same side of the casing 16, as shown in Figs. 3 and 5. A leaf spring 38 is provided for insuring firm engagement between the worm 36 and worm gear 37, said spring having one end secured to the casing in any suitable manner as by means of screws 39 and having its other end bent downwardly as shown at 40 so that said end fits into a groove 41 on the shaft 35.

From the foregoing structure, it will be seen that when the knob 33 is rotated, the magnets 17, 18 (Fig. 4) are revolved about the axis of the non-magnetic member 25 so that when the magnets are in the position shown, if they are revolved counter-clockwise, the magnet 17 will be moved angularly downward and away from the armature 19 while the magnet 18 will be moved angularly upward and nearer to the armature 19. Thus, the field of the magnet 17 increases as the magnet moves away from the armature 19 and the field of magnet 18 simultaneously decreases as the latter magnet approaches armature 19. This adjustment may be effected to any desired degree depending on the relative angular positions of the magnets with respect to the armature 19. The armature 19 serves as a shield or by-pass for the magnetic lines of force of that magnet which happens to be closer to it. As shown in Fig. 4, for example, the magnetic lines of force of magnet 17 are substantially completely absorbed or by-passed by the armature 19. If the magnets are moved clockwise, from the position shown in Fig. 4, the effect of the magnet 18 on the compass is gradually decreased and the effect of the magnet 17 will gradually begin to increase. If the magnets 17, 18 are rotated through 90°, either clockwise or counter-clockwise, from the position shown in Fig. 4 so that they are in a vertical plane and, hence, parallel to the armature, the net effect of the magnets on the compass is zero. Inasmuch as the member 25 is capable of being rotated through a complete circle of 360°, the magnets 17, 18 may be revolved so that the magnet 18 will be positioned closer to the armature 19, i. e., the position of the magnets 17 and 18 will then be reversed from that shown in Fig. 5.

The effect of the lower magnets 20, 21 on the compass may be varied in the same manner except that this effect is at right angles to that of magnets 17 and 18.

The compass together with its compensating mechanism is installed upon an aircraft such, for example, as an airplane, in such a manner that the axis of revolution of the compensating magnets 17 and 18 is parallel to the fore and aft axis of the craft, and the axis of revolution of the compensating magnets 20 and 21 is athwartship of the craft, i. e., coincides with the transverse horizontal axis of the craft, while the intersection of the vertical planes containing these axes coincides with the vertical axis of the post 13 about which the card 12 rotates.

The manner of compensating the compass, by turning the craft on which the compass is mounted through 360° and adjusting the compensating magnets to obtain the desired effect on the compass, is well known to those skilled in the art and the details thereof need not be described herein.

Thus, it will be seen that there is provided a compensating device for a compass, in which the compensating component magnetic fields produced by the units of the device are always at right angles to each other, and by revolving the magnets of each unit a differential effect is produced on the compass, the effect produced by the magnets of one unit being in a direction at right angles to the effect produced by the magnets of the other unit. The compensating mechanism is simple inasmuch as relatively few parts are involved, thereby making it possible to easily manufacture large quantities of devices having such a mechanism, and yet the mechanism is reliable and accurate for the purpose of compensating for errors introduced into the indication of a compass due to the presence of permanently magnetized bodies in the vicinity of the compass.

Although only one embodiment of the invention has been illustrated and described, other changes in the form and relative arrangement of the parts, which will now appear to those skilled in the art, may be made without departing from the scope of the invention. The armatures 19 and 22, for example, instead of being adjacent the members 25 and 28 at the sides thereof, respectively, might readily be positioned beneath said members or over them without affecting the fundamental principle of operation, as long as the magnets are parallel and are capable of being revolved about a common axis parallel to the armature so that said magnets may be revolved into two positions in which they are equidistant from the armature and their net effect is zero in such positions but when they are revolved out of either of these positions, a differential effect is produced.

If desired, the two armatures 19, 22, when disposed over or under their respective pairs of magnets, may be made integrally with each other in the shape of a cruciform wherein one armature is provided with a bend substantially midway between its ends to form a yoke for providing clearance for the magnets associated with the other armature; and the latter is made to project from this yoke in a direction at right angles to the first armature.

Reference is, therefore, to be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. A compass compensating unit comprising two adjacent opposing parallel magnets mounted for revolution about a common axis parallel to and disposed between the magnetic axes of said magnets, a stationary armature of magnetic material mounted adjacent said magnets and parallel thereto, and means for revolving said magnets to produce a varying effect in the external fields of said magnets by the armature.

2. A compass compensating unit comprising two adjacent opposing magnets mounted horizontally in parallel relation for simultaneous revolution about a common axis parallel to and disposed between the magnetic axes of said magnets, a stationary armature of magnetic material mounted adjacent said magnets and parallel thereto, and means for simultaneously revolving said magnets whereby one of them angularly approaches said armature and the other angularly recedes therefrom to produce a differential varying effect in the fields of said magnets by said armature.

3. A compensating device for compasses, comprising a stationary armature of magnetic material, a pair of oppositely disposed parallel magnets adjacent said armature, means mounting said magnets for revolution about a common axis parallel to the armature and to their magnetic axes, means for simultaneously revolving said magnets, a second stationary armature of magnetic material disposed in a direction at right angles to the first armature, a second pair of oppositely disposed parallel magnets adjacent said armature, means mounting said second pair of magnets for revolution about a common axis parallel to the second armature and to their magnetic axes, and means for simultaneously revolving said second pair of magnets.

4. A compensating device for compasses, comprising a housing adapted to be secured to a compass, a pair of stationary armatures of magnetic material disposed in said housing one over the other and at right angles to each other, a nonmagnetic carrier adjacent each armature, means mounting said carriers for rotation about axes respectively parallel to the armatures, a pair of parallel magnets carried by each carrier on opposite sides thereof, each of said pairs of magnets having poles of unlike polarity adjacent each other, and means for rotating said carriers about their respective axes whereby the magnets of each pair are revolved with respect to their associated armatures in such a manner that one magnet of each pair moves nearer to its associated armature and the other magnet of each pair moves away from its associated armature.

5. A compass compensating unit comprising a stationary armature, a pair of parallel magnets disposed near said armature with their opposite poles adjacent each other, means mounting said magnets for revolution about a common axis disposed between said magnets substantially in the same plane therewith and parallel to the armature, and means for revolving said magnets to produce a varying effect in the external fields of said magnets by the armature.

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