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(56) Documents cited
**GB 1543895**

(58) Field of search
**G1N**

# (54) Hall effect transmitting compass

(57) A Hall effect transmitting compass comprises a ring magnet (1) which is pivotally mounted in an oil-filled chamber of casing (7) and at least one pair of Hall effect sensors (11) mounted on the casing in the plane of the ring magnet when said magnet is horizontal. The sensors (11) are connected by electric leads (15) to an electric circuit on a printed circuit board (12) secured by screws (13) to the casing (7). The circuit, described in detail, evaluates signals from the sensors and provides an output from which a compass heading of the ring magnet can be determined. One pair of Hall effect sensors is preferred for use in automatic pilot systems, whereas two pairs are needed to obtain an unambiguous directional signal.

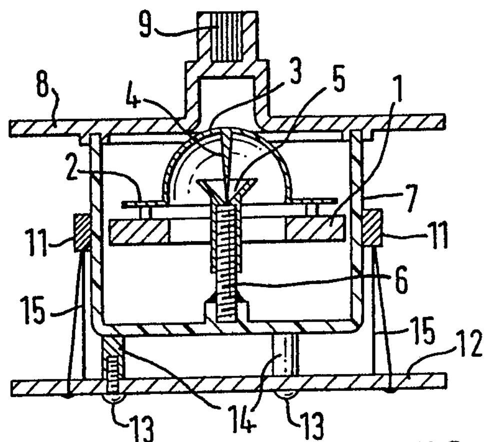



FIG. 2

GB 2 151 790 A

The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.

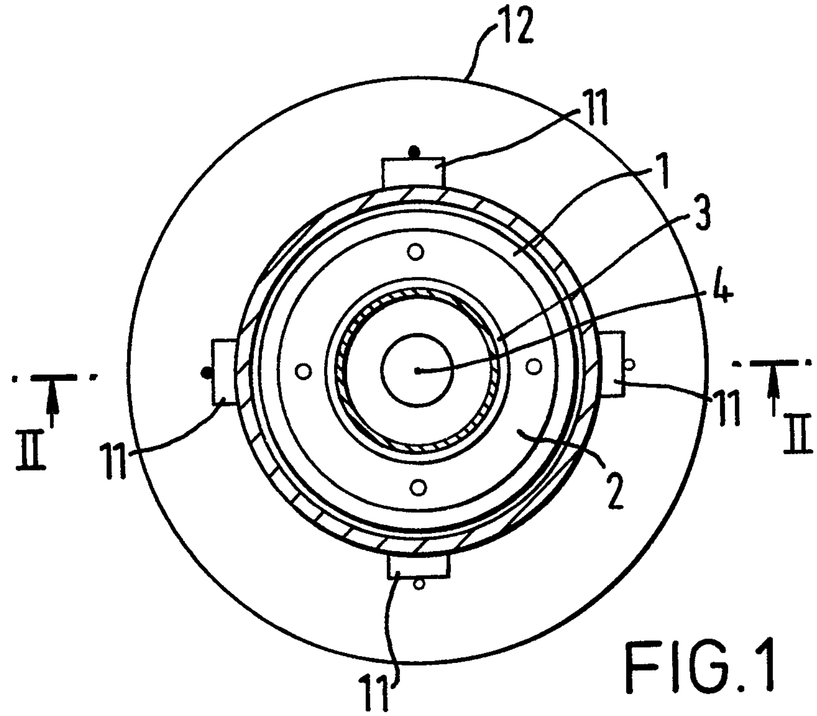



FIG. 1

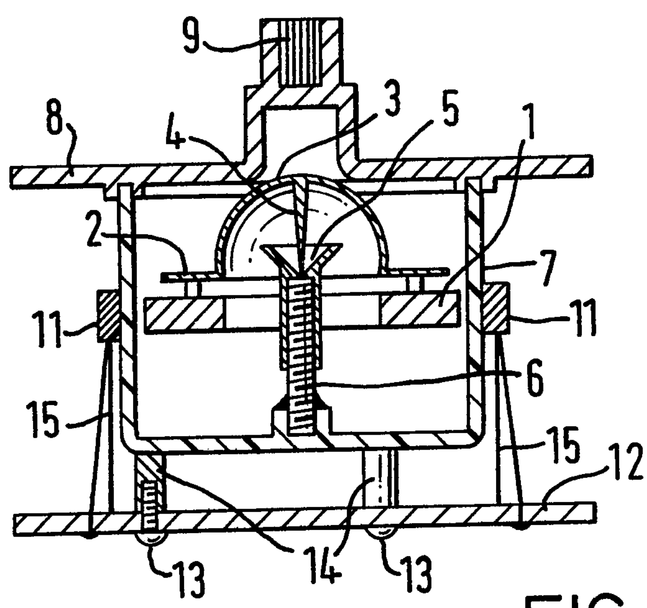



FIG. 2

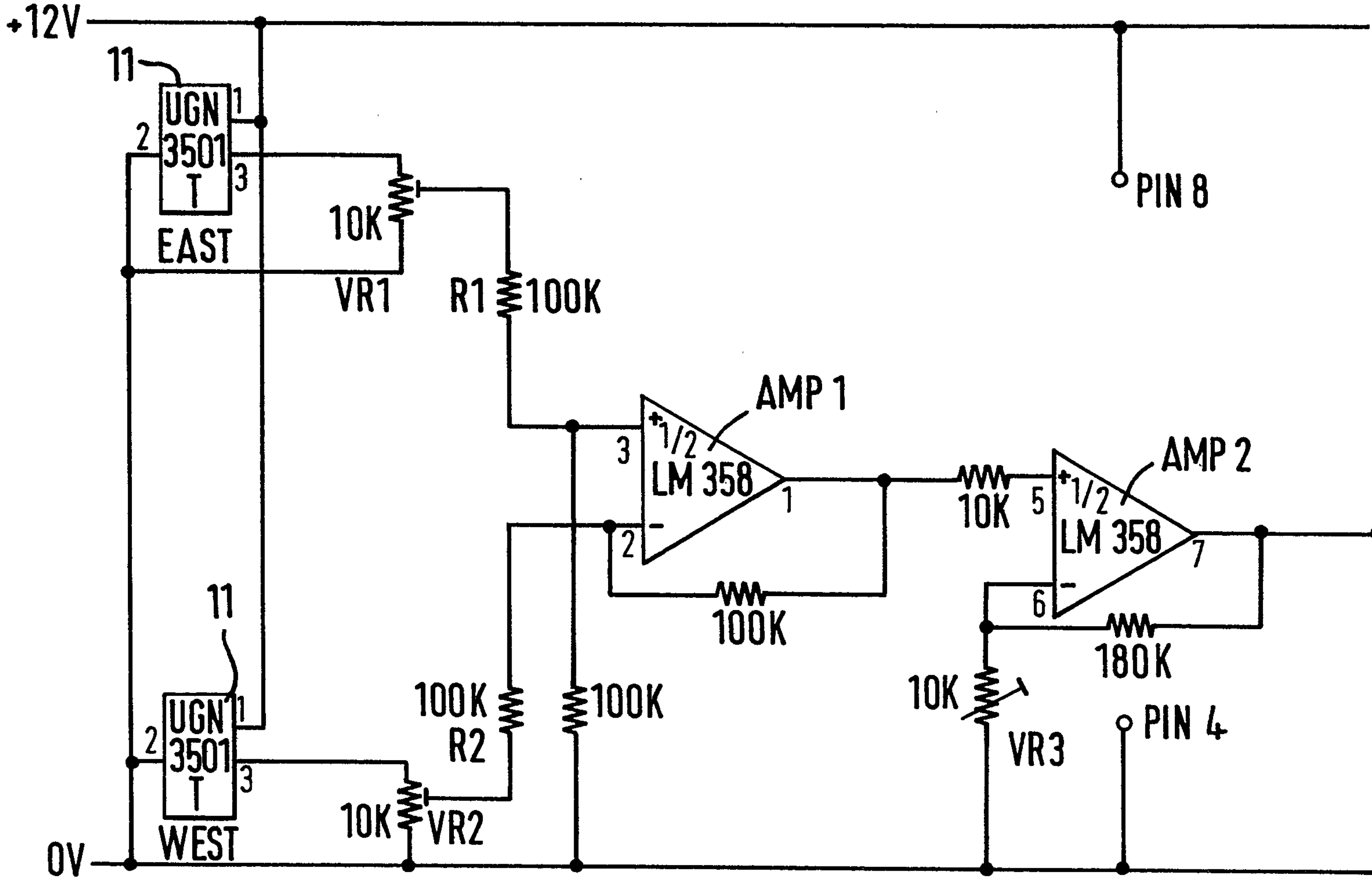
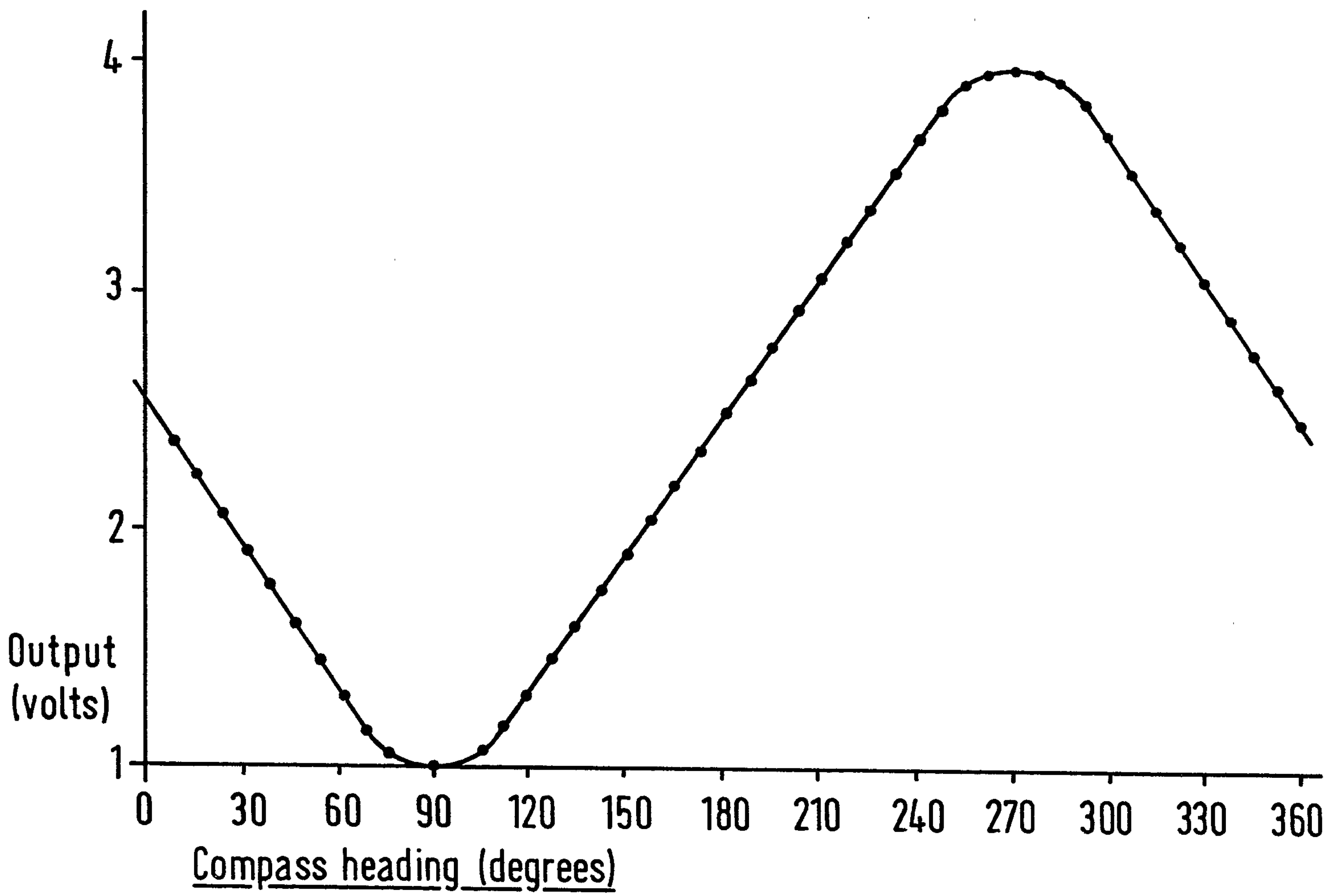

+12V
11
UGN 3501 T
1
2
3
EAST
10K
VR1
R1
100K
PIN 8
AMP 1
1/2 LM 358
3
2
1
100K
10K
AMP 2
1/2 LM 358
5
6
7
OUTPUT
180K
10K
VR3
PIN 4
11
UGN 3501 T
1
2
3
WEST
10K
VR2
100K
R2
100K
0V

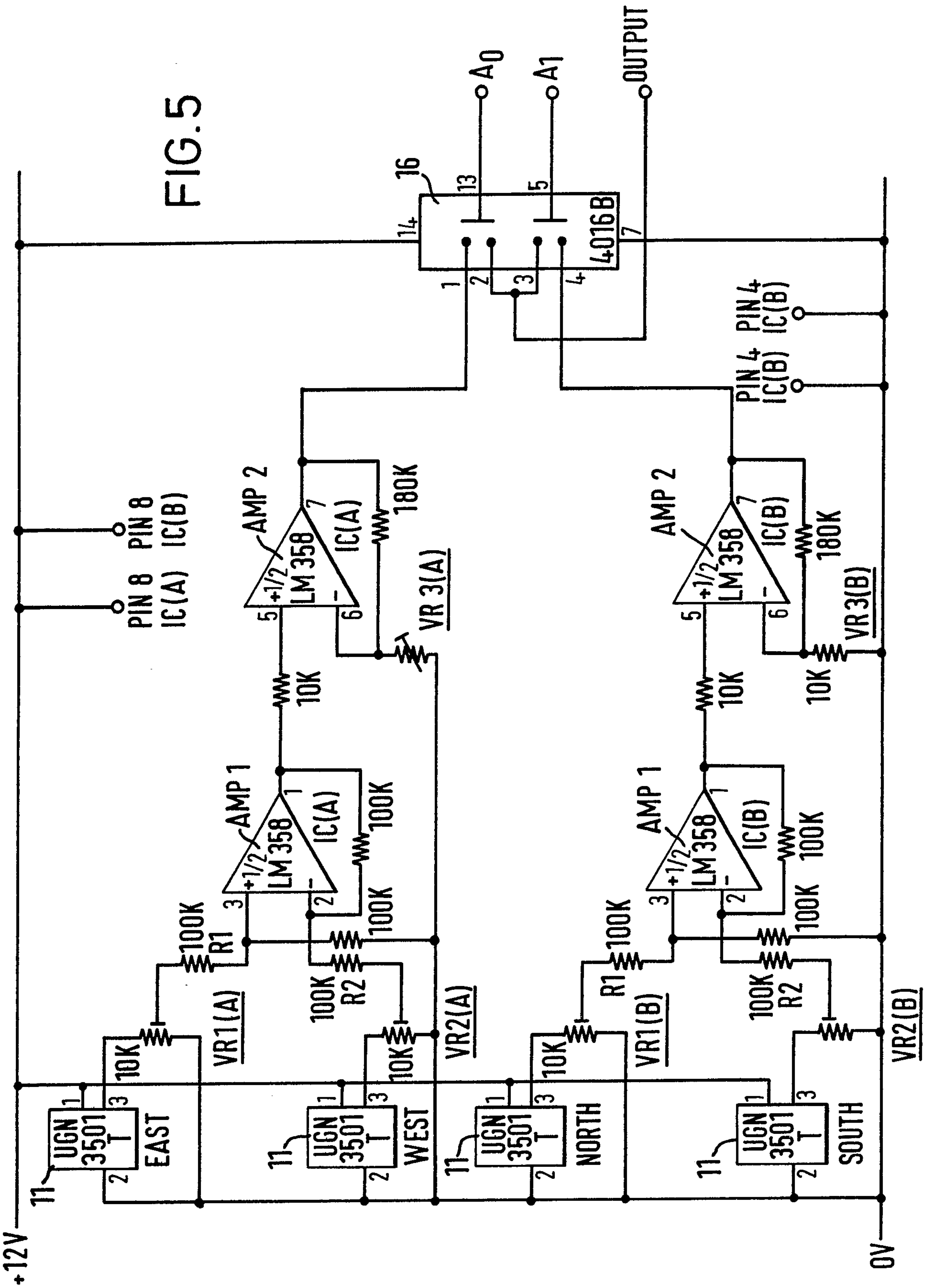
FIG.3



Output
(volts)
1
2
3
4
0
30
60
90
120
150
180
210
240
270
300
330
360
Compass heading (degrees)


FIG. 4

FIG.5


+12V
0V
A0
A1
OUTPUT
16
4016B
14
13
5
7
1
2
3
4
PIN 8 IC(A)
PIN 8 IC(B)
PIN 4 IC(B)
PIN 4 IC(B)
AMP 1
AMP 2
+1/2 LM358
IC(A)
IC(B)
100K
180K
10K
R1
R2
VR1(A)
VR2(A)
VR3(A)
VR1(B)
VR2(B)
VR3(B)
UGN 3501 T
EAST
WEST
NORTH
SOUTH
11

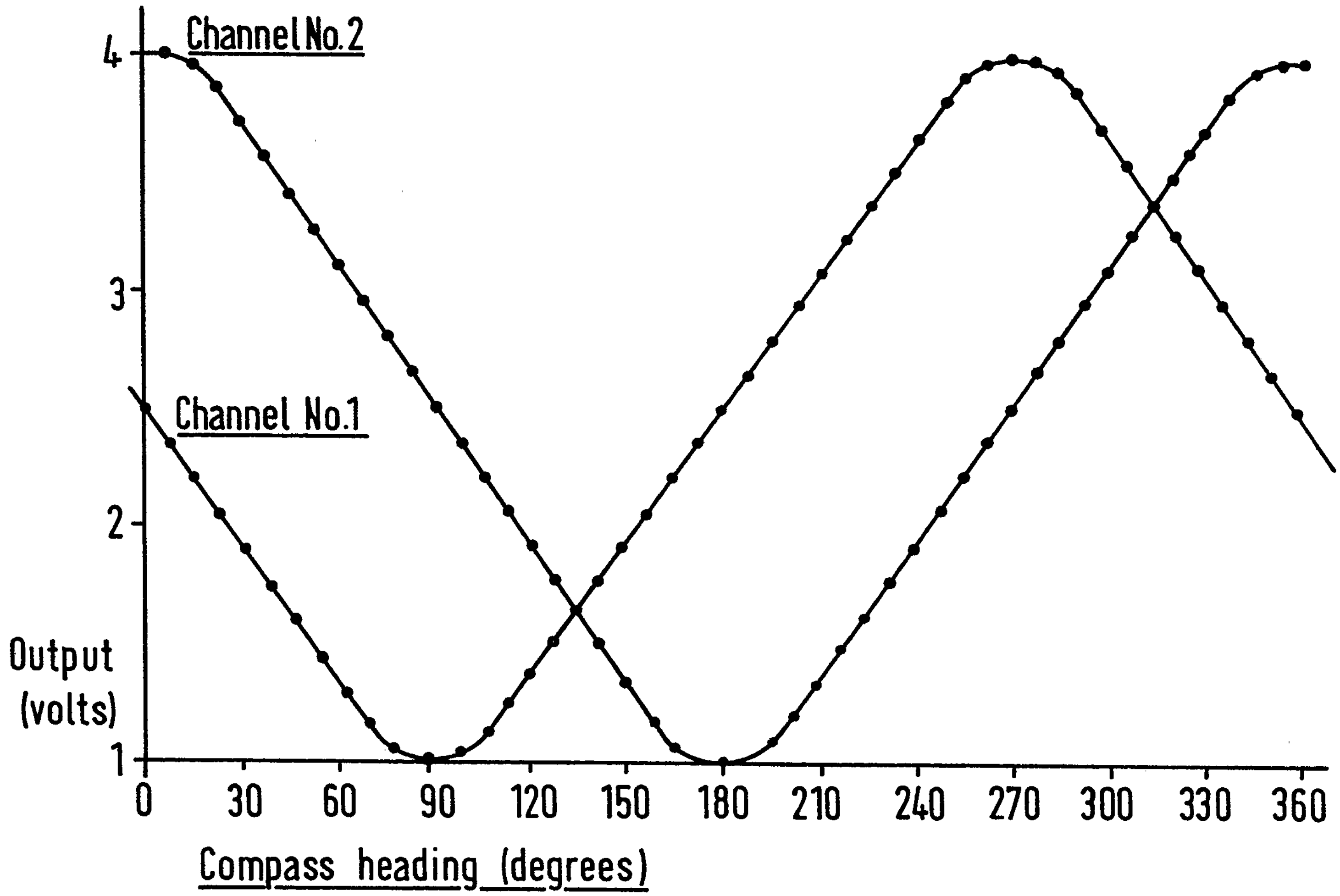

Channel No.2
Channel No.1
Output
(volts)
4
3
2
1
0
30
60
90
120
150
180
210
240
270
300
330
360
Compass heading (degrees)

FIG. 6

SPECIFICATION

**Hall effect transmitting compass**

This invention relates to an electronic transmitting compass.

Transmitting compasses are well-known and widely used pieces of equipment both as navigational aids and as control sensors for other equipment such as automatic pilots.

Transmitting compasses currently available fall into three major categories:

i) *The flux gate compass:* This compass is a completely solid state device with no moving parts which derives a heading by sensing the direction of the lines of magnetic flux generated by the earth's natural magnetic pole.

ii) *The optical pick-up compass:* This compass uses a conventional magnetic movement with a specially prepared card. A heading is derived by shining light through the special card onto a light dependant resistor or photo-diode.

iii) *The coil sensing compass:* This compass uses three coils connected in a star formation mounted above or below a conventional magnetic compass. A fourth coil is used as an exciter at high frequency and hence the output from the three other coils can be decoded to determine the exact position of the magnet in the compass.

All three types of compass suffer from the same inherent fault; they are all very sensitive to tilt i.e. they will all return an incorrect heading if the compass housing is tilted by as little as 3°-5°. In order to overcome this problem these compasses are usually mounted in an elaborate gimball system however, due to friction and inertia, errors still occur.

The present invention aims to provide a compass which avoids the disadvantages of the known compasses discussed above.

According to the invention, there is provided a Hall effect transmitting compass comprising a ring magnet pivotally mounted in an oil-filled chamber of a casing and at least one pair of Hall effect sensors mounted on or in close proximity to the casing in the plane of said ring magnet when said magnet is horizontal, said sensors serving to sense the position of the magnet.

Preferably, the sensors are mounted at diametrically opposite locations on the casing whereby said sensors are spaced apart by 180°. If the sensors were mounted below or above the magnet then the output would be no better than that of any of the three conventional transmitting compass designs discussed above because as the magnet tilted, it would be nearer to one sensor than the other and so return a false reading. By locating the sensors in the same plane as the ring magnet when the latter is horizontal, and positioning two Hall effect sensors at the edge of the ring magnet at 180° to each other, accurate readings over 180° of compass movement can be obtained and would find application in control mechanisms such as an automatic pilot.

In order to return accurate readings over a full 360° a second pair of sensors must be fitted at 90° to the original pair. Thus, according to a preferred embodiment of the invention, a second pair of Hall effect sensors is mounted on or in close proximity to the casing in the same plane as said first pair of sensors.

The sensors of the second pair are desirably mounted at diametrically opposite locations on the casing whereby said second pair of sensors are spaced apart from each other by 180° and adjacent sensors are spaced apart from each other by 90°.

The Hall effect sensors are desirably connected to a circuit for evaluating values sensed by the sensors and for giving an indication of the associated compass heading.

This configuration renders the compass completely immune from any tilt error as only the two sensors that are positioned opposite each other (at 180° spacing) are read at any one instant in time and hence no matter what angle the magnet is tilting at, it is always the same distance away from the two 'live' sensors.

The invention will now be further described, by way of example, with reference to the drawings, in which:-

*Figure 1* is a part-sectional plan view of one embodiment of a compass according to the invention;

*Figure 2* is a section taken on the line II-II of Figure 1;

*Figure 3* is a circuit diagram of a compass according to the invention having two Hall effect devices;

*Figure 4* is a graph showing the output curves produced by the circuit shown in Figure 3;

*Figure 5* is a circuit diagram of a compass according to the invention having four Hall effect devices and a channel selector; and

*Figure 6* is a graph showing the output curves produced by the circuit shown in Figure 5.

Reference will first be made to Figures 1 and 2 of the drawings in which the compass comprises a conventional ring magnet 1 to which a peripheral flange 2 of a dome 3 is secured. The dome 3 carries on its lower, concave, face a pivot pin 4 which is pivotally mounted in a jewelled bearing 5 mounted on a screw-threaded pin 6 which is secured to the base of a casing 7. The ring magnet 1 and a dome 3 are mounted for pivotal movement in the casing 7 which is filled with oil in order to damp pivoting movements of the magnet. The magnet is free to tilt up to 30° in any direction and it will be noted that no compass card is provided.

The casing 7 is desirably made of plastics material and is closed at the top by a cover 8 which prevents the escape of oil from the casing. The cover is provided with a splined sleeve 9 for the reception of knob (not shown). The cover 8 and sleeve 9 have been omitted from Figure 1 in the interests of clarity.

Positioned on diametrically opposite sides of the casing, at 180° to each other respectively, are two Hall effect sensors 11. In the embodiment shown in Figure 2, two pairs of Hall effect sensors are provided, adjacent sensors being spaced from each other by 90° and diametrically opposite sensors constituting each respective pair. However, as will be explained later, it is possible to provide only one pair of Hall effect sensors for some uses of the compass according to the invention.

The Hall effect sensors 11 are positioned on the sides of the casing 7 at the same time horizontal level as the ring magnet 1 when said magnet is horizontal. A small printed circuit board 12 is secured by screws 13 to pillars 14 extending from the base of the casing 7 and is electrically connected to the Hall effect sensors 11 by electric leads 15.

Turning now to Figure 3, the circuit comprises two of the Hall effect sensors 11, which are positioned respectively at East and West locations and are connected in the manner shown in this drawing.

The output from the sensor 11 located in the West position is fed, via a setting resistor VR2 and an impedance matching resistor R2, into the inverting input of a first amplifer AMP1. The output level of this Hall effect sensor is set at 3 volts by adjusting the resistor VR2 at zero magnetic flux density.

The output from the sensor 11 located in the East position is fed, via a setting resistor VR1 and an impedance matching resistor R1 into the non-inverting input of the first amplifier AMP1. The output of this amplifier is now set to 0.10 volts by adjusting the resistor VR1 at zero magnetic flux density.

The output from the amplifier AMP1 is now fed into the non-inverting input of a second amplifier AMP2 which is adjusted by a setting resistor VR3 to give an output of 2.5 volts at zero magnetic flux density.

Figure 4 shows voltage output against compass heading. It can be seen that for any given voltage it is possible to derive two different headings of 180° ambiguity. This feature makes this compass ideal for use in applications such as automatic pilots where the compass itself is turned to set the desired steering course. The 180° ambiguity is desirable to allow for port or starboard mounting of tiller accuators without any changes at all to the circuitry.

The compass housing is pointing directly north or south when a voltage output of 2.5 volts is achieved.

Figure 5 shows the circuitry for a 360° version having four Hall effect sensors 11. Each pair of sensors is arranged in a circuit having the same configuration as the 180° version shown in Figure 3 but arranged as two separate channels which can be individually selected by a master control unit 16 by using the two address line Ao and Al. By selecting first one channel and then the other, two values can be obtained which when integrated will give a unique position between 1 and 360°.

Figure 6 shows voltage output against compass heading for both channels on the 360° version. It can be seen that for any heading there is always a unique combination of voltage outputs on channel 1 and 2 and hence a fully proportional and accurate heading can be derived from the two outputs by the master control unit.

It will be seen that, by means of the invention, it is possible to provide a Hall effect transmitting compass which is immune from tilt error without the need for gimballing. The output can be set to cover just 180° of magnet movement or by duplicating the basic configuration can be set to cover the full 360° of magnet movement. The compass can therefore be used for either simple automatic pilot control in its 180° mode or as a full repeater compass or large ship automatic pilot control in its 360° mode.

## CLAIMS

1. A Hall effect transmitting compass comprising a ring magnet pivotally mounted in an oil-filled chamber of a casing and at least one pair of Hall effect sensors mounted on or in close proximity to the casing in the plane of said ring magnet when said magnet is horizontal, said sensors serving to sense the position of magnet.

2. A Hall effect transmitting compass according to claim 1, wherein said sensors are mounted at diametrically opposite locations on the casing whereby said sensors are spaced apart by 180°.

3. A Hall effect transmitting compass according to claim 1 or claim 2, wherein a second pair of Hall effect sensors is mounted on or in close proximity to the casing in the same plane as said first pair of sensors.

4. A Hall effect transmitting compass according to claim 2 and claim 3, wherein the sensors of said second pair are mounted at diametrically opposite locations on the casing whereby said second pair of sensors are spaced apart from each other by 180° and adjacent sensors are spaced apart from each other by 90°.

5. A Hall effect transmitting compass according to any preceding claim, wherein the Hall effect sensors are connected to a circuit for evaluation values sensed by the sensors and for giving an indication of the associated compass heading.

6. A Hall effect transmitting compass substantially as described herein with reference to the drawings.

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