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P. ORLICH ET AL

ECHO-SOUNDING DEVICE WITH ARRESTED INDICATOR

Filed July 19, 1939

Serial No. 285,310

4 Sheets-Sheet 1

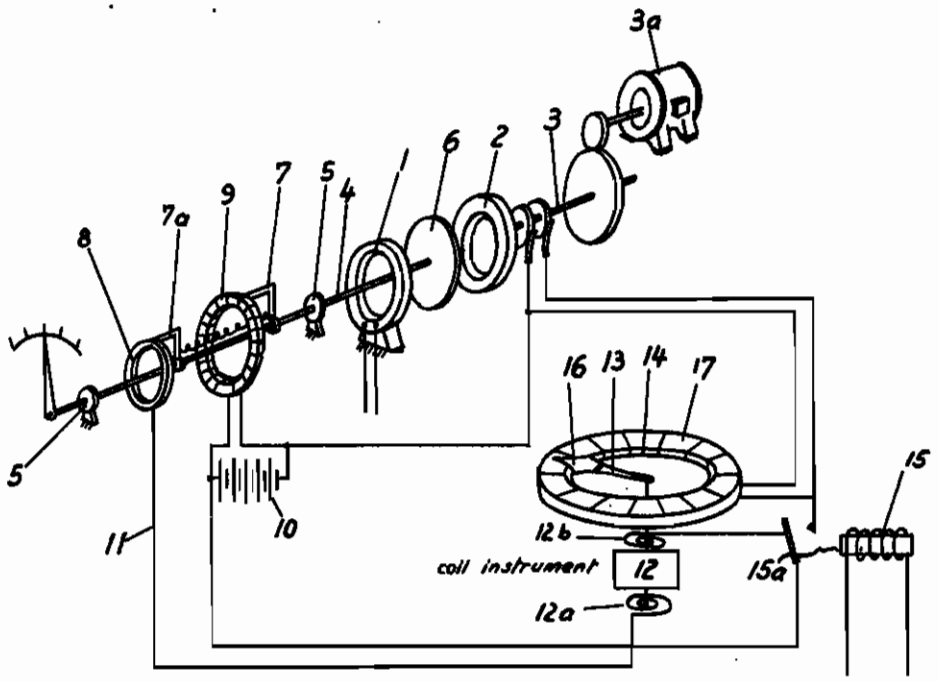

Fig. 1

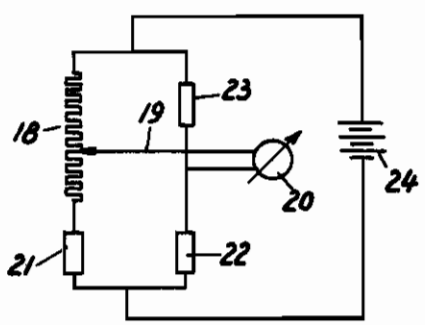

Fig. 2

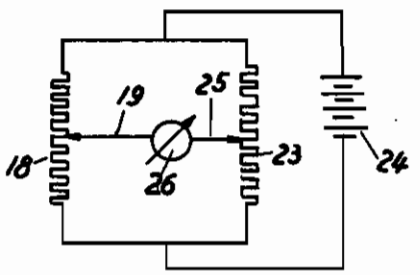

Fig. 3

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4 Sheets-Sheet 2

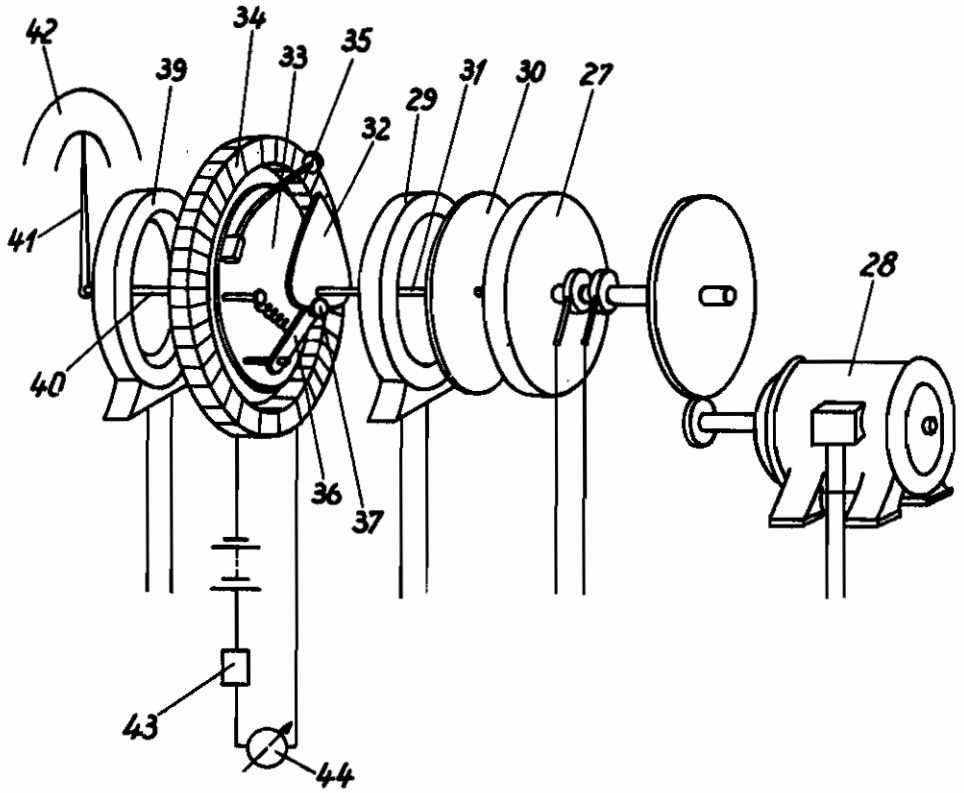

Fig. 4

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4 Sheets-Sheet 3

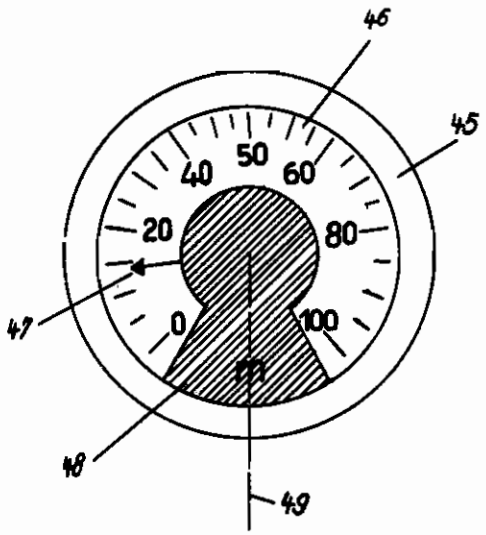

Fig.5

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4 Sheets-Sheet 4

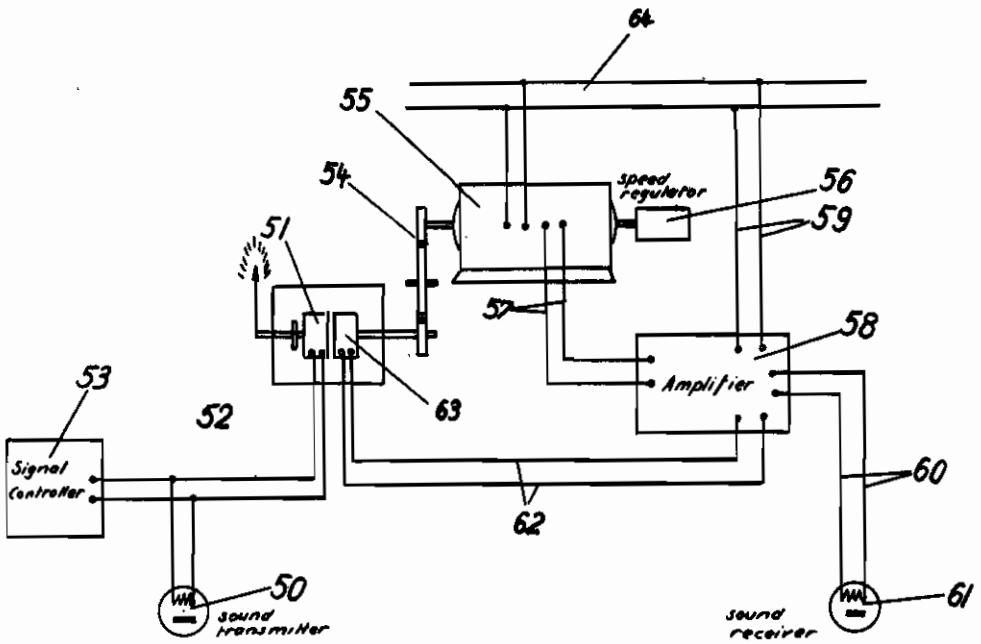

Fig. 6

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ALIEN PROPERTY CUSTODIAN

ECHO-SOUNDING DEVICE WITH ARRESTED INDICATOR

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vested in the Alien Property Custodian

Application filed July 19, 1939

For echo-sounding devices with stationary indication up to the present, optical indicating means have generally been used which travel over a scale and which flash at the moment of the arriving echo. These indicating means usually consist of a lighted spot produced by a Braun tube or a glow cathode or of an illuminated slot, the opening of which is controlled by mechanical means. The optical indicating means, however, have the disadvantage that they fail, if for some reason the echo does not arrive, so that the reading is thereby rendered difficult.

Furthermore, indicating devices for this purpose are known, which operate with an indicator hand, which permit a stationary reading. In these devices a rotating magnet field is used which is energized for a short time at the moment of the echo arriving and in the direction of which a magnetic hand adjusts itself. These devices, however, have the disadvantage which is inherent to all magnetic indicators, namely that they are subject to stray currents from outside and that errors are thereby introduced into the indication.

According to the present invention the aforementioned disadvantages are removed by using an indicating device which does not operate with a directly stationary indicator but by connecting the indicating device to echo-sounding devices of well-known type which permit only a momentary reading and which operate with a magnetic indicator. Such a device cannot be used directly for a continous indication, because it is necessary in these devices to return the indicator every time to zero after a sounding has been made. Devices of this character are constructed, for instance, in such manner that between a stationary and a rotary electromagnet an armature disc is disposed and mounted on a shaft which is axially movable and which is provided with an indicator hand. Thereby the disc is attracted by the rotary magnet at the moment when the sound is originally transmitted and attracted by the stationary magnet at the moment of the echo arrival.

According to the present invention a stationary indication is produced with an echo-sounding device of the above-described character by interposing between the rotary mechanical element and the indicator an electrical angle transmission device, and by coupling with the rotary mechanical element an electric contact which actuates the electric angle transmission for a short time at the moment when the echo arrives. In this manner the visible indicator hand is completely separated functionally from the echo-sounding device proper and the indicating device can be suitably damped so that it will not change its position in the time between two successive distant controls.

The invention is illustrated in the accompanying drawings, in which—

Fig. 1 represents semi-diagrammatically one form in which the invention may be reduced to practice.

Figs. 2 and 3 represent wiring diagrams of two modified forms of the circuit, Fig. 1.

Fig. 4 represents semi-diagrammatically a modification of the electromechanical arrangement shown in Fig. 1.

Fig. 5 represents in larger scale the face of the altitude or depth indicating instrument, and

Fig. 6 represents a block diagram of the entire measuring arrangement of the modification, Fig. 4.

Before referring in detail to the several modifications, it should be stated that the invention is useful not only in measuring depth of water by means of echo sounding, but also altitudes of aircraft or the like, in both cases the ground being used for producing the echo. Therefore, when the term "altitude" is used in the following description, it is meant to imply also depth of water, i. e. altitude of the craft above the bottom of the sea.

Referring to Fig. 1, in which the several elements are shown drawn apart for clearness sake, 1 represents a stationary annular electromagnet and 2 a similar annular magnet mounted on a shaft 3 so that it can be rotated in plane in parallel to the plane in which the annular magnet 1 is located. Shaft 3 is continuously rotated by a source of power capable of rotating the shaft continuously at uniform speed, such as for instance an electric motor 3^a. Between the two electromagnets 1 and 2 is disposed an armature disc 6 mounted on a shaft 4 which is longitudinally movable in its bearings 5, 5. This shaft carries besides a yielding contact arm 7 insulated from the shaft and supplied with current from a supply contact arm 7^a electrically connected with arm 7 and sliding on a stationary slide contact 8. The contact arm 7 is mounted on shaft 4 in such position that when the shaft is shifted longitudinally to the left in Fig. 1, it will contact with a toroid resistance coil 9 disposed in a plane in parallel to the plane of electromagnet 1. This resistance coil 9 is supplied with current from a source 10.

As described so far, the device operates as follows. By means of the elements 1 through 6, the traveling time of the echo is measured as a function of the traveled path of disc 6 during the

running of the echo in a manner shown and described, for instance, in the U. S. patent to Settegast et al, No. 2,032,893. The armature disc is normally attracted by the stationary magnet 11. When the signal which produces the echo is originally sent out, magnet 1 is deenergized and electromagnet 2 is energized so that armature 6 is at that moment released from magnet 1 and attracted by magnet 2 so that it commences to rotate with the latter. The arrangement of this prior art device is such that at the moment of the arrival of the echo, rotary magnet 2 is deenergized and stationary magnet 1 is reenergized whereby armature 6 is arrested. The angular distance which shaft 4 has traveled during the echo-traveling time is used for moving contact arm 7 from an original position at the moment of sound transmission on annular resistance 9 to another position at the arrival of the echo. If contact 7 is in contact with annular resistance 9, which is supplied with current from source 10 and acts as a potentiometer, a current flows from arm 7 by way of contact 8, conductor 11, lead 12^a, galvanometer coil 12, lead 12^b, switch contact 15^a back to resistance 9, the intensity of which current depends upon the position of the contact on annular resistance 9. As previously stated, this resistance, together with arm 7, acts as a potentiometer. Coil 12 may be placed any desired distance from the actual echo-sounding device 1 through 9 previously described. Between two soundings contact arm 7 is returned to the zero position in a manner known in the art and shown, for instance, in the aforementioned U. S. patent.

The locking distance-indicating device, of which the aforementioned coil 12 is a part, consists in the present example of coil 12 rotatably disposed on an arbor on which an indicator hand 13 is mounted. Cooperatively mounted with hand 13 is an annular electromagnet 14 which is normally energized from source 10 so long as relay 15 attracts its switch armature 15^a and thereby maintains the energizing circuit closed. The relay is controlled so that it drops its armature at the moment when the rotating magnet 2 releases its armature 6, so that at this moment also magnet 14 is deenergized. So long as magnet 14 is energized, it holds indicator hand 13 attracted, wherever it happens to stand. For this purpose, hand 13 is either made of magnetic material or it is provided with a small armature 16 which is located closely adjacent to the magnet. 17 represents a scale mounted on magnet 14, and which is graduated in sounding altitude or depth units as the cas may be.

The sounding time-measuring device 1 to 6, as well as the indication transmitting arrangement, may be substituted according to the invention also by other means. For instance, the circuit arrangement for transmitting the angular position of the contact arm 7 after the arrival of the echo may be arranged in the manner shown in Fig. 2. In this figure, 19 represents the annular resistance such as 9 in Fig. 1, and 19 represents the equivalent of contact arm 7 of Fig. 1. 20 is a long distance receiver 21, 22 and 23 are fixed resistances, approximately of the order of the annular resistance 18, and 24 represents a source of current. This arrangement constitutes a Wheatstone bridge and has the advantage that the scale of the instrument 20 may be divided linearly.

The arrangement, however, may also be made as shown in Fig. 3, in which the fixed resistances 21 and 22 are omitted and in which resistance 23 is formed as a second annular resistance similar to 18 and is provided with a sliding contact 25. This sliding contact 25 is mechanically connected with the receiving instrument 26 in such manner that it follows up the motion of contact arm 19 until the current in the bridge branch 19, 26, 25 equals zero. Such an arrangement has the advantage that it is insensitive against voltage variations of source 24. Besides, it is possible in such a case to bring about the contact between arm 7 as in Fig. 1, or arm 19 as in Fig. 3, with its appertaining annular resistance, not mechanically by shifting the shaft as described with reference to Fig. 1, but magnetically by an annular magnet which attracts the contact arm 7, in this case made of magnetic material, and thereby brings about its contact with the annular resistance 9.

Furthermore, in place of the long distance angle transmission shown and described with reference to Figs. 1 to 3, any other suitable angle transmission device may be used, such as with the aid of photocells. Finally, in place of the arresting magnet 14 in Fig. 1, any other arresting device may be used which holds the indicator hand in its position during the time when no long distance indication occurs.

It may be desirable at times to modify the arrangement according to the invention, and as described so far, in such manner that the electric contact at the annular resistance, such as 9 in Fig. 1, remains permanently at the point at which it has been brought by the arrival of a first echo until a second echo has arrived, at which time it is moved to a new point according to the running time of the second echo. Thereby the differences in running time between the two echoes can be ascertained. The manner in which such an arrangement may be reduced to practice is shown in Fig. 4. In this figure, 27 represents a rotating electromagnet operated by the electric motor 28 at constant speed. Opposite electromagnet 27 is mounted the stationary annular magnet 29, and between the two magnets is disposed the disc armature 30 which in turn is fixed at one end of an axially movable shaft 31. At the other end of shaft 31 is fixed a heart cam 32. In parallel to heart cam 32 and in axial alinement with shaft 31 is mounted an annular resistance 34 of the type described with reference of Fig. 1, which forms part of an angle transmission device. Within annular resistance 34 is disposed an armature disc 33 whose plane is in parallel to heart cam 32 and which is mounted at the end of a shaft 40 disposed in axial alinement with shaft 31. Armature disc 33 carries a sliding contact 35 which cooperates with annular resistance 34. Armature 33 furthermore carries at its side facing heart cam 32 a rotatable lever 36 at the end of which is disposed a roller 37 which rolls on the periphery of heart cam 32. Lever 36 is held in contact with the cam by means of a spring 38, fixed at its other end on disc 33. In parallel to the plane of armature disc 33 is disposed a stationary annular electromagnet 39 so that it can control the rotation of armature disc 33 by permiting its free rotation when the electromagnet is deenergized, and arresting the rotation by attracting the disc when the electromagnet is energized. The energizing circuit of electromagnet 39 is not shown here but assumed to be arranged so that it is energized and deenergized respectively at the same time when the rotary magnet 27 is energized and deenergized. The free end of shaft 40 carries an

indicator hand 41 which travels over a scale 42. Contact 35 of disc 33 is included in a circuit containing the annular resistance 34, a fixed resistance 43 and an electric measuring instrument 44.

This indicating instrument operates as follows. When a sound impulse is sent out, electromagnet 29, previously energized, is deenergized and electromagnet 27 is energized, so that armature disc 30 is taken along by the latter and thereby also heart cam 32 is rotated. Since, as previously stated, electromagnet 39 is energized simultaneously with magnet 27, armature disc 33 is held attracted by electromagnet 39, and thereby the spring 38 is put under tension by the rotation of heart cam 32. When the echo arrives, the exciting current of magnets 27 and 39 is interrupted, and at the same time the armature disc is reattracted by stationary electromagnet 29, which in the same manner as described with reference to Fig. 1 is now reenergized. Thus the heart cam is arrested and armature disc 33 is released and free to rotate. Now the tension of spring 38 exerts itself and tends to set the roller 37 of lever 36 to the lowest point of heart cam 32 as shown in Fig. 4. This will rotate disc 33 a corresponding angular distance. Shortly before the next sound impulse is sent out, magnet 39 is reenergized and thereby reattracts disc 33 and arrests it in the position which it has assumed after roller 37 had reached the lowest point of the heart cam. After the arrival of the next echo, disc 33 is merely turned to the new position in which the heart cam 32 had arrived after the arrival of the new echo. Thus the different angular positions which armature disc 33 assumes at the arrival of the several echoes are transmitted as currents of different potentials, by contact 35 and resistance 34 which together with the contact acts as a potentiometer, to the distant electrical instrument 44 which is calibrated in depth or altitudes. By suitably choosing the value of fixed resistance 43 it becomes possible to maintain the angular indication of the electric measuring instrument 44 proportional to the angular position of the potentiometer contact 35.

It is also possible, of course, instead of using a single heart-shaped cam and a single lever such as in Fig. 4, to use several of such cams and levers symmetrically mounted on their respective supports in order to avoid a one-sided pressure against shaft 31. Furthermore, it may also be desirable some time, instead of using an electric indicating instrument 44, to use a recording instrument which may also be used together with the indicating instrument.

When exercising the invention the following should be taken into consideration. The indicating instrument is in general arranged so that the transmission of the original sound occurs when the indicating element travels through the zero point of the scale, which would mean zero depth or height as the case may be. However, the zero point of the scale, which is disposed either ahead of or behind the indicator, does not always coincide with the zero point of the indicator or of the indicating instrument itself. This occurs when the transmitter and/or receiver is not located at the lowest point of the craft, the distance of which above ground is to be measured. This is the case in particular in echo-sounding devices which are arranged on aircraft. In this case, the transmitter as well as the receiver are frequently mounted in the wings of the craft, and are thereby removed a considerable distance from the lowest point of the craft, for instance from either the landing wheels or the pontoons. In order to avoid confusion in the operator's mind between the zero point of the indicating instrument and the zero point of the scale, the indicator is made ineffective for indicating purposes within the sector of the indicating instrument between the zero point of the instrument and the zero point of the scale. This may be attained, for instance, by covering the sector in question by means of a screen which is disposed in front of the indicator and preferably made a part of the casing of the instrument.

In Fig. 5 such an arrangement is shown. In this figure, 45 represents the indicating instrument of the sounding device provided with a scale 46 over which an indicator hand 47 travels. In the central part of the instrument a screen 48 is arranged which covers the scale 46 and hand 47 through a given angle. This sector covers an area which is located between the dash line 49 and the zero point of the scale. The indicating instrument is built so that when hand 47 or a traveling adjusting device for hand 47 passes through the point represented by dash line 49, the sound emission occurs so that thus line 49 represents the zero point of the indicating mechanism itself.

Such an arrangement may also be useful, for instance, in echo-sounding devices which have light points traveling over a scale. If a rotating optical indicator is used, this indicator may also be removed from the operator's observation by interrupting the current which energizes the optical indicator, and this can be accomplished, for instance, by means of a cam which controls the contact of the circuit through which the optical indicator is supplied with current.

It is further desirable to operate the entire echo-sounding system according to the invention by means of a controlled motor which is constructed as a single armature converter, preferably as a direct current-direct current converter. It is well known that in echo-sounding arrangements of this type, besides the receiver, frequently an amplifier is also required. This amplifier requires a constant operating voltage which in most cases is different from the available line or battery voltage. If now the driving motor of the sounding system is constructed as a converter of the type aforementioned, the different operating voltages can be derived from the generator portion of the converter. Thus, special anode batteries or current transformers may be eliminated.

Such a converter may, of course, be used at the same time for any auxiliary devices which are connected with the indicating device and which likewise require constant operating voltages.

In Fig. 6, an echo-sounding arrangement in connection with a converter current supply is shown in the form of a block diagram. In this figure, 50 represents the sound transmitter which is connected with the fixed electromagnet 51 of an echo-sounding device 52, for instance of the type shown in Fig. 4 and which is controlled by means of a signal controller 53. The echo-sounding device 52 is operated by way of a gear train 54 from a motor 55 which is constructed as a direct current-direct current single armature converter. The motor is maintained at constant speed by means of the speed regulator 56 which may be of any conventional construction known in the art. From this motor, which is

supplied with current from the line 64, a generator line 57 extends to the amplifier 56 which requires constant anode voltage. The necessary cathode heating current is supplied to the amplifier from the main line by way of supply line 59. The amplifier is connected by way of line 60 with the sound receiver 61. The latter is connected by way of the amplifier and line 62 with the rotary electromagnet 63 of the echo-sounding device.

A particular advantage of the arrangement according to Fig. 6 resides in the fact that in this manner considerable space is saved which is particularly important in aircraft or in sounding devices mounted in submarines.

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