Oct. 30, 1956 R. A. FRYKLUND 2,769,160

ELECTRICAL DISTANCE-MEASURING DEVICE

Filed March 20, 1953 2 Sheets-Sheet 1

FIG. 1

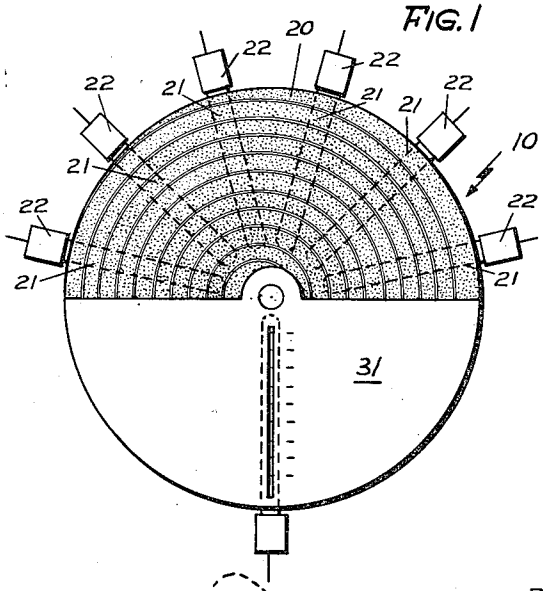
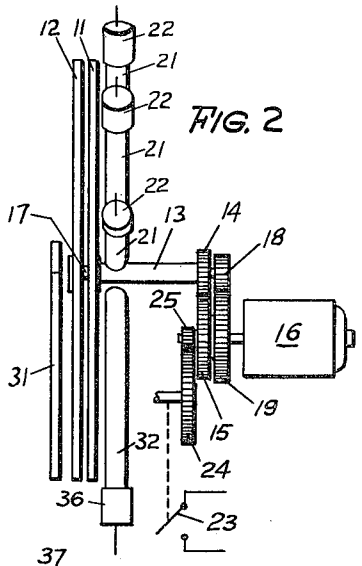


FIG. 2



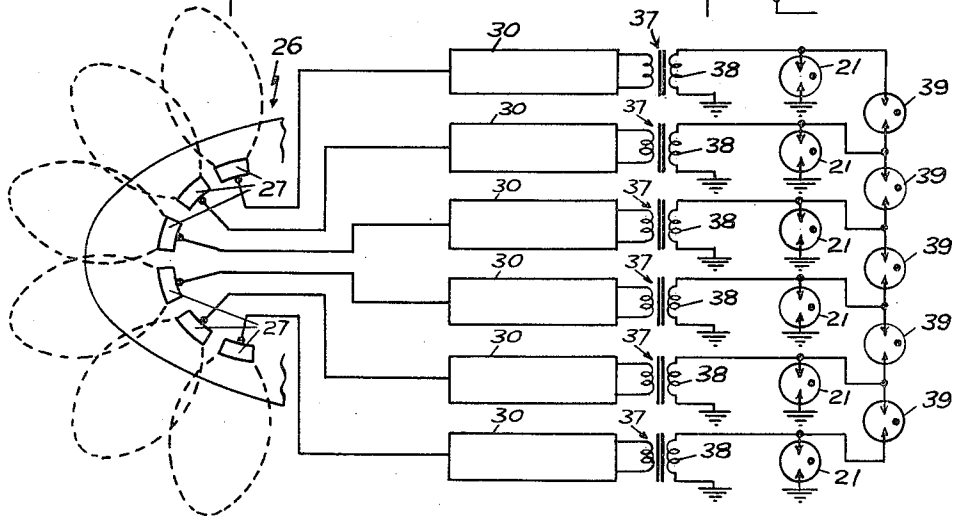


FIG. 4

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ELECTRICAL DISTANCE-MEASURING DEVICE

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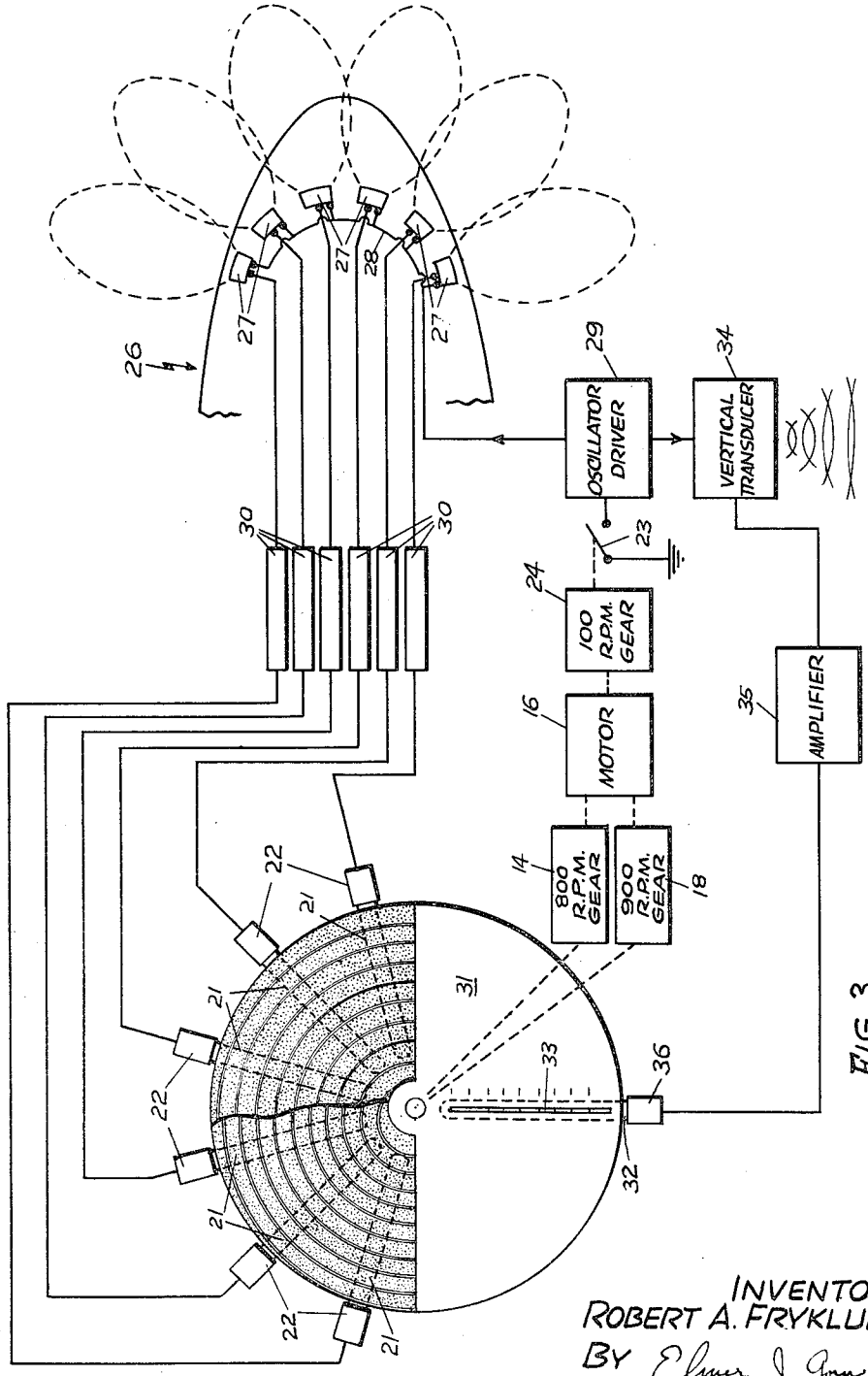


FIG. 3

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ELECTRICAL DISTANCE-MEASURING DEVICE

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Application March 20, 1953, Serial No. 343,775

8 Claims. (Cl. 340—3)

This invention relates to signal-indicating devices and more particularly to echo ranging signal indicators, such as underwater sound distance and positioning determining apparatus.

In copending application, Serial No. 333,941, filed January 29, 1953, by Robert A. Fryklund, there is disclosed a system for determining the distance and position of objects by simultaneously pulsing a number of directive radiating elements oriented in different directions. The returning echo signals are then picked up by the radiating elements and transferred to a cathode ray tube indicating device.

This invention discloses a simple indicating device, which may be used as a plan-position indicator in the above-mentioned system. Briefly, the device comprises a pair of concentrically rotating disks containing transparent apertures behind which are positioned light-producing devices. The aperture in each disk is made in the form of a spiral, the spiral of one disk having a greater radial increase per revolution than the spiral of the other disk, with the disk, whose spiral has the greater radial increase per revolution, rotating more slowly than the other disk. As a result, the portions of the spiral apertures of the two disks appear to coincide along a path which is approximately circular and which expands gradually from the center to the outside of the disks and then returns to the starting position adjacent the center of the disks. Each of the light-producing means is in the form of an elongated lamp fed through suitable amplification means from one of the directive radiating elements with the lamp extending radially outward substantially from the axis of the disks in a direction corresponding to the radiating direction of the radiating element.

The radiating elements are pulsed simultaneously when the portions of the spirals of the disk coincide adjacent their axis, and the returning echo signals light the lamps dependent on the direction from which the echo signals are received and at a time after the coinciding portion of the spirals have moved outwardly thereby resulting in a planned position indicator display.

This invention also discloses that one of the lamps may be energized from a radiating element directed downwardly such that the indications produced by the lamp correspond to the depth of the water body.

This invention further discloses an additional embodiment wherein interpolation between the radiation patterns of the elements may be obtained by connecting lamps to be energized by the sum of the signals of two adjacent radiating elements and interposing said lamps between the lamps which are respectively energized by separate radiating elements.

Other and further objects and advantages of this invention will be apparent as the description thereof progresses, reference being had to the accompanying drawings, wherein:

Fig. 1 illustrates a front elevation view of an indicator embodying the invention;

Fig. 2 illustrates a side elevation view of the indicator illustrated in Fig. 1;

Fig. 3 illustrates an echo-ranging system utilizing the indicator illustrated in Figs. 1 and 2; and

Fig. 4 illustrates a modification of the system wherein additional lamps are used in the indicator of Figs. 1 and 2 to produce interpolation readings between the patterns of the separate radiating elements.

Referring now to Figs. 1 and 2, there is shown an indicator system **10** comprising a pair of concentrically-rotating disks **11** and **12**, respectively. The inner disk **11** is rigidly attached to a hollow shaft **13**, which is attached to a spur gear **14** driven by a spur gear **15**, which, in turn, is driven by a motor **16**. The outer disk **12** is attached to a shaft **17** which extends through a shaft **13** concentric therewith and is attached to a spur gear **18**, which is driven by a spur gear **19**, which, in turn, is driven by motor **16**. The sizes of gears **14**, **15**, **18** and **19** are such that the disks **11** and **12** are driven at different speeds. For example, the disk **11** may be driven at 800 R. P. M. and the disk **12** at 900 R. P. M. The disks **11** and **12** each have a transparent spiral aperture positioned therein. This may be accomplished, for example, by making the disks **11** and **12** out of a transparent plastic material, and applying a coating of black paint **20** to one face of each of the disks while masking off a spiral section of each of the disks with the desired spiral aperture such that, when the masking is removed, a transparent spiral aperture is exposed. The number of convolutions of the spiral apertures is different for the two disks. For example, the outer disk **12** has nine spiral convolutions while the inner disk **11** has eight spiral convolutions. With this arrangement and for the particular speeds of the disks disclosed, a portion of approximately one convolution of the spirals will coincide, and, starting adjacent the axes of the disks, the coinciding position will move gradually outward to the outer edge and then reappear at the center, this process occurring 100 times a minute.

Positioned behind the disks **11** and **12** is a plurality of lamps **21**, each of which comprises an elongated tubular member which may, for example, comprise a neon lamp. Each of the lamps **21** extends from a point adjacent the axis of the disks **11** and **12** radially outwardly to a point somewhat beyond the periphery of the disks **11** and **12** where it terminates in a socket **22**. A switch **23** is geared by means of a spur gear **24** to a spur gear **25**, which is attached to motor **16** such that switch **23** closes for a short period of time before the innermost convolutions of the spirals are in registry, the closure of said switch being used to trigger the emission of energy in the system.

Referring now to Fig. 3, there is shown a system adapted to utilize the indicator shown in Figs. 1 and 2. The hull of the boat **26** has a plurality of directive radiation devices **27** positioned thereon having directive radiation patterns, which slightly overlap, spaced around in a substantially half circle. For example, as shown here, the elements **27** may be sonic transducers positioned below the water line in the region of the bow of the boat hull **26**. One terminal of each of the elements **27**, which may be, for example, a crystal or magnetostrictive device, is connected to a common bus **28**, which is fed from an oscillator driver **29**, triggered by switch **23**, attached to the 100 R. P. M. gear **24**, geared to the motor **16**. The other terminal of each of the elements **27** is connected through a separate amplifier **30**, which, if desired, may also include a detector stage, to the socket **22** of the lamp **21** which extends radially from the center of disks **11** and **12** in the direction corresponding to the direction of the radiation pattern of the transducer **27**.

The operation of the system is as follows. When the portions of the spiral convolution of disks 11 and 12 nearest the center of said disk are substantially in registry, the switch 23 closes, thereby triggering oscillator driver 29, which generates oscillations at a suitable frequency, preferably lying within the supersonic range, the duration of said oscillations being relatively short, for example, ten to one hundred cycles. The oscillations generated by the oscillator driver 29 energize the radiating elements 27, which preferably are tuned to the frequency of oscillator driver 29, thereby resulting in a sharp burst of supersonic oscillations being radiated through the water in each of the radiating patterns of elements 27. Echoes from distant objects, such as other vessels, fish or the shore, are reflected back toward the elements 27 and are picked up after the elapse of a period of time corresponding to the time of travel of the signal from the elements 27 to the objects and back to the elements 27. The echoes are picked up on one of the transducers 27 dependent on the direction of the object producing the reflections and are amplified by the amplifiers 30, and, thence, applied to the tubes 21 through the sockets 22.

The tubes 21 may be in the form of a long neon tube with the signals applied to the tubes at one terminal, the other terminal being connected to ground or to a biasing circuit which would apply a suitable pre-ionizing potential across the gap of the neon tube. The direction from which the signal reflection comes is determined by which of the tubes 21 is illuminated by the signal, and the distance of the object is measured by the distance which the coinciding convolutions of the spirals have moved outward from the center of the disks 11 and 12, the result being a plan position indication of the echoes. Since the system illustrated has radiation patterns directed only to the forward part of the vessel, lamps 21 are positioned only behind the upper halves of disks 11 and 12, and, if desired, the lower halves of disks 11 and 12 may be shielded by means of a shield 31. However, it is to be clearly understood that the system could have radiation elements 27 directed in all directions around the vessel, and, in this event, lamps 22 would be positioned around the entire area of the disks 11 and 12. In the particular modification illustrated herein, a lamp 32 is provided behind disks 11 and 12 coincident with a slot 33 in shield 31. This lamp 32 may be used to indicate the depth of objects below the vessel. This is accomplished by feeding the output of the oscillator driver 29 to a vertically oriented transducer element 34, which radiates a sonic pattern downward and receives echo signals from objects below the vessel or the bottom of the water body. The output of the transducer 34 is fed through an amplifier 35 to the socket 36 of the lamp 32 such that echo signals will light the lamp 32, and the depth of the water body will be measured vertically downward along the slot 33 with the light 32 shining through the convolutions of the spirals in disks 11 and 12, which are in registry when the returning echo signal is applied to the lamp 32.

Referring now to Fig. 4, there is shown a modification of the system illustrated in Fig. 3, which is adapted to give more accurate bearing readings. The transducers 27, vessel 26 and amplifiers 30 are similar to those illustrated in Fig. 3. The outputs of amplifiers 30 are transformers 37, whose secondary windings 38 each has one end connected to ground. The neon lamps are illustrated diagrammatically at 21 and each has one of its terminals grounded and the other of its terminals connected to the ungrounded end of the respective transformer secondaries. The polarity of adjacent secondary windings 38 is so arranged that, when a signal of the same phase is applied to the amplifiers 30, the outputs of transformers 38 cause their ungrounded ends to be out of phase such that the voltage between the ungrounded ends to adjacent transformer secondaries 38 is automatically

equal to the sum of the voltages across the tube windings 38. A second set of lamps 39 is interposed between the lamps 21, the terminals of each of the lamps 39 being connected between the ungrounded ends of adjacent transformer secondary windings 38. Thus it may be seen that, while there are six of the lamps 21, there are only five of the lamps 39. With this arrangement signals which come from directions falling between the patterns of two of the transducers 27 are partially picked up by by both of the transducers 27 and energize the lamp 39 connected across the secondaries 38 fed by the transducers 27, thus illuminating lamp 39 while being of insufficient intensity to illuminate the lamps 21 on either side or to illuminate the lamps 21 only dimly. Thus it may be seen that the lamps 39 act as interpolation indicators for objects lying in the fringe areas of the patterns of transducers 27.

This completes the description of the invention illustrated herein. However, many modifications thereof will be apparent to persons skilled in the art without departing from the spirit and scope of this invention. For example, many different types of lights could be used instead of neon lamps. The system is not necessarily limited to underwater sound but could be used with radio waves or other types of waves, and the particular gear ratios and disks speeds may be varied to produce different keying rates and ranges. Accordingly, it is desired that this invention be not limited by the particular details of the embodiments disclosed herein except as defined by the appended claims.

What is claimed is:

1. An indicating device comprising a plurality of concentrically rotatable members having transparent apertures therein, said members having different speeds of rotation, and a plurality of light-producing devices positioned in fixed positions behind and illuminating respectively different portions of said members and being indicative of different signals.

2. An indicating device comprising a plurality of concentrically rotatable members having spiral apertures therein, said members having different speeds of rotation, and said spiral apertures having respectively different radial increases per revolution, and a plurality of light-producing devices positioned in fixed positions behind and illuminating respectively different portions of said members and being indicative of different signals.

3. An indicating device comprising a plurality of concentrically rotatable disks having spiral apertures therein, said disks having different speeds of rotation, and said spiral apertures having respectively different radial increases per revolution, and a plurality of light-producing devices positioned in fixed positions behind said members, each of said lights illuminating a different radial sector behind said disks and being indicative of different signals.

4. Electron discharge apparatus comprising a directive signal radiation system, means for deriving signals from said system indicative of different directions of radiation of signals with respect to said system, an indicating device comprising a plurality of concentrically rotatable members having transparent apertures therein, a plurality of light-producing devices positioned in fixed positions behind said members, and a signal translation system for coupling said radiation system to said light-producing devices, the signals fed to each of said light-producing devices corresponding to respectively different directions of radiation of signals with respect to said system.

5. Electron discharge apparatus comprising a directive signal radiation system, means for deriving signals from said system indicative of different directions of radiation of signals with respect to said system, an indicating device comprising a plurality of concentrically rotatable disks having transparent apertures therein, a plurality of light-producing devices positioned in fixed positions be-

hind said disks, each of said lights illuminating a different radial sector behind said disks, and a signal translation system for coupling said radiation system to said light-producing devices, the signals fed to each of said light-producing devices corresponding to respectively different directions of radiation of signals with respect to said system.

6. Electron discharge apparatus comprising a directive signal radiation system, means for deriving signals from said system indicative of different directions of radiation of signals with respect to said system, an indicating device comprising a plurality of concentrically rotatable disks having spiral apertures therein, said disks having different speeds of rotation, said spiral apertures having respectively different radial increases per revolution, a plurality of light-producing devices positioned in fixed positions behind said members, each of said lights illuminating a different radial sector behind said disks, and a signal translation system for coupling said radiation system to said light-producing devices, the signals fed to each of said light-producing devices corresponding to respectively different directions of radiation of signals with respect to said system.

7. Electron discharge apparatus comprising a directive signal radiation system, means for deriving signals from said system indicative of different directions of radiation of signals with respect to said system, an indicating device comprising a plurality of concentrically rotatable disks having transparent apertures therein, a plurality of light-producing devices positioned in fixed positions behind said disks, each of said lights illuminating a different radial sector behind said disks, a signal translation system for coupling said radiation system to said light-producing devices, the signals fed to each of said light-producing devices corresponding to respectively

different directions of radiation of signals with respect to said radiation system, and a keyer activated periodically for producing bursts of radiation from said radiation system.

8. Electron discharge apparatus comprising a directive signal radiation system, means for deriving signals from said system indicative of different directions of radiation of signals with respect to said system, an indicating device comprising a plurality of concentrically rotatable disks having spiral apertures therein, said disks having different speeds of rotation, said spiral apertures having respectively different radial increases per revolution, a plurality of light-producing devices positioned in fixed positions behind said members, each of said lights illuminating a different radial sector behind said disks, a signal translation system for coupling said radiation system to said light-producing devices, the signals fed to each of said light-producing devices corresponding to respectively different directions of radiation of signals with respect to said system, and a keyer activated periodically for producing bursts of radiation from said radiation system, activation of said keyer substantially coinciding with coincidence of the innermost portions of said apertures.

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