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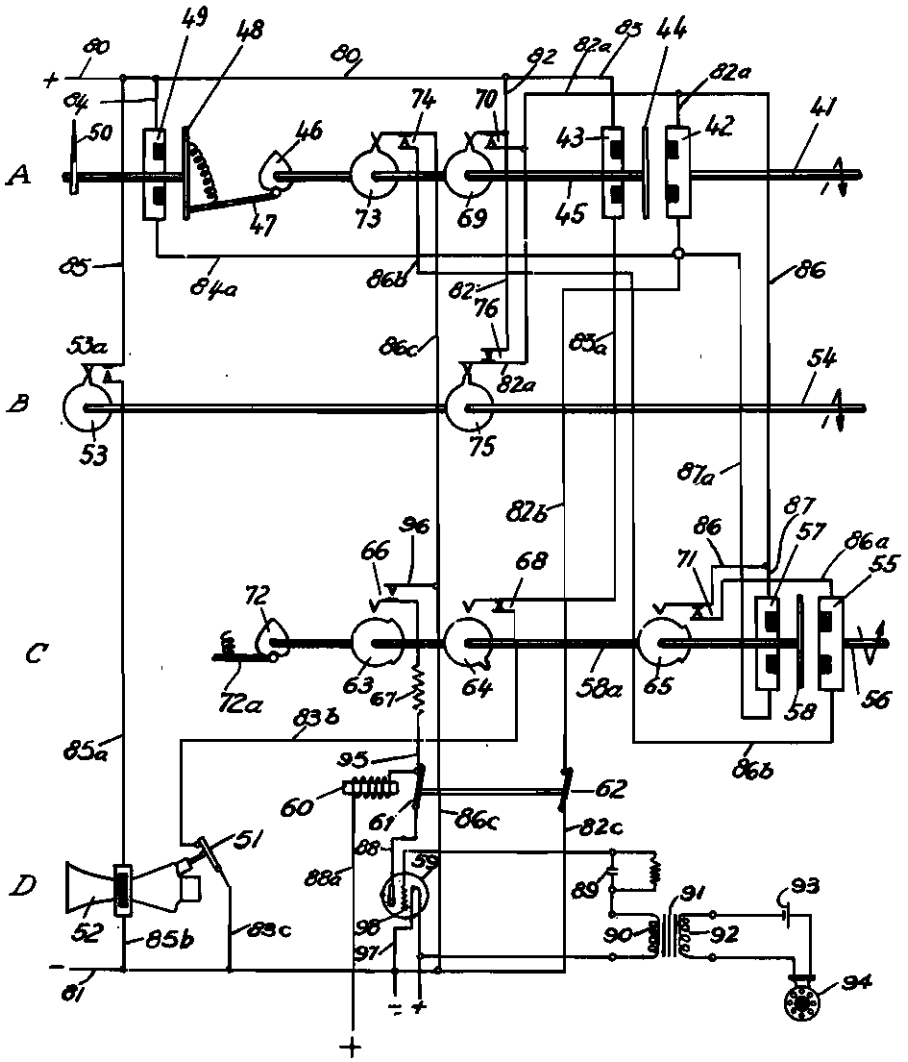

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ECHO SOUNDING DEVICE

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Application filed November 14, 1940

This invention pertains to an echo sounding apparatus of the type comprising measuring mechanism which travels at a constant rate during the period between the emission of a sound signal and the return of the echo and which gives an indication at the time the echo returns and is subsequently restored to starting position. In this type of apparatus difficulty arises through the periodic return to zero of the measuring mechanism, due to the fact that under certain circumstances, for instance at low altitudes, it is necessary to pause in the indicating position of the measuring mechanism, until the return of the latter to zero position is initiated. At high altitudes the time of pause in the indicating position is short. Also the time required to return the mechanism to zero is short, but for this reason the following pause in the zero position until the sending out of a new sounding signal is long. However, since the measuring device has to be made up for a certain range of altitudes, this superfluous period of delay had to be provided for. On this account the succession of soundings was relatively slow. Such losses of time are now prevented and higher sounding speeds are obtained, by combining the indicating apparatus with a detaining relay providing for the return to zero of the measuring mechanism, which is set in operation by the echo. The result is that at the instant when the echo is received, and thereby the measuring procedure of the measuring mechanism is terminated, a cut-out relay comes into action, having a delay only sufficiently long so that the interval will provide for the resetting of a stationary indicator, for example, for the transmission from the measuring mechanism by remote control to the indicating device. It is then possible to increase the rapidity of repetition of the soundings by varying the rotary speed of the shaft which actuates the sound emitting switch, either automatically or by hand. It is also possible to arrange the sound emitting switch in such a way that it is actuated again immediately upon the return of the measuring apparatus to zero position. The conformance of the sequence of soundings to the elevation to be measured can thereby take place continuously or intermittently.

The invention will be described in detail by reference to the accompanying drawing, which shows diagrammatically one illustrative form of the apparatus.

This apparatus comprises a timing and indicating mechanism A, a repeater mechanism B, a detaining mechanism C, and a signal mechanism D. The timing mechanism is a known time interval measuring device, shown, for example, in the Patent No. 2,032,893 to Bernhard Settegast and Wilhelm Rudolph, which comprises a constantly running rotary magnet **42** mounted upon a shaft **41** rotating at constant speed, and opposite the running magnet a holding magnet **43**. Upon an axially shiftable shaft **45** there is fastened an armature disk **44** between the magnets **42** and **43**, which are separated by a narrow air gap. Upon the shaft **45** of armature disk **44** is fixed a heart cam **46**, acting through a spring-influenced control arm **47** to set an indicator armature disk **48**. The armature disk **46** can be held stationary by a locking magnet **49**, whereby a pointer **50** fixed rigidly to the armature disk **48** is locked. The pointer **50** can be made as a stationary indicator itself, or it can be constructed as a control device for operating an auxiliary indicating device, by means of electrical remote control, in a manner not illustrated in the drawing, but shown in the copending application of Peter Orlich and Hans Hartz, Serial No. 285,310, filed July 19, 1939.

The repeater mechanism B comprises a constantly rotating shaft **54** bearing a cam disk **53** which operates a switch **53***a* controlling the circuit of a sound emitter **52**, for instance of the kind shown in Fig. 1. The sound emitter circuit is preferably controlled by switch **53***a* through a relay, in a manner not shown in the drawing, but which will be readily understood.

The detaining mechanism C comprises a second time interval measuring device similar to the one first described, comprising a constantly running rotary magnet **55** mounted on a drive shaft **56** running at constant speed, a holding magnet **57**, and a disk armature **58** fixed to an axially shiftable shaft **58***a*. The shaft **58***a* has fixed to it cams **63**, **64** and **65** to operate switches **66**, **68** and **71** in a manner to be described presently. The shaft also has fixed to it a heart cam **72** coacting with a spring-influenced arm **72***a* in a manner which tends to return the shaft to a certain zero position, when the armature **56** is released by the demagnetization of both magnets **55** and **57**.

The signal control devices D include, in addition to the signal emitter **52**, a starting switch **51** for the measuring mechanism, which may be a pneumatic switch such as **38** in Fig. 3; a relay-operated switch mechanism **60**, **61**, **62**; and an electron tube **59** to the grid of which the echo receiver (not shown) is connected, for instance, in the manner shown in the above-mentioned Settegast and Rudolph Patent No. 2,032,893.

The apparatus is shown in its starting position at the instant the repeater cam **53** has opened switch **53***a* to energize the sound emitter **52**. At this time, which terminates the condition of rest of the apparatus, the holding magnet **43** of the measuring mechanism stands energized, switches **51** and **68** being closed, and shaft **45** is thereby held at zero position. In the condition of rest of the apparatus prior to the signal emission,

switches 76 and 70 are both open and the circuits of running magnet 42 of the measuring mechanism and holding magnet 57 of the detaining mechanism are broken. The circuit of running magnet 55 of the detaining mechanism is broken by switch 74. The shaft 56a is held in position of rest by heart cam mechanism 72, 72a. The relay 60 is excited through its circuit including electron tube 59 and holds closed switch 62 controlling the circuits of running magnet 42 and holding magnet 57. The circuit of locking magnet 49 is closed through switch 62, thus retaining the pointer 50 in its previously set position.

Just prior to the actuation of switch 53a by cam 53, the cam 75 closes switch 76 and thus excites the running magnet 42 of the measuring mechanism and holding magnet 57 of the detaining mechanism. The armature 44 remains attracted by holding magnet 43, but armature 58, which has been free, is attracted by holding magnet 57 and held in its normal angular position shown. At the instant that the signal is emitted switch 51 is momentarily opened and the circuit of holding magnet 43 is broken, which allows the armature 44 to jump to the previously energized running magnet 42. As soon as armature 44 begins to turn, switch 78 closes, completing holding circuits for the running magnet 42 and holding magnet 57. This condition continues until the echo is received, at which time simultaneously the measuring mechanism 42—44 stops the shaft 45 and the detaining mechanism 55—57 sets in operation the shaft 58. This occurs, according to the example illustrated, through the effect of the echo upon the grid charge of the electron tube 59, which momentarily blocks the circuit of the electron tube and demagnetizes relay 60. The contacts of switches 61 and 62 open the switch 61, serving to cut out completely the exciting current of relay 60, while switch 62 cuts out the running magnet 42 of the measuring mechanism and the holding magnet 57 of the detaining mechanism. Hereby the armature disk 44 of the measuring mechanism is attracted by the holding magnet 43, the switch 51 having meanwhile closed, and is brought to rest, locking the heart cam 48 in an angular position which corresponds to the time interval between the signal emission and the echo reception. If this position is different from the one which controlled the previous setting of the pointer 50, the spring of lever 47 is under tension, tending to pull the disk 48 toward the new setting. The circuit of holding magnet 49 is broken by switch 62 simultaneously with the opening of the circuit of running magnet 42, so that the armature disk 46 is released and allowed to assume the new position corresponding to the setting of heart cam 46, moving with it the pointer 50. The opening of switch 62 breaks not only the circuits of running magnet 42 and holding magnet 48, but also the circuit of holding magnet 57 of the detaining mechanism. The running magnet 55 having been excited by closure of switch 74 when shaft 45 began to rotate, armature 58 jumps to the running magnet, when the holding magnet 57 is deenergized, and shaft 58a begins to rotate. Cams 63, 64 and 65 become operative upon their respective switches successively. Cam 63 first closes switch 66, which applies voltage to relay 60 through a resistance 67 and thereby excites the relay. Switches 61 and 62 are thus closed and the holding circuit of relay 60 through tube 59 is restored to ready condition. The closure of switch 62 completes the circuit of holding magnet 49, locking the armature disk 48 and its pointer 50. Shortly after, the cam disk 64 momentarily opens switch 68, breaking the circuit of holding magnet 43 and allowing armature 44 to jump back to the running magnet 42, previously excited by closure of switch 62. The rotation of shaft 43 thus recommences and continues until cam 69 raises switch 70 and interrupts the circuit of running magnet 42. The circuit of holding magnet 43 having been reestablished by closure of switch 68 after its momentary opening, the armature 44 jumps to the holding magnet and holds the shaft 45 in starting position.

Meanwhile, the detaining mechanism 55—58 is restored to starting position in the following manner: Upon the closure of switch 62 the circuit of holding magnet 57 was completed and this magnet reenergized, but without effect, at that time upon armature 56, which was held by running magnet 55. A short time after the cam disk 64 again sets in operation the measuring mechanism shaft 45, cam disk 65 opens switch 71, breaking the circuit of running magnet 55 and allowing the armature 58 to jump to the holding magnet 57, which had been reenergized by closure of switch 62. The armature 58 and its shaft 56a are held stationary until shaft 45 has reached the starting position shown in the drawing, at which time the circuit of holding magnet 57 is broken by the opening of switch 70. The armature 58 being now freed from both magnets 55 and 57, the heart cam mechanism 72, 72a, turns the shaft 58a, with its cams 63, 64, 65, back to starting position. The closure of switch 71, as cam 65 moves away from it, is without effect, because the circuit of running magnet 55 is open at switch 74. The whole apparatus is now again in ready position.

This conception for eliminating the waste time delay is obviously not limited to the illustrative example. The example itself, in the first place, can be changed in a number of respects. For instance, the shafts 41 and 53, or even all the shafts 41, 54 and 56, can be driven in common. It is also possible to unite the two timing mechanisms 42—44 and 55—57. Also the cam disks can be replaced by equivalent devices, for instance induction switches. Furthermore, it is not necessary to limit the device to the particular form of detaining relay, as shown in the illustrative example. Any desired form of detaining relay could be used, the detaining time of which is just long enough to allow for a setting of the stationary indicator. Furthermore, the detaining relay, under certain conditions, can be replaced by an equivalent electrical reversing mechanism, known per se, which operates with a given delay.

Finally, all these devices can be used in any kind of echo sounding apparatus, which operate by the method of returning to zero position. They are therefore not limited to acoustical soundings, but can also be used with advantage, for example, for electromagnetic echo soundings.

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