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METHOD AND APPARATUS FOR DISTANCE AND DIRECTION MEASUREMENT

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2 Sheets-Sheet 1

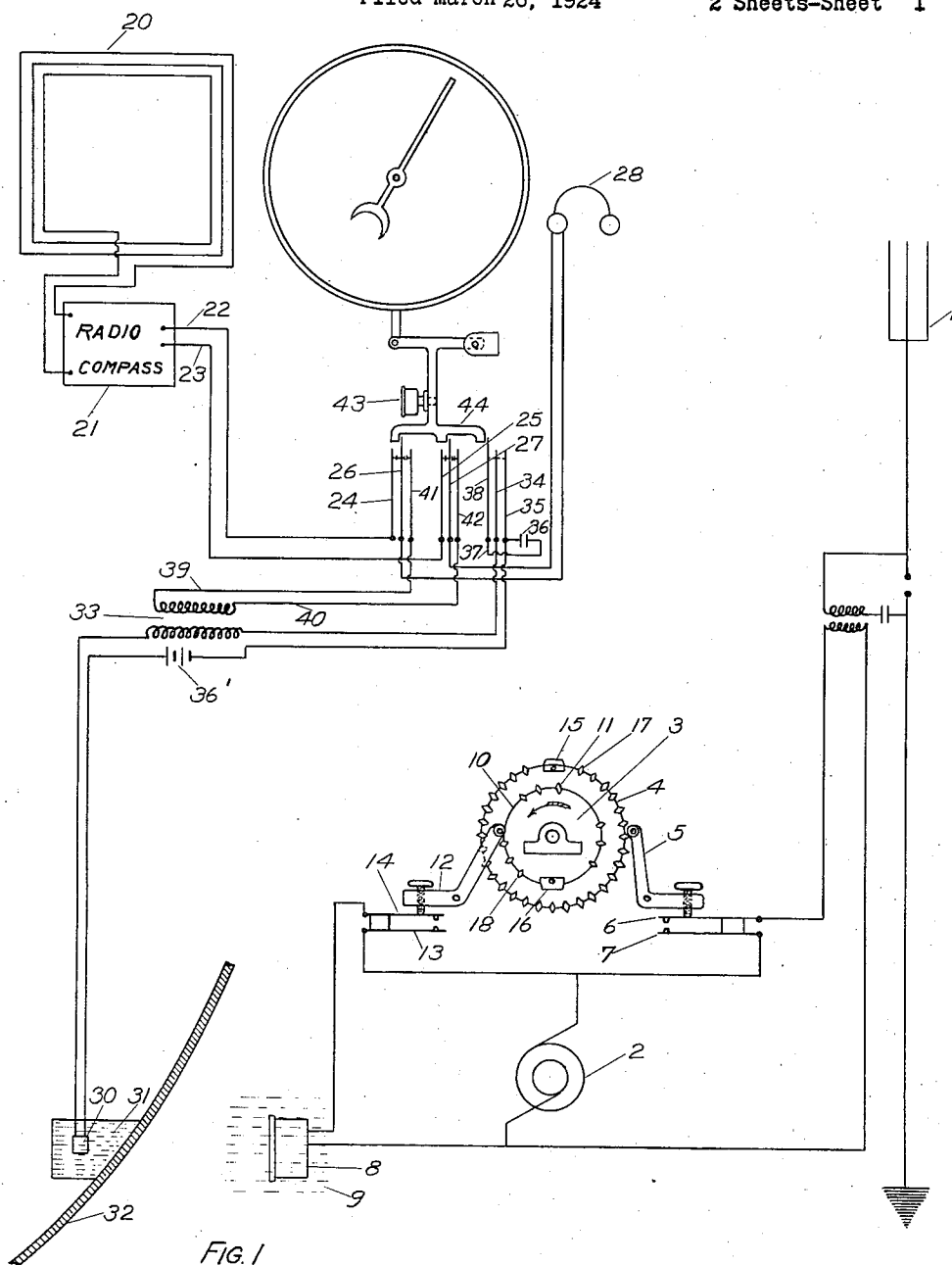


FIG. 1

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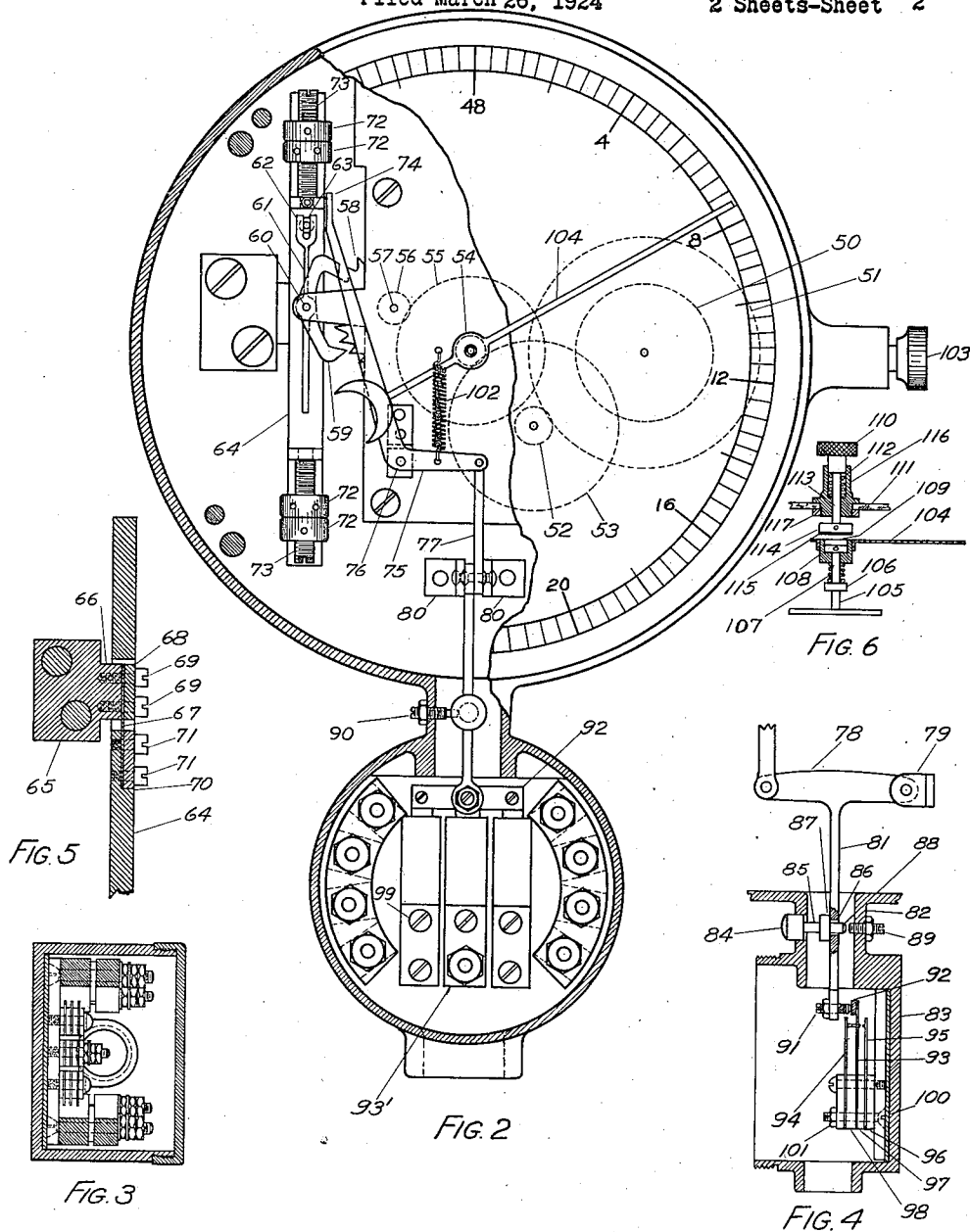
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2 Sheets-Sheet 2



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METHOD AND APPARATUS FOR DISTANCE AND DIRECTION MEASUREMENT.

Application filed March 26, 1924. Serial No. 702,082.

In my present invention, a wave of electromagnetic energy is sent at the same time that a compressional wave is sent in the water. The distance between the sending and receiving station is measured by noting the elapsed time between the arrival of the electromagnetic wave and the sound wave at the receiving station. Although the present specification embodies only the use of electromagnetic waves and sound waves in water it is conceivable to use other combinations of waves having different velocities in their transmitting mediums, such for instance, as sound waves in water and sound waves in air.

In the preferred embodiment of my invention, I use a submarine oscillator or some form of sound transmitting means to transmit a sound in water at the same time that an electromagnetic wave is sent through the air. At the receiving station, the electromagnetic signal is heard first by the observer who presses a button immediately upon hearing the signal, thereby simultaneously disconnecting the radio receiving circuit, connecting the submarine receiving circuit and at the same time starting a stop watch. Upon the receipt of the submarine signal, the observer releases the button which he has pressed, the watch is stopped and the radio receiving circuit is again connected, all by the single operation of releasing a button. This is a distinct advantage in the present system as will appear from the description of the apparatus in the specification.

Another feature of this invention is that direction may be found with the submarine signal in the usual manner or with the radio signal alone while the distance of the sending station is being determined.

Another feature of my invention is that the radio receiving apparatus is in circuit at all times and entirely disconnected from the submarine receiving circuit so that electrical effects which may be induced in one circuit will not affect the other.

Additional features of my invention involve the clock mechanism which is started and stopped by the pressing and releasing of a button, the character of the code signal and other features which will become evi-

dent from the following description and drawing in which:

Figure 1 represents a schematic view of the invention.

Figure 2 shows the clock mechanism.

Figure 3 shows a detail of the electrical connections in the clock.

Figure 4 shows a section through the lower part of Figure 2 showing a cross section of the switch and lever mechanism.

Figure 5 shows a detail of the clock mechanism.

Figure 6 shows the structure of mounting the hand upon the driving spindle of the clock.

As shown in Figure 1, on the right there is a sending station comprising a radio sending apparatus of any of the well known types and also a submarine oscillator or bell capable of emitting sounds in water. The radiant energy of the antenna 1 is derived from a generator 2 in the usual manner known in the art when the circuit is closed by the code machine 3 through the action of the dogs of the wheel 4 on the lever 5 making a contact between the spring blades 6 and 7. In Figure 1, the generator 2 also furnishes the power for the submarine sound sender 8 immersed in the liquid 9 but this is not necessary as the oscillator or other sounder may be operated under separate power. The wheel 10 of the code machine 3 controls the sending circuit of the oscillator 8. Each time a dog 11 comes under the lever 12, the spring 14 is forced downward and with spring 13 closes the sending circuit and a sound is thereby emitted from the oscillator.

The code of the code machine is of such a character that the complete signal is extended over a period long enough to allow the sound signal to reach its maximum audible range. At present this limit is about fifty miles which is equivalent to about one minute of time since sound travels about 4800 feet per second in water. A long warning dash is sent out each minute simultaneously by water and radio as shown by the dogs 15 and 16, followed by a dot which is also sent simultaneously by water and radio as shown by 17 and 18. The operator listens to the code of the radio transmitter and, upon hearing the warning dash, will be pre-

pared upon the following dot to press the button starting his timing mechanism and connecting the submarine receiver as shown in the left of Figure 1. When the operator
 5 hears the warning dash through the microphone of the submarine receiver, he will be prepared to release the button upon the next following dot, thus stopping the timing
 10 mechanism and connecting his radio circuit again to his telephones. Since the cycle of signals is repeated, as shown by the code mechanism in Figure 1, it will be obvious that after determining the distance by releasing the button, before the operator again
 15 has an opportunity of checking his measurement, some time must elapse until the button is pressed and the timing mechanism is again started. During this interval, the radio circuit is connected to the operator's
 20 telephone and affords an opportunity of determining the direction of the sending station before taking the next distance measurement.

Between the times of these signals, the
 25 usual code of the station may be sent and the operator may use the radio receiving circuit to determine the direction of the sending station, or he may use the submarine signal to determine the direction of the sending
 30 station, or he may determine the direction by one means and check this finding by the other means.

In the left of Figure 1, the radio waves are received upon a loop antenna 20, detected
 35 and amplified by the radio compass 21, used together with the loop antenna. The output leads 22 and 23 of the radio compass connect to the switch blades 24 and 25 respectively
 40 which are normally in contact with blades 26 and 27 respectively leading the current to the head telephones 28. It is evident therefore that normally the radio circuit is connected to the telephones of the listener.

The submarine signal is received in the
 45 usual manner by means of a microphone 30 in a liquid tank 31 abutting the skin of a vessel 32 or by any other submarine receiving device adapted for the purpose. The microphone receiving circuit comprises a trans-
 50 former 33, the switch blades 34, 35 and the battery 36'. There is also shunted across the switch blades 34 and 35 a condenser 36 by means of a lead 37 connected to the third
 55 blade 38 of the microphone switch. Normally the battery 36' furnishes no power. When the microphone circuit is closed first, the blade 38 comes in contact with the blade 34 shunting the condenser across the micro-
 60 phone and then the blade 34 comes in contact with the blade 35 completing the closing of the circuit. In this manner the first rush of the current is absorbed by the condenser and prevents packing of the microphone insur-
 65 of the microphone. The same effect takes

place in the reverse action where the contact is first broken and then the condenser is disconnected from the circuit.

The secondary of the transformer 33 is connected by the leads 39 and 40 to the
 70 switch blades 41 and 42 respectively which are connected to blades 26 and 27 respectively leading to the head telephones when the button 43 is pushed to the right.

When the button 43 is pushed to the right
 75 in Figure 1 the clock mechanism, which will be described later, is set in motion at the same time that the blades 26, 27 and 38 are bent to the right by the arm 44. The contacts between 26 and 24 and between 27 and
 80 25 are thereby broken and the new circuit to the head telephones is made through 26 to 41 and 27 to 42 connecting the head telephones to the secondary of the transformer 33 and thereby in receiving relation to the
 85 microphone.

The details of the clock mechanism are shown in Figure 2, and reference is made to the application of D. W. Mann, Serial Number 455,805, Division 47, filed March 26,
 90 1921, for other features of this clock not embraced in this invention.

The main spring is shown dotted at 50 which is controlled in the usual manner successively through the gears 51, 52, 53, 54, 55,
 95 and 56. The spindle 57 of the gear 56 carries the escapement wheel 58 of the usual construction. The escapement lever 59 works in the teeth of the escapement wheel 58 allowing a step by step movement of the wheel
 100 58 as the lever oscillates back and forth. On the same shaft 60 as the escapement lever 59 is mounted, there is also mounted a spring lever 61 which oscillates with the lever 59. The spring lever 61 has a forked end 62
 105 working on a pin 63 mounted upon the vibratory member 64 whose period controls the action of the hand and timing of the clock. The vibratory member 64 is shown in section in Figure 5. The block 65 has a
 110 projecting piece 66 in which is clamped the spring 67 by the clamping piece 68 and the machine screws 69, 69. The other end of the spring 67 is clamped to the member 64 by the clamping piece 70 and the screws 71, 71.
 115

The timing is effected by the adjusting
 nuts 72, at both ends of the member 64, Figure 2, on the screw threads 73.

The flat face 74 of the bell crank lever
 120 75 normally presses against the side of the vibrating member 64 when the clock is not in operation. This lever 75 is mounted upon an axis 76 about which it operates. The other end of the lever 75 is connected to a rod 77 which is hinged similarly at its other
 125 end to an end of a T shaped lever 78; see Figure 4. The other end of the T lever is pivoted in a fixed bearing 79, as shown in Figure 2 by the bracket bearings 80, 80. The stem 81 of the T lever passes through
 130

the neck 82 of the clock case to the switch case 83. The push button has a head 84 which screws onto a neck 85 passing through a hole 86 in the lever stem 81. A collar 87 is formed upon the neck and presses against the stem 81, while the end 88 of the button presses against the adjustable stop 89 when the button is operated. The button is prevented from falling out by the screw 90 which works in the stem or neck 85 of the button.

The lower end of the stem 81 carries an adjustable screw 91 which presses against the block 92 mounted upon the spring switch 93 as shown in Figure 2. The piece 92 is of insulating material and is fastened into the end blades of the switch 93 and rests upon the center blade 93'. Normally when the radio circuit is in operation as shown in Figure 1, the switch blades of 93 make contact with the forward blades 94 which correspond to the blades 24, 25, of Figure 1. The blades 95 are connected with the blades of 93 when the radio circuit has been disconnected and the submarine microphone is connected. These blades correspond to the blades 41, 42, and 35 of Figure 1. The blades 93, 94, and 95 are mounted between the insulated blocks 96 and 97, and 97 and 98, which are held in place by the screws 99 and the screw and nut 100 and 101 respectively, which also serves to hold the whole switch block in place as shown. The screws and the nut are insulated so that no connection is made between blades except in the manner prescribed.

To return the button to position quickly when the submarine signal is received as mentioned above, a coil spring 102 is provided which tends to pull one end of the lever 75 upwards thus forcing the end 74 of the lever 75 against the vibrating member 64 and preventing the member 64 from oscillating, thereby stopping the clock, while at the same time it causes the end 78 of the T lever to move upwards as shown in Figure 4, thereby forcing the button outwards and also releasing the pressure of the screw 91 upon the bar 92 allowing the blades of the contact 93 to contact again with the blades 94.

The clock is wound by turning the winding knob 103 as shown in Figure 2.

Figure 6 shows the manner of setting the clock indicator 104 back to the zero mark after each operation. The hand 104 is rotated by means of the spindle 105 operated through the gear 55. The spindle 105 carries a collar 106 which holds a spring 107 coiled about the spindle 105 and pressing against a cup 108 about the upper rim of which the indicator hand is mounted. Pinned to the spindle 105 is a disc or collar 109 which normally sets into the base of the cup 108 when the cup is forced upwards by the spring 106.

The knurled knob 110 is directly over the hub of the hand 104 and operates through the glass cover 111 to set the hand. The knob 110 is centered upon a spindle or rod 113 which passes through the glass and has pinned to its end a disc 114 fitted with a friction surface such as felt 115. The knob 110 rests upon a coil spring 112 in a cup 116 fitting through a hole in the glass. The lower end of the cup is threaded and extends sufficiently below the lower surface of the glass so that a small nut 117 may be screwed to the cup and hold the whole mechanism in place. To set the hand 104 it is simply necessary to press the knob 110 downward and turn it at the same time. The felt disc 115 grips the indicator 104 at the same time that the latter is released from the spindle 105 so that as the knob 110 is turned the hand 104 follows after it.

The manner of operation and method involved has been indicated somewhat throughout the description of the apparatus.

The velocity of transmission of electromagnetic waves is so much greater than sound waves in water that the interval between the sending of the signal and its reception by radio may be neglected and the time of the reception of the radio signal may be taken as the time at which the submarine signal, which is sent simultaneously with the radio signal, was sent from the sending station. The operator normally has the apparatus connected so that he is listening to the radio signals as indicated by the contacts as set in Figure 1. He may hear the code signal of the sending station and adjust for its direction by means of the loop 20 of Figure 1. He then will hear the long warning dash as indicated by the dog 15 which will tell him to be ready to press the button 84, corresponding to 43 of Figure 1, when the sharp dot follows as indicated by the dog 17. At the time the operator hears the dog 17, he presses the button 84 which pulls down the rod 77 and releases the member 64 which vibrates and causes the hand 104 to rotate from its zero position at which it has previously been set before listening was begun. The operator must press the button quickly if the clock is to go since a slow press of the button will release the member 64 slowly and the latter will, therefore, not have enough energy to carry it over its center position and allow the action of the main spring to continue the oscillation. This may easily be understood when it is noted that the vibrating member 64 and the face 74 move in the same direction and the latter must move quickly enough to allow the vibrating member to move freely and without touching the face 74. This is a distinct feature since it insures quick action in starting the clock and slight lag between hearing the radio signal and the starting

of the clock by the operator. The hand will then rotate indicating the distance until the operator hears the submarine signal through the microphone which is now connected through the contact members 93 and 95. When the submarine signal is heard the operator releases the button which stops the clock and connects the ear telephone with radio receiving circuit. The indication of the hand may be read upon the dial which, as shown in Figure 2, indicates the distance in miles. When the indicator has made one revolution 48 will have to be added to the indicated value to get the total distance. By gearing the hand differently, the spaces may indicate greater distance and one revolution made to serve the maximum range.

Having described my invention I claim:

1. A means for measuring distance by the use of electromagnetic and sound signals which are sent simultaneously from a sending station, comprising means for receiving said electromagnetic signal, means for receiving said sound signals, said means having a common indicating means, switching means for changing the connections of said indicating means from said electromagnetic receiving means to said sound receiving means, a normally inoperative timing mechanism, manually operated means for simultaneously setting said timing means into operation and operating said switching means to change the connection of the indicating means from the electromagnetic receiver to the sound receiver.

2. A system for direction and distance determination, comprising in combination, means for sending simultaneously radio and submarine compressional wave signals consisting of a warning signal followed by a timing signal and further code signals at repeated intervals, and means for receiving at the receiving station and making measurements of direction and distance comprising means for receiving radio signals and determining the direction thereof, means for receiving the submarine signals, switching means normally positioned for the reception of the radio signals at the receiving station, measuring means, means manually operated, for simultaneously commencing the operation of the measuring means and operating the switching means to position the latter for the reception of said submarine signal and means including in part said previously claimed means for restoring the switching means and stopping the measuring mechanism upon the release of the manually oper-

ated means whereby the operator is free to determine the direction of the radio signals before the next warning signal is given.

3. In a system for direction and distance determination wherein a sending station is provided with means for sending simultaneously radio and submarine compressional wave signals and a receiving station is provided with means for receiving both signals and determining both direction and distance, means provided at the sending station for sending signals comprising, in repeated cycles, a warning signal, a timing signal, and designation code simultaneously both by radio and submarine means, said cycle being of sufficient period to allow the submarine compressional wave signals to reach their maximum audible distance before the cycle is again repeated.

4. In a system for distance determination, a receiving station including means for receiving electromagnetic and compressional wave signals, a measuring means, an operating lever connected therewith, a plurality of switch arms for connecting said receiving means to a listening device, a pivoted lever forked at one end for engaging said switch arms and connected at the other end to said lever for operating the measuring means and means manually operating said switch and said operating lever for operating the timing mechanism and changing from listening by said electromagnetic receiving means to listening by said submarine receiving means and means for restoring said mechanism upon the release of said manually operated means.

5. In a system for distance determination, a receiving station including means for receiving electromagnetic and compressional wave signals, a measuring means, an operating lever connected therewith, a plurality of switch arms for connecting said receiving means to a listening device, a pivoted lever forked at one end for engaging said switch arms and connected at the other end to said operating lever for operating the measuring means and means manually operating said switch and measuring lever for operating the timing mechanism and changing from listening by said electromagnetic receiving means to listening by said submarine receiving means and spring means for restoring said mechanism upon the release of said manually operated means.

In testimony whereof I affix my signature.

ROBERT LONGFELLOW WILLIAMS.