F. W. WOOD.
ELECTRIC INDICATOR SYSTEM.
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Inventor:

Frank W. Wood

By

Attorney
To all whom it may concern:

Be it known that I, Frank W. Wood, a citizen of the United States, residing at New York city, in the county of New York and State of New York, have invented new and useful Improvements in Electric Indicator Systems, of which the following is a specification.

My invention relates to electric indicator systems for transmitting signals and giving orders, and more particularly to systems more or less analogous to telegraphs, and especially adapted for use on shipboard for the purpose, for instance, of conveying information as to the course of a vessel, the number of revolutions made per minute by the engine shaft, or the angular position occupied by a torpedo gyroscope; or for making known such things as range, deflection, or a brief and specific battle order.

More particularly stated my invention comprehends among other things an electrically operated indicator somewhat in the nature of a receiver and having a number of magnetic members, and a revolvable indicating member controllable by the magnetic members, these magnetic members when in use being stationary and permanently spaced relatively to each other, yet so arranged as to confer polarity upon a revolvable pole piece so as to turn the latter step by step, the pole piece in turn conferring a step by step movement upon a revolvable dial.

My invention further relates to means for removing and replacing the several magnetic members practically as a single unit by grouping all of said magnetic members, and various parts immediately associated therewith, in a frame and providing detachable connections to facilitate the removal and replacement of this frame relatively to the casing.

My invention further relates to various advantageous arrangements of diver parts whereby the efficiency of systems of this character and mechanism of the various types employed are greatly increased. In this connection it may be explained that in my system the indicator used makes provision for shifting, step by step, the angular position of a revolvable pole piece by virtually shifting the location of a magnetic field extending in the general direction of the length of the pole piece, so that although the pole piece moves step by step, yet the various magnetic members for conferring polarity upon the pole piece have, while in use no motion whatever, the motion of the pole piece being produced, as above indicated, by virtual movements of the magnetic field alone.

My invention admits of use in a great variety of independent relations and the specific apparatus employed may be changed within wide limits without departing from the spirit of the invention. The particular devices may with very little alteration be so grouped as to constitute range, deflection, and battle order instruments, or devices for indicating the course of a vessel, the position of a torpedo gyroscope, the revolutions made by the engine shaft per minute, or an angle to be indicated for any purpose whatever.

Generally speaking my system includes a number of transmitters and a number of indicators placed together in a single receptacle at the transmitting station and a similar aggregation of like mechanisms at the receiving station. This enables the operator at the receiving station to repeat back an order which he has received, or a signal which has been made known to him.

Reference is to be made to the accompanying drawings forming a part of this specification and in which like letters indicate like parts.

Figure 1 is a front elevation of my improved indicator which in this instance contains five pairs of peripherally spaced magnets, the revolvable dial, however, being removed. Fig. 2 is a substantially central section through the indicator. Fig. 3 is a substantially central section through another form of my indicator which in this instance contains only two magnets. Fig. 4 is an elevation of the indicator shown in Fig. 3. Fig. 5 is a diagram illustrating the wiring associated with the indicator shown in Figs. 3 and 4. Fig. 6 shows a convenient arrangement of wiring for the indicator appearing in Figs. 1 and 2. Fig. 7 shows how the wiring may be arranged for an indicator of the general type appearing in Figs. 1 and 2, but provided with three pairs of peripherally disposed magnets instead of five pairs. Fig. 8 is a diagram showing how a number of indicators and a number of transmitters may be conveniently grouped together and connected with wiring for any desired special
A purpose. Fig. 9 shows a telegraph instrument built in accordance with my system and used for indicating an angular deviation, such as that of a sailing course or of a torpedo gyroscope. Fig. 10 shows my invention used for purposes of an engine revolution counter. Fig. 11 is a perspective view of certain details of the controlling switch.

A casing 10 is provided with a window 9 (see Fig. 2) and is further provided with a depression 11; located within this depression is a plate 12 of insulating material. Another plate 13 of insulating material is secured to the casing by aid of bolts 14. The center of the plate 13 presses against the plate 12. Extending through the plate 13 are a number of metallic sleeves 15 severally provided with metallic leaves 16 to facilitate the proper connection of the sleeves 15 with various wires of a switchboard.

A metallic plate 17 having generally a circular form is fitted upon the plate 13 of insulating material and serves the purpose of a frame or spider for supporting various other parts. Secured to the plate 17 and extending outwardly therefrom are a number of rods 18, the outer ends of which are threaded and fitted with nuts 19. Carried by these rods 18 is a metallic plate 20, smaller than the plate 17 and parallel with the latter. Between the plates 20 and 17 are a number of magnets 21, 22 arranged in pairs as shown, each pair of magnets having a common axis as shown, perpendicular to said plates, there being in this particular instance five such pairs. Located between the five magnets 21 and the five magnets 22 is a ring 23 of insulating material, which serves to some extent as a brace or support for the magnets and is held securely in position by aid of the rods 18 which extend through the wall of the ring. Metallic strips 24, 25, constitute terminals for the magnets 21, 22, and are connected together in pairs by screws 26, one of which is shown in Fig. 2. The magnets 21 are also provided with terminal wires 27 at the ends of the magnets opposite the strips 24, as will be understood from Fig. 2. The magnets 21, 22, are provided with pole pieces 28, 29, the several pole pieces extending radially inward toward the central or axial line of the indicator.

Disposed concentrically of the central or axial line of the indicator are two solenoids 30, 31, in alignment with each other and supported by the plates 20, 17. The solenoid 30 is provided with a core 33 of magnetic material having a general tubular form and the solenoid 31 is provided with a core 34 similar to the core 33. Both of these tubular cores 33, 34, are mounted rigidly upon a revolvable spindle or shaft 32. The cores are provided with pole pieces 35, 36, secured rigidly to them and to the shaft 32 and extending in opposite directions as indicated in Fig. 2. The pole pieces 35, 36, are thus rendered revolvable with the shaft 32 and cores 33, 34. A milled nut 37 extends through the plate 20 and serves as an adjustable bearing for one end of the shaft 32. The end in question of this shaft supports a revolvable dial 22a which is provided with any suitable legends or indicating marks, for instance numerals 0 to 9 inclusive, so arranged that they may be observed through the window 9. Adjacent to the milled nut 37 is a spring 38 which bears on the milled edge of said nut and locks it against rotation. A wire 40 is connected with the various terminal wires 27 and has the general form of a ring, and acts as a common return wire as hereinafter explained. Dowel pins 41 extend through the wall of the casing 10 and also through the plate 13 of insulating material, so as to protrude from the latter. The plate 17 is provided with holes 42 for receiving the tapered ends of the dowel pins. The plate 17 together with the rods 18 and various magnets and other parts supported by the plate 17 may as a unit be removed and replaced relatively to the plate 13. Bolts 43 are provided for the purpose of holding the various parts just mentioned, considered as a unit, in place upon the plate 13. For convenience I will hereinafter designate the plate 17, bolts 18 and various related parts as a frame which carries the various magnetic members, with the shaft 32 and dial 22a. The frame and parts carried by it I conveniently designate as a unit. The dowel pins 41 serve to prevent mistakes in placing a particular unit against the plate 13; that is to say, if a particular unit and no other belongs to the plate 13 the operator will find it impossible to place upon the plate 13 some other unit which does not belong there.

The plate 17 carries a number of metallic plugs 44 constituting terminals for the magnets 22 insulated from the plate by encircling rings 44a of suitable material. The outer ends of the plugs 44 are split, as shown, to enter the metallic sleeves 15 in the insulating plate 13 and form therewith more or less resilient connections. The metallic sleeve 15, mounted within and extending through the plate 13 of insulating material, correspond in number to the magnets 22. I provide two additional sleeves 15a (see Fig. 1) corresponding to the solenoids 30, 31, and also provide two split plugs 15b for extending into these two last mentioned sleeves. These two plugs constitute the terminals of the solenoids 30, 31, which are in series with each other. The operator in order to remove the unit merely takes out the bolts 43, whereupon the plate 17 and parts carried by it may be pulled directly from the plate 13, the various plugs 44, 15a, 130
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becoming detached from the sleeves 15, 15. The various magnets 21, 22 being energized in proper sequence, the pole pieces 35, 36, shaft 32 and dial 22, are rotated step by step so that ten definite positions are given to the dial.

The indicator 300 shown in Figs. 3 and 4 differs from the one appearing in Figs. 1 and 2 in that the number of magnets is greatly reduced. In the indicator shown in Figs. 3 and 4 there are but two magnets and the dial has but two positions, to wit, the normal or neutral position and the active position. Such being the case the dial has merely the form of a fan. The casing 10 is fitted with a plate 45 of insulating material and mounted upon the casing adjacent to this plate is a thick plate 46 of insulating material. Extending through the plate 46 are metallic sleeves 47, 48, each provided with a metallic leaf 49, 50, to facilitate making electrical connections with wires or conductors suitable for the purpose.

A pair of plates 51, 52, made of metal are connected together by magnet cores 53, 54, which form, together with the plates 51, 52, practically a frame work, the cores 53, 54, also serving as parts of magnets 55, 56. These magnets are provided with stationary pole pieces 57 and 58 secured by bolts or plates 59 which also hold the magnets in place on the plate 52. A revolving shaft 60 is located between the magnets 55, 56, and is encircled by a spiral spring 61. One end of this spring is secured to the plate 51, and its opposite end is connected with a pole piece 62 on the shaft 60. A reduced portion of the shaft 60 extends through a milled nut 63 which serves as a bearing for the same. Adjacent to this milled nut and pressing upon it is a spring 64 which serves to hold the milled nut in any definite position in which it may be placed when turned by hand. By turning the milled nut 63 the dial 65 may be adjusted. The dial 65 having generally a fan-like form is mounted rigidly upon the reduced end portion of the shaft 60. When the magnets 55, 56, are energized, the stationary pole pieces 57, 58, acting by magnetic induction upon the revolving pole piece 62, cause the latter to turn, and thus shift the dial 65 from its normal position into its abnormal position. In doing this the tension of the spring 61 is increased. When, however, the magnets 55, 56, are deenergized the pole piece 62 under tension of the spring 61 returns to its normal position, carrying with it the dial 65 and shaft 60. I provide binding posts 66, 67, for use as terminals for the magnets 54, 55, as will be understood from Fig. 4.

In Fig. 5 I show a simple circuit suitable for use in connection with the indicator appearing in Figs. 3 and 4 with a simple type of transmitter. A switch arm 68 is mounted upon a pivot pin 69 and carries a pair of metallic shoes 70. The transmitter as a whole I conveniently designate by the numeral 71. It contains a metallic circle 72 and a number of metallic sectors 73, 74, 75 which are insulated at 75 from each other and from the circle 72. Current is supplied from any convenient source such as the ship mains. The positive wire is shown at 76, a two blade switch at 77, and a fuse at 78.

From this fuse a wire 79 leads to the transmitter 71 and is there connected to the metallic circle 72. Connected with the sector 74 is a wire 81 and similarly connected with the sector 73 is a wire 80. Wires 80, 81 are joined together and connected with a wire 82, the latter leading to the receiving station and being there connected to the magnet 56. A wire 83 connects the magnet 55 with the magnet 56, these two magnets being thus in series with each other at all times. The magnet 53 is connected by a wire 84 with a fuse 85. A wire 86 constituting the negative wire of the system is connected with one blade of the switch 77. The switch 77 being closed and the switch arm 68 being in the position indicated in Fig. 5, the following circuit may be traced.

Positive wire 76, right blade of switch 77, fuse 78, wire 79, metallic circle 73, metallic shoe 70, metallic sector 73, wires 80, 82, magnet 56, wire 83, magnet 55, wire 84, fuse 85, negative wire 86, to source of supply, thence back to positive wire 76. This energizes the magnets 55, 56, and causes the pole piece 62 to rotate half a turn carrying with it the shaft 60 and shifting the position of the dial 65. The switch arm 68 being turned in either direction a quarter of a revolution the circuit above traced is broken and the spring 61 now causes the shaft 60 and the dial 65 to turn back and assume their normal positions.

In Fig. 6 may be seen a convenient arrangement of wiring for the indicator shown in Figs. 1 and 2 and which I conveniently designate as a five-pole indicator. The transmitter or controlling switch is shown at 88. It contains a number of metallic sectors 91, 92, 93, 94, 94', insulated from each other and separated at their ends by small blocks 95 of insulating material.

The transmitter 88 is further provided with two circles 89, 90 of metal. A switch bar 96 carries a pair of shoes 97, 98, of conducting material, these shoes being each of a general arcuate form and engaging the various sectors and circles as indicated in Fig. 6. Connected with the circle 89 is a wire 99, and connected with the latter is a wire 99' which leads to the fuse 85. A wire 87 is connected with the circle 89 and extends therefrom to a wire 87' which is connected with the fuse 78. A wire 100 leads from the sector 91 of the switch 88 to one of the mag-
nets 22 of the indicator. Similarly wires 101, 102, 103, 104, lead from the various sectors 92, 93, 94, 95*, to the various other magnets 21. From these magnets wires 106, 107, 108 and 109, lead to the magnets 21, said magnets having their opposite ends connected to the common wire 40. A wire 110 extends from the solenoid 30 to the solenoid 81 connecting these solenoids in series.

A wire 111 extends from the solenoid 30 to the wires 87 and 87*. A wire 112 leads from the solenoid 31 to the wires 99, 99*. The switch 77 being closed and the switch arm 96 being turned into the position indicated in Fig. 6, a circuit may be traced as follows: wire 76, right blade of switch 77, fuse 78, wires 87*, 87, circle 89, shoe 97; here the current divides, a portion proceeding as follows: sector 91, wire 100, magnet 22 connected with this wire, wire 105, magnet 21 corresponding to the same, wire 40, a magnet 21, wire 108, a magnet 22, wire 108, sector 94, shoe 98, circle 90, wires 99, 99*, fuse 85, left blade of switch 77, negative wire 86 to source of supply, thence back to positive wire 76. The other portion of the circuit from the shoe 87 where the current divides as above stated assumes the following path: sector 92, wire 101, a magnet 22, wire 106, a magnet 21, wire 40, a magnet 21, wire 106, a magnet 22, wire 103, sector 94, shoe 98, circle 90, wire 99, wire 99*, fuse 85, left blade of switch 77, wire 86 to source of supply, thence back to wire 76. Another circuit which is completed independently of the transmitter 88 and consequently is normally closed whenever the switch 77 is closed may be traced as follows: wire 76, right blade of switch 77, fuse 78, wires 87*, wire 111, solenoid 30, wire 110, solenoid 31, wire 112, wire 99*, fuse 85, left blade of switch 77, wire 86 to source of supply, thence back to wire 76. This circuit energizes the solenoids 30, 31, and covers polarity upon the movable pole pieces controlled by these solenoids.

It will be noted that with the transmitter in the position indicated in Fig. 6, the shoe 97 contacts with two sectors 91 and 92, whereas the shoe 98 only makes contact with one corresponding sector to wit the one numbered 94. If, however, the switch arm 96 be turned slightly, say in a clockwise direction, the shoe 97 may be moved out of engagement with the sector 91, and the shoe 98 will then rest upon two sectors. Each successive step or movement of the switch arm 96 will cause one of its shoes 97, 98, to engage two sectors of the series numbered 91, 92, 93, 94, 95*, the opposite shoe for the moment engaging only one sector of this series and at the next successive position assumed by the switch arm the conditions are reversed the shoe which formerly engaged two sectors of the series, now engaging only one while the opposite shoe which had previously engaged only one sector of this series now engages two. The net result is that at any particular moment when a single magnet 22 is energized, two other magnents 22 approximately opposite the first mentioned magnet 22 in diametrical direction are also energized. Simultaneously an equal number of magnets 21 corresponding in position with the energized magnets 22 will be energized. At the next successive movement of the switch arm, however, the conditions are reversed, the single magnet 21 and the single magnet 22 being now assisted by the next successive magnets 21, 22, while diametrically opposite the two magnets 21 and the two magnets 22 thus energized, there is now only a single magnet 21 and a single magnet 22 energized. At any particular step in the movement of the switch arm there are six magnets energized, three of them being magnets 21 and the other three being magnets 22. The revolvable pole pieces do not turn at any one step a distance represented by the angle between consecutive magnets of the same series, but rather by distances representing half of this angle. If, therefore, as indicated in Figs. 1 and 2 there are five magnets 21 and five magnets 22, the revolvable pole pieces will have ten definite positions.

The system used as indicated in Fig. 7 differs but slightly from that indicated in Fig. 6; the chief difference being the number of magnets used in the indicator and the corresponding number of sectors used in the transmitter for the purpose of energizing the magnets. In the system as shown in Fig. 7, there are but three magnets in each series, the indicator being thus arranged to make six successive indications or steps. The transmitter is shown at 113, and the transmitter arm at 114, the shoes are shown at 115, 115* two metallic circles are shown at 116, 117, and at 118, 119, 120, are sectors insulated from each other by small blocks 121 of insulating material. The indicator is shown at 122 and is provided with magnets 128, 124, 125, 126, 127, 128. The magnets 123, 124, 125, corresponding in character to the magnets numbered 25 in Fig. 6, and the magnets 126, 127, 128 corresponding to the magnets 21 in said figure. The solenoids are shown at 129, 130, the revolvable shaft at 131, and at 132 is a wire 120 connecting the solenoids. A wire 133 extends from the sector 119 to the magnet 123. A wire 134 extends from this magnet to the magnet 126. A wire 135 having the general form of a ring is connected to the three magnets 126, 127, 128. A wire 136 extends from the magnet 124 to the magnet 127. A wire 137 extends from the magnet 128 to the magnet 125. Wires 138, 139, extend from appropriate sectors in the switch 113 to the 120.
magnets 124, 125. A wire 140 is connected with the fuse 78 and with the circle 117 of the transmitter 113. A wire 141 is connected with the circle 116 of this transmitter and with the fuse 85. A wire 142 is connected with the wire 140 and the fuse 78 and also with the solenoid 129. A wire 143 is connected with the solenoid 130 and with the wire 141, and also with the fuse 85.

The operation of the system as shown in Fig. 7 differs from that shown in Fig. 6 in no respect except that the number of steps executed by the transmitter is smaller and consequently a smaller number of movements or steps are indicated by the indicating mechanism 122. I do not deem it necessary to trace the circuits in Fig. 7 for the reason that the circuits in Fig. 6 are quite analogous to them, in fact if the circuits appearing in Fig. 6 are once understood those appearing in Fig. 7 will be obvious.

In Fig. 8, I show how the systems illustrated in Figs. 5, 6 and 7 may be employed together, that is, the various transmitters and receivers may be grouped together and even placed in a single casing, the wiring being for the most part similar to that above described with reference to Figs. 5, 6 and 7.

An audible signal or bell circuit is also shown in connection with each transmitter. I will now point out such differences as there may be in the wiring. The mains are shown at 144, 145, a two-blade switch at 146, fuses at 147, 148, and connected with these are wires 149, 150. Connected with the wire 149 is a wire 151 which leads to the outer circle 89 of the transmitter 88. A wire 154 is connected with wire 151 and leads to the circle 72 of the transmitter 71. A wire 155 is connected with the wire 151, and leads to the outer circle 117 of the transmitter 113. A wire 156 is connected with the wire 150 and leads to the inner circle 90 of the transmitter 88. A wire 157 branches from the wire 156 and leads to the inner circle 116 of the transmitter 113.

The transmitters 88 and 113 are connected to their receivers in the same manner as in Figs. 6 and 7 respectively, the same reference numerals being used to designate similar parts. From the main 149 a wire 173 is carried to the solenoid 30 which is connected by a wire 110 with the solenoid 31 and the latter by a return wire 167 is connected to the other main 150. A branch wire 173 connected to the wire 173 extends to the solenoid 129 from which latter a wire 192 passes to the solenoid 130. A return wire 169 leads from the latter solenoid to the return wire 170. From the contact sectors 71°, 71°, and 71° of the transmitter 71°, wires 175, 176 and 176° respectively extend and are joined to a common wire 174 leading to the magnet 56 of the two magnet receivers 300.

A wire 83 connects magnet 56 with magnet 55, from which latter magnet a wire 171 extends to and is connected with the return wire 172.

From the foregoing description relative to Figs. 5, 6 and 7, the operation of the mechanism shown in Fig. 8 will be readily apparent. Suffice it to say that the switch 88° controls an indicator containing ten magnets and in which the indicating mechanism discloses ten distinct positions; the transmitter 113° controls an indicator containing six magnets and having a maximum of six steps or indications; transmitter 71° controls a very simple form of indicator having only two steps or positions.

The receivers hereinabove described may be grouped to form a telegraph signal instrument on any combination most suitable for the end in view. If, as shown in Fig. 9 the instrument is to indicate degrees, the maximum reading of which is 360, a five magnet receiver such as shown in Figs. 1, 2 and 6 will be employed to display the units number; a similar or if preferred a three magnet receiver as in Fig. 7 may be used in the tens position; a three magnet receiver will be sufficient for the hundreds position. When used as an engine counter to record the revolutions when the maximum number to be shown is 199, see Fig. 10, the units and tens places will be filled each by a five magnet receiver, while a two magnet receiver such as represented in Figs. 3, 4 and 5 will be all that is necessary in the hundreds place and where "0" and the numeral "1" are the only characters displayed. Additional receivers will be added when numbers as high as the thousands and ten thousands are to be signaled as will be the case when used as range signals. To operate the receivers, a separate transmitter must be provided for each receiver.

Forming a part of transmitter 88°, Fig. 8, is a ring or circular series of contact sectors 88°, ten in number, separated by insulating strips 88° and connected electrically by short wires as shown. One of the shoes, as 97, on the switch arm 96 contacts at its outer end only with the sectors 88°, and as the switch arm is turned closes a circuit through an electric bell 165. The shoe 97 has its central portion raised so that only its extreme lateral ends rest upon or contact with the sectors 88° when the circuit is to be closed through two of said sectors. The depending ends of the shoe 97 are spaced sufficiently far apart to bridge a sector when said ends rest upon two insulating strips 88°. When however the shoe 97 is in any one of its ten indicating positions the bell circuit is broken because the shoe ends bear on two insulating strips 88°, as in Fig. 8 and bridges a contact sector 88°. A similar ring of six contact sectors 113° forms a part of transmitter 113°.
and a like ring 71° is employed in connection with the transmitter 71°. In each instance the sections are separated by insulating strips and electrically connected by short wires as shown.

Electrical connections between the several rings of contact sectors and the bell are made as follows: A wire 158 extends from one of the sectors 88° to a sector 71°, from which wire a branch 160 extends to a sector 113°. A wire 161 joined to the wire 158 extends to a bell 165 connected by a wire 162 to the return wire 167. As thus connected, whenever any one of the transmitters is actuated a portion of the current to the indicator by the wire 151 is shunted through the bell circuit every time a shoe on a transmitter switch arm makes contact with one of the sectors 88°, 113° or 71° in the bell circuit. If, for instance, transmitter 88° be actuated, every time the shoe 97 on the switch arm 96 makes contact with a sector 88°, a portion of the current passing through the switch arm will be deflected to the sector, and from one to another by the connecting wires to the wire 151, thence by wire 161 to bell 165, and back to main through wire 162 and return wire 167. This would cause the bell to sound and apprise the operator at the receiving station that an indication is being made or changed. Any movement of any one of the transmitters thus causes the alarm to be sounded, and the operator notified. It is only during the rotation of the switch arm of the transmitter when one of the depending ends of the shoe 97 contacts with a sector 88° as it moves that the bell circuit is closed. When the switch arm is in position to indicate a numeral, the shoe bridges a sector or lies on an insulating strip and so prevents closing the bell circuit.

Having thus described my invention, what I claim is:

1. In an electrically operated indicator, the combination with an insulating base block having contact sockets embedded therein, of an indicating unit removably mounted on said block comprising a base plate, a plurality of electromagnets affixed on said plate about a common axis in two aligned rows, a solenoid in the center of each row, and a revolving shaft common to said solenoids carrying a core and pole piece for each solenoid, and an indicating device, projecting contact plugs connected each to an electromagnet of one row and to each solenoid mounted on said base plate and insulated therefrom in position to enter said contact sockets when the indicating unit is placed in position, pins projecting from said base block to enter perforations in the base plate and guide said indicating unit toward said block and insure proper connection between said contact sockets and plugs, and fastening means for removably securing said indicating unit to the insulating block.

2. In an electrically operated indicator, the combination with an insulating base block having contact sockets embedded therein, of an indicating unit removably mounted on said block comprising a base plate, a plurality of electromagnets arranged in two groups about a common axis, said groups separated by an insulating ring, means for securing one group of said magnets directed to the base plate, separate means for securing the other group of magnets to said base plate in such manner as to permit removal thereof independently of the first group, and fastening means for removably securing the indicating units as a whole to said block.

3. In an electrically operated indicator, the combination with an insulating block having contact sockets embedded therein, of an indicating unit removably mounted on said block comprising a base plate, a plurality of electromagnets arranged in two groups about a common axis, said groups separated by an insulating ring, means for securing one group of said magnets directly to the base plate, separate means for securing the other group of magnets to said base plate in such manner as to permit removal thereof independently of the first group, a solenoid in the center of each group of electromagnets, one of said solenoids being connected to the base plate and the other removable with the group by which it is encircled, projecting contact plugs connected each to an electromagnet in the first-named group and to the two solenoids, mounted on said base plate and insulated therefrom, said plug being in position to enter said contact sockets when the indicating unit is placed in position, and fastening means for removably securing said unit as a whole to said plug.

4. In an electrically operated indicator, the combination with an insulating base block having contact sockets embedded therein, of an indicating unit removably mounted on said block comprising a base plate, a plurality of electromagnets arranged in two groups about a common axis, said groups being separated by an insulating ring, means for securing one group of said magnets directly to the base plate, an outer plate upon which are mounted the electromagnets of the other group, means for securing said outer plate to said base plate to permit independent removal of the electromagnet group mounted thereon, and fastening means for removably securing the unit as a whole to said block.

5. In an electrically operated indicator, the combination with an insulating base block having contact sockets embedded therein, of an indicating unit removably
mounted on said block comprising a base plate, a plurality of electromagnets arranged in two groups, about a common axis, said groups being separated by an insulating ring, means for securing one group of said magnets directly to the base plate, an outer plate upon which are mounted the electromagnets of the other group, means for securing said outer plate to said base plate to permit independent removal of the electromagnet group mounted thereon, a clip secured to one end of the winding of each electromagnet, means for connecting the clip of a magnet in each group in pairs to said insulating ring, and fastening means for removably securing the unit as a whole to said block.

7. In an electrically operated indicator, the combination with an insulating base block having contact sockets embedded therein, of an indicating unit removably mounted on said block comprising a base plate, a plurality of electromagnets arranged in two groups about a common axis, a pole piece on each magnet extending radially inward, an insulating ring separating the pole pieces of each group, a solenoid in the center of each group of electromagnets, a removable shaft common to both solenoids carrying a core for each solenoid and an indicating device, a pole piece on each solenoid core extending in opposite directions and rotatable each in the fields of the electromagnets only by which it is encircled, and fastening means for removably securing the unit as a whole to said block.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

FRANK W. WOOD.

Witnesses:

J. GRANVILLE MEYERS,
L. A. HAMMERSLEY.