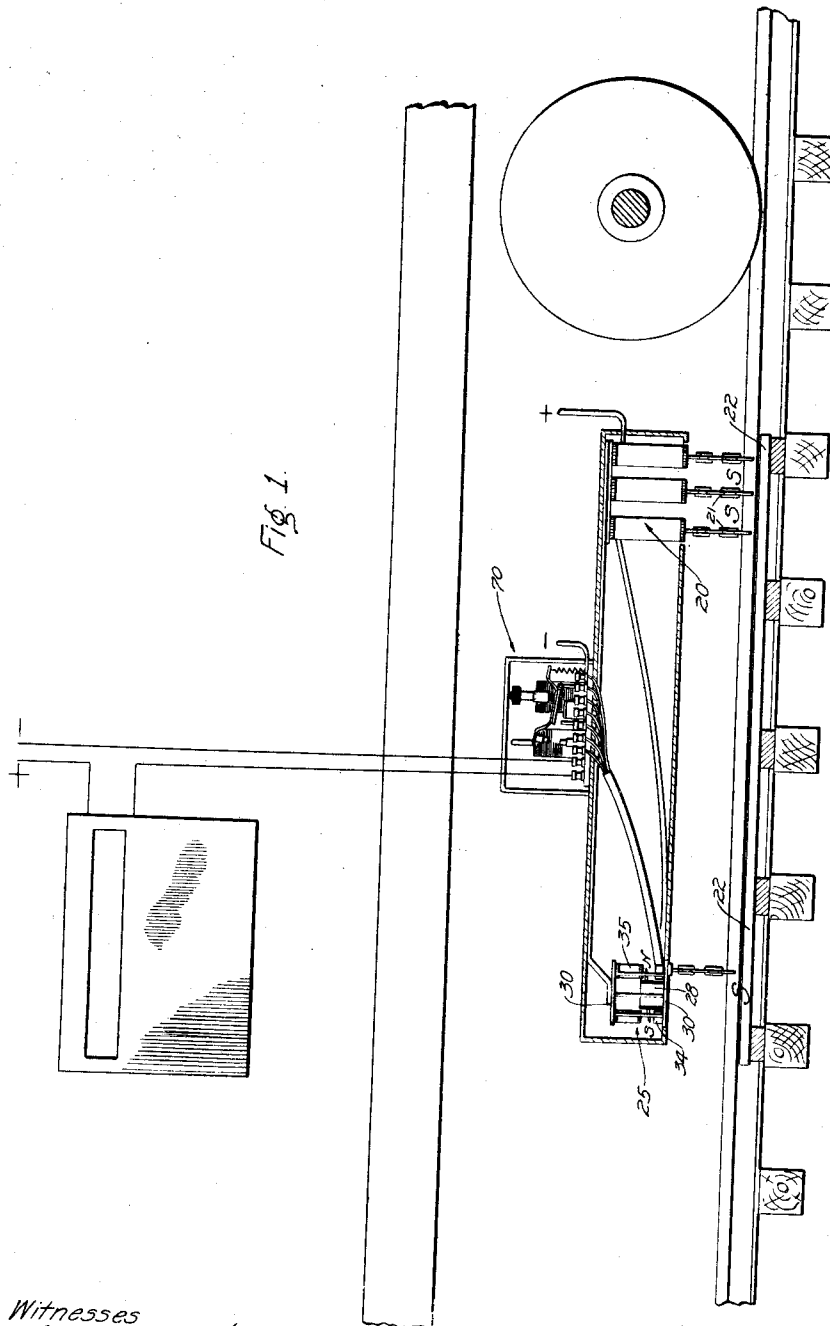


E. J. PACE.  
 INDICATOR OPERATING MECHANISM.  
 APPLICATION FILED MAY 29, 1912.

1,064,927.

Patented June 17, 1913.  
 7 SHEETS—SHEET 1.



Witnesses  
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 M. C. Brown

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 by  
 James T. Barkley  
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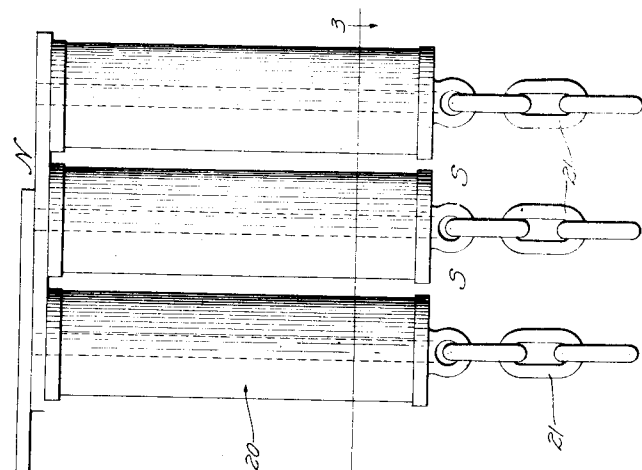


Fig. 2.

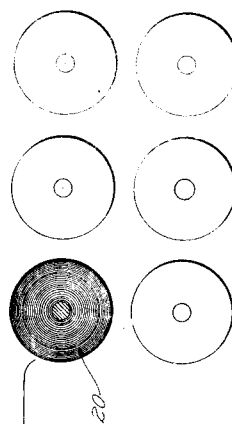


Fig. 3.

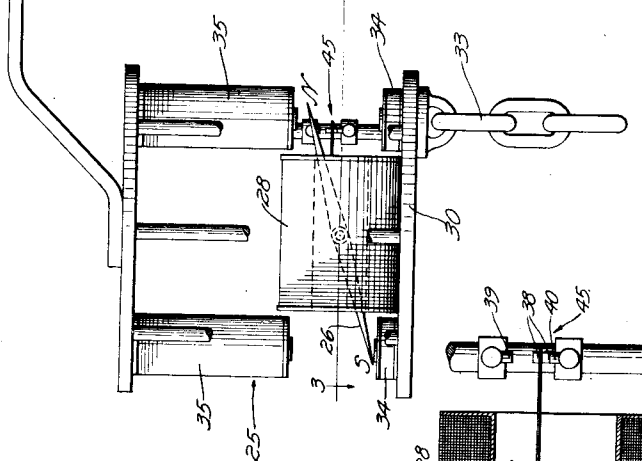
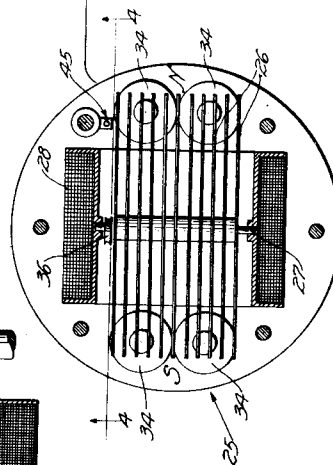
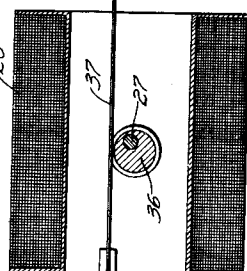


Fig. 4.



Witnesses  
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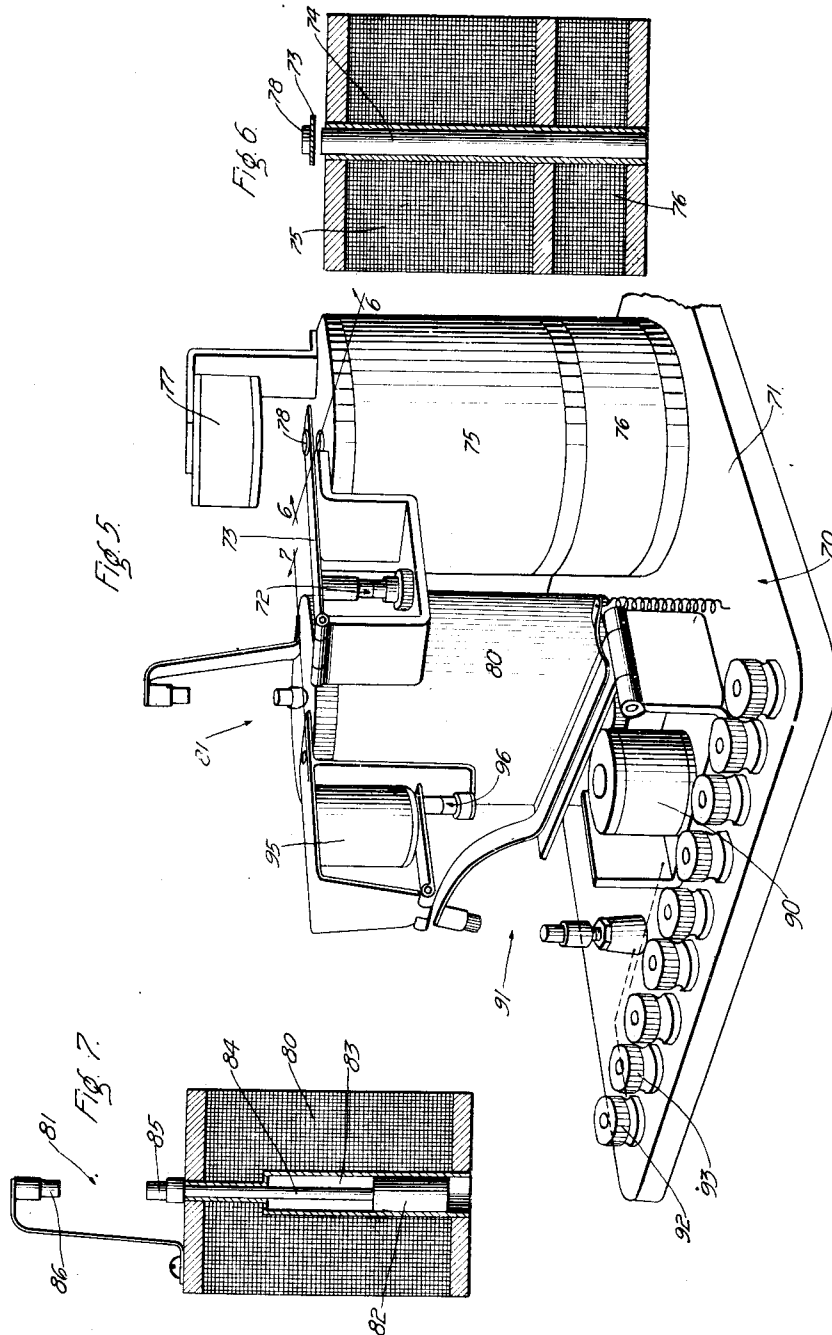
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7 SHEETS—SHEET 3.



Witnesses  
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 W. R. Brown

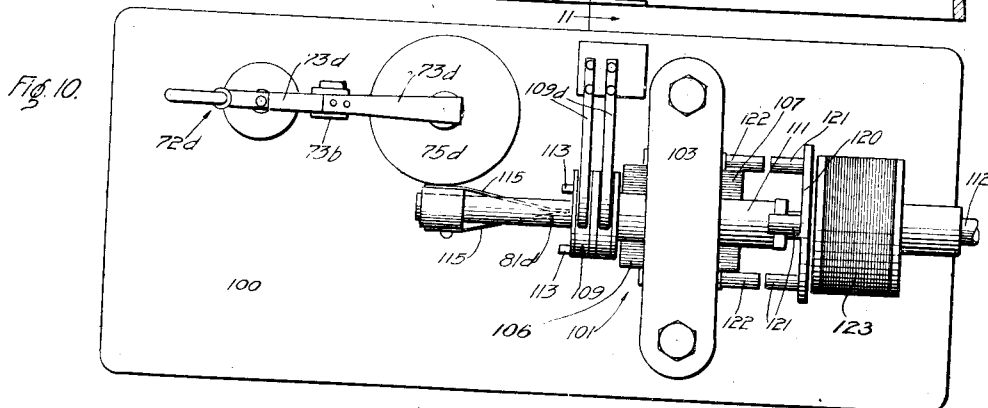
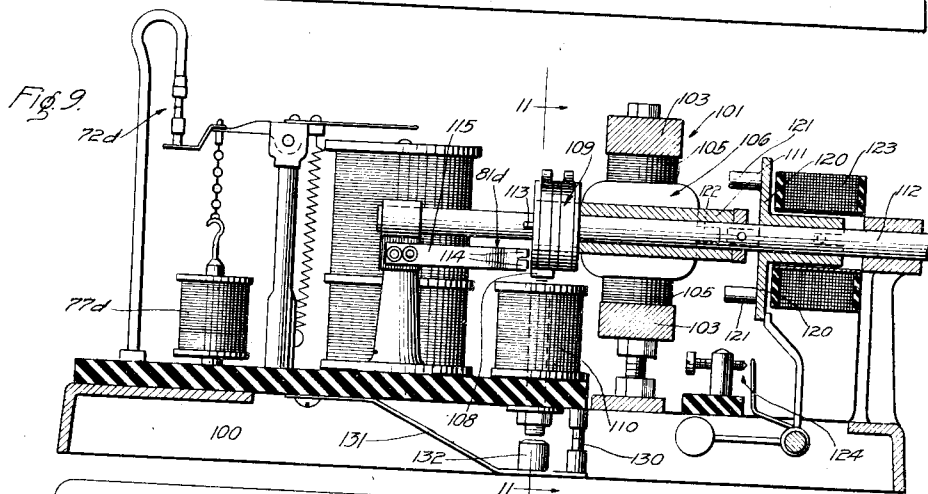
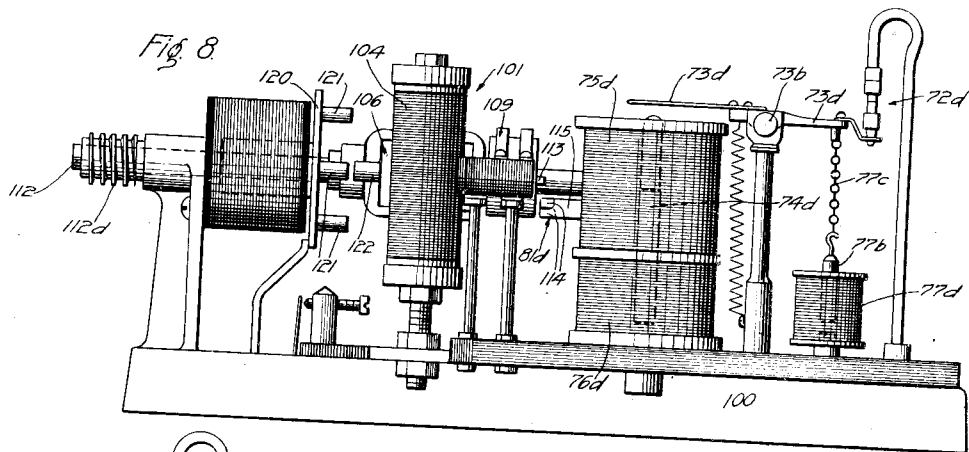
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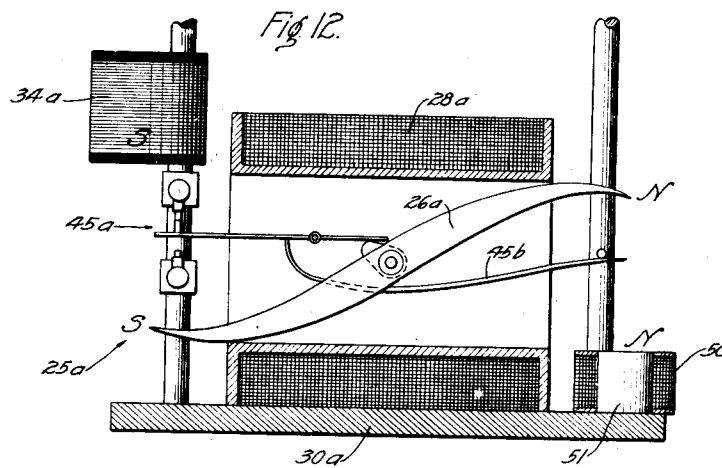
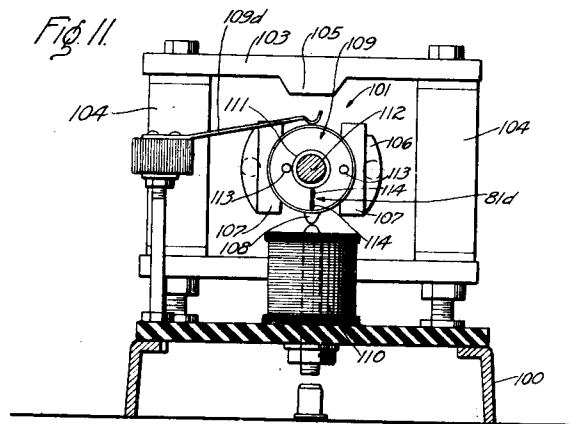
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7 SHEETS—SHEET 5.



Witnesses  
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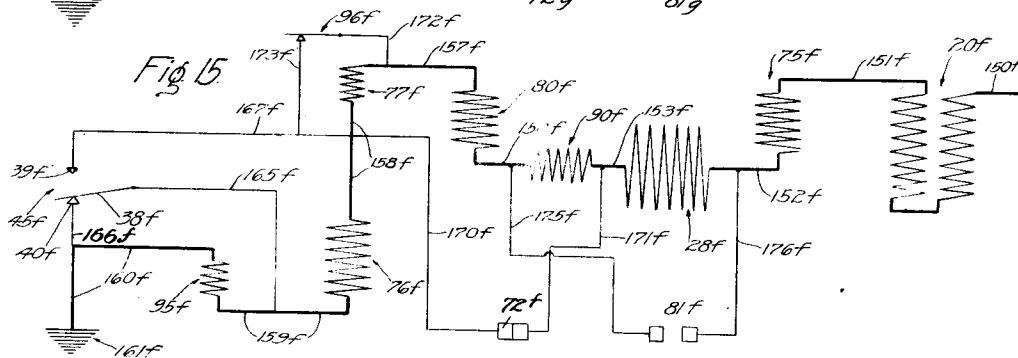
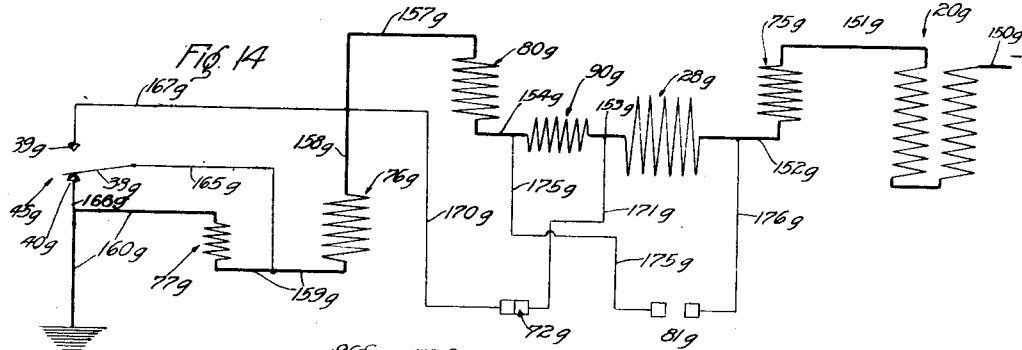
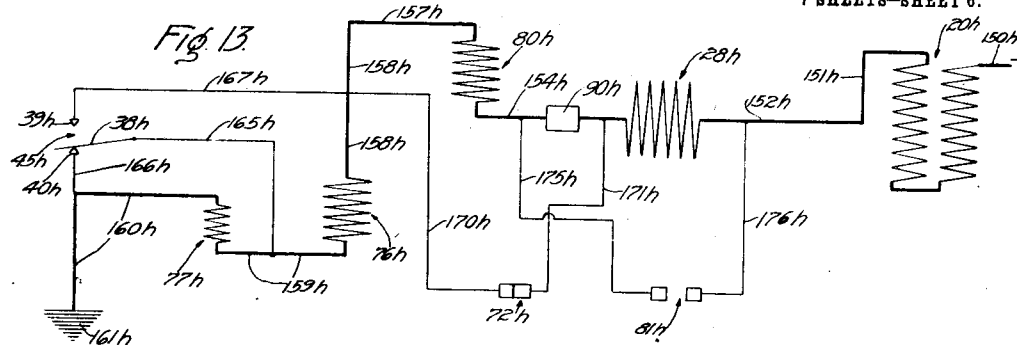
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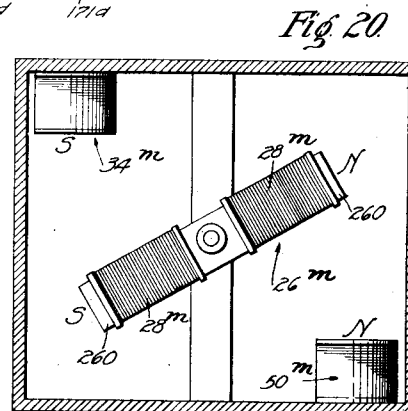
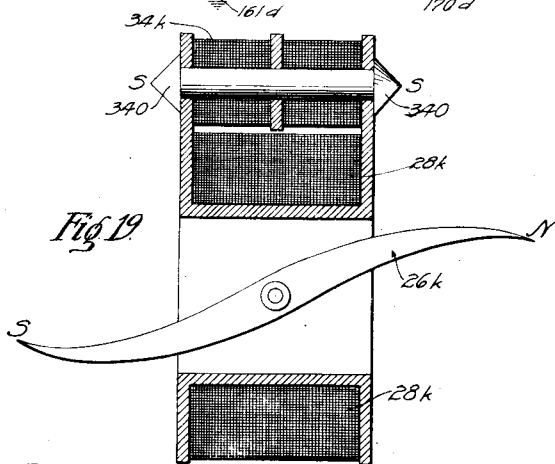
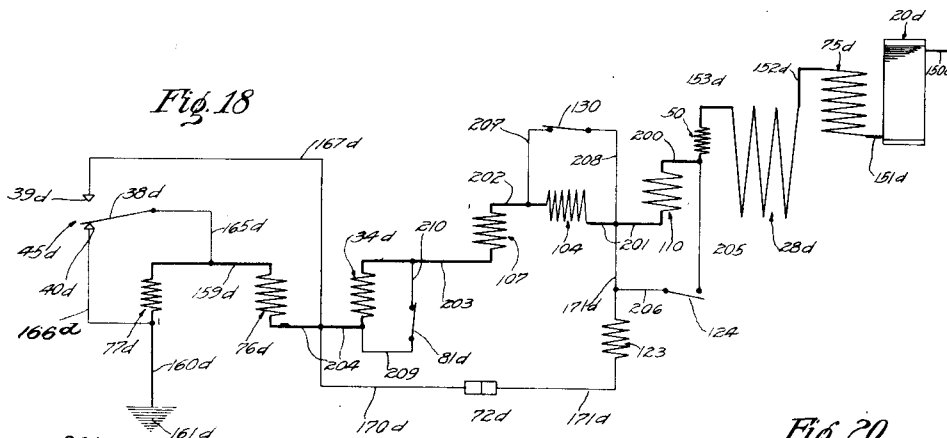
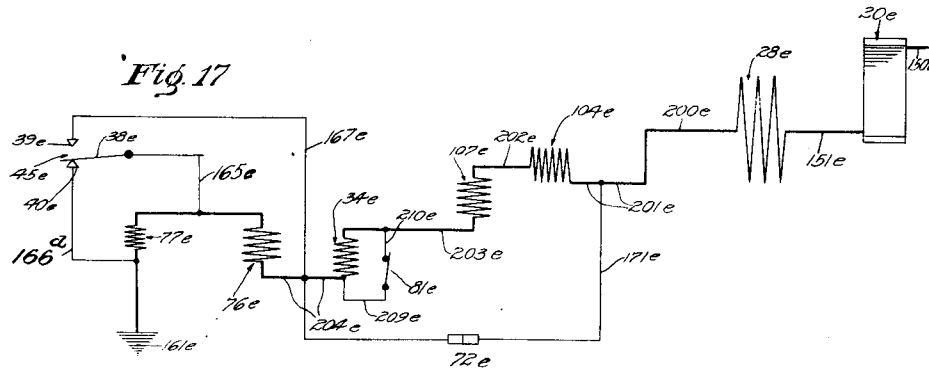


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7 SHEETS—SHEET 7.



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# UNITED STATES PATENT OFFICE.

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## INDICATOR-OPERATING MECHANISM.

1,064,927.

Specification of Letters Patent.

Patented June 17, 1913.

Application filed May 29, 1912. Serial No. 700,442.

*To all whom it may concern:*

Be it known that I, EDGAR J. PACE, a citizen of the United States, residing in Los Angeles, county of Los Angeles, State of California, have invented new and useful Improvements in Indicator-Operating Mechanisms, of which the following is a specification.

This invention relates to mechanism adapted for operating indicators, signals and the like on moving trains or, in fact, for operating any sort of mechanism where the initial operating impulse must be derived momentarily and where the operated mechanism requires an appreciable duration for its complete cycle of movements.

I am well aware that there have been large numbers of station indicators, signaling devices and the like heretofore proposed; and I am aware that some of the devices have been experimented with and tried out in practice; but, so far as I know, these devices have failed of perfection in operation primarily on account of the lack of suitable actuating mechanisms. For instance, in street and station indicators for cars, there have been many forms of track contacts, switch mechanisms and the like to actuate an indicator; but I do not know of any in which there are combined the desirable qualities of sensitiveness, reliability, simplicity of operation, and cheapness of manufacture.

It is the prime object of my present invention to overcome the difficulties herein named; and in reaching these objects there have been developed many minor objects which will appear hereinafter.

One of these minor objects is the entire obviation of any sort of physical or mechanical contact between any parts on the moving car and any stationary parts on the track.

It also becomes an object to provide such an arrangement as will be certainly operated whenever operation is desired and which will just as certainly never be operated under any other conditions.

Besides these objects, there are others which have to do more directly with the purely electrical aspect of my invention; chief among which is ease and certainty in handling the operating current. On the ordinary street car current is available at a potential of five hundred volts. Although

I use this potential for operating my device, I have made such arrangements that at no time is the full voltage broken by the operating of any switch. The operation of the device never entirely breaks the current passing therethrough; there is always some current passing through some part of the mechanism; and I am enabled to make such arrangements that the maximum potential between the points of any opening switch is about fifteen volts.

These foregoing objects and many others will be more fully understood by reference to the following specification where I have set forth preferred forms of my apparatus, and by reference to the accompanying drawings, in which:

Figure 1 is a view showing more or less diagrammatically an arrangement of one form of my complete device upon a car, showing also the stationary portions of the device arranged upon the track. Fig. 2 is an enlarged view of portions of the apparatus shown in Fig. 1. Fig. 3 is a section taken as indicated by line 3—3 of Fig. 2. Fig. 4 is a section taken as indicated by line 4—4 of Fig. 3. Fig. 5 is a perspective showing an arrangement of what I may term the relay mechanism of my device. Fig. 6 is a sectional detail thereof taken as indicated by line 6—6 of Fig. 5. Fig. 7 is a sectional detail taken as indicated by line 7 of Fig. 5. Fig. 8 is a side elevation illustrating what I may term the motor mechanism of my device, being a modification of the forms illustrated in the previous figures. Fig. 9 is a longitudinal section of the same taken in the aspect opposite to that of Fig. 8. Fig. 10 is a plan view of the same. Fig. 11 is a section of the same taken on line 11—11 of Fig. 9. Fig. 12 is a sectional view showing a modified form of a portion of the mechanism shown in Fig. 2. Figs. 13, 14, 15, 16, 17 and 18 are diagrams of electrical connections of the complete device, in various modifications, the parts of which will be hereinafter explained. Figs. 19 and 20 are views showing modified forms of the needle mechanism.

Fundamentally, my mechanism consists in: (1) a primary actuating switch adapted to be momentarily moved by some device exterior to the indicator operating mechanism, this device being in practice a track

combination which operates the switch virtually instantaneously; (2) a motor, or indicator moving mechanism, which is operatively connected with the momentarily actuated switch and which is started in its operation by the operation of said switch, this motor mechanism requiring an appreciable time for its complete operation; and (3) a means whereby the motor mechanism holds the primary switch in its operated or abnormal condition during the operation of the motor mechanism and then restores the switch at the end of the motor operation (or, in one of the preferred forms of the device, the switch mechanism is arranged so that it will in itself remain in either its normal or abnormal position, and the motor mechanism only operates to return the switch from its abnormal to its normal position). With these fundamentals in mind, I will proceed to explain first the different subsidiary portions or mechanisms and will then explain how they cooperate to produce the desired result.

I will first explain the switch mechanism, shown in Figs. 2, 3, 4 and 12. I employ preferably an electro-magnet 20, which may be either single or composite as shown in the drawings, which is suspended from a car and preferably has flexible magnetic conductors 21 depending from its lower end coming into proximity with a track plate 22 of magnetic material. Track plate 22 is preferably a flat bar of soft iron; and it may be laid between the rails of a track or in any other convenient position. Spaced at some distance from the magnet 20 is a switch mechanism 25 having no direct magnetic connection with the magnet 20 except when the magnet and the switch mechanism pass over the track plate 22. Switch mechanism 25 is preferably composed of suitable needles 26, forming a single multiple needle, pivoted at 27 on a shaft which extends transversely across the interior of an annular magnetizing coil 28. Coil 28 is constantly excited so that needle 26 is constantly magnetized. It is essential that the relative polarities of the different magnets be properly maintained; and I have therefore, for purposes of making a clear explanation, assumed the polarities of the different parts to be as illustrated in the drawing. The coil 28 is mounted in a suitable frame 30 which is secured to and suspended from the car in such relation to magnet 20 that the needle will hang over one end of plate 22 when the magnet 20 is over the other end of the plate. A flexible magnetic conductor 33 may be provided for concentrating the lines of force from the magnetic plate 22 upon the needle 26; but this is not absolutely necessary. But, in my latest improved devices, I do not use either of the chains 21 and 33, the magnet and needle hanging about four inches from the

plate with a clear gap between. My mechanism is so sensitive that it operates positively over this gap and still uses a very small amount of current. Beneath the ends of the needle 26 I have shown small electro-magnets 34; and above the ends of the needle I have shown larger electro-magnets 35. These magnets, as will be hereinafter explained, are used to hold the needle 26 in either of its positions and to return it to its normal position shown in Fig. 2. The needle shaft 27 has a suitable cam 36 which engages with a spring arm 37 carrying contact 38 adapted to engage with contacts 39 and 40. The spring arm 37 acting upon the cam 36 tends to hold the needle in the position illustrated; and when in this position the contacts 38 and 40 are in electrical engagement. But when the needle is moved to a position inclined oppositely to the inclination shown in Fig. 2 the contacts 38 and 39 are electrically engaged. These contacts form the primary switch, which I will designate by the numeral 45, whose function is to initially start the operation of the motor mechanism.

The operation of this switch mechanism is broadly as follows: Under normal conditions, the needle 26 remains in the position shown, being constantly magnetized by the action of coil 28. The magnet 20 is also constantly energized and is ready to inductively energize the track plate 22 when it passes to the relative position shown in Fig. 1, over the track plate. The track plate immediately becomes inductively energized and will, according to the polarities indicated in the drawings, have a south polarity at its left hand end in Fig. 1 while the upper right hand end of the needle has a north polarity. This upper right hand end of the needle will consequently be attracted downwardly to the plate 22, while the lower left hand end of the needle will be repelled upwardly away therefrom. This action will immediately cause the switch 45 to change position, in turn causing the motor mechanism to begin its operation. It will be seen that the passage over the track plate 22 is almost instantaneous, and that the needle will not be held in its abnormal position for any appreciable length of time (in fact, the needle in my most improved mechanism actually completes its movement long after the track plate has been left behind receiving but an initial impulse while over the plate); but the immediate operation of the motor or relay mechanism causes such operation of the magnets 34 and 35 as will hold the needle 26 in its position oppositely inclined to that shown in Fig. 2, releasing the needle and allowing it to come to its normal position only when the operation of the indicator moving mechanism has been completed. The form of needle shown in Figs. 2 to 4 has a tend-

ency, under the action of spring arm 37, to return to its normal position; and it therefore requires opposing force to hold it in its abnormal position. But I have shown in Fig. 12 a form of needle mechanism which will remain of itself in either its normal or abnormal position, and which therefore does not require to be actively held in its abnormal position. In this form of needle mechanism I have shown an annular magnetizing coil 28<sup>a</sup> and a needle 26<sup>a</sup> pivoted therein similarly to that before described. The needle 26<sup>a</sup> is of curved configuration so as to conform more closely to the natural curvature of the lines of force passing there-through. (I have found that this form of needle is much more efficient than the straight needle.) I have found that the needle, if perfectly balanced with regard to gravitational influence, has a tendency to be magnetically drawn either to the position shown in Fig. 12 or to the position oppositely inclined; that is, the magnetizing coil 28<sup>a</sup> tends to draw the needle to a position where some of its portions will be as close as possible to the inner periphery of the coil. Consequently, the needle is in unstable magnetic equilibrium in any position intermediate its two terminal positions. I have, in this form of needle, provided a switch mechanism 45<sup>a</sup> which has little or no tendency to return the needle to the position shown in Fig. 12, having but a very light spring 45<sup>b</sup> for returning it (the switch mechanism) to the normal position shown in Fig. 12. With this form of needle it will be seen that, once in its abnormal position, there is required no positive force to hold it therein; and I therefore only provide a means for returning the needle to its normal position after complete operation of the motor mechanism. This is practically provided in a small single electro-magnet 34<sup>a</sup> arranged above one end of the needle and having a polarity to repel the needle to the position illustrated in Fig. 12. In the form of device shown in Fig. 12 I have also illustrated a small compensator winding 50 wound around a concentrating core 51. This concentrating core is primarily for the purpose of concentrating the lines of force from the track plate to the needle, serving the same purpose as may be served by flexible magnetic conductor 33 shown in Fig. 2. The compensator winding 50 is arranged around this core more for convenience than for any resultant effect, the winding being as effective without a core as with one. This compensator has a polarity to repel the needle and tend to oppose its movement to its abnormal position; but its winding is so arranged that its opposition is relatively feeble. In practice I constantly excite the magnet 20, the magnetizing coil 28 or 28<sup>a</sup> and the compensator mag-

net 50; and I so connect them into a common electrical circuit that the same voltage fluctuations affect them together. Thus, if the voltage should rise and the action of the needle consequently tend to become quicker, the opposing force of magnet 50 would also become greater and would more strongly oppose the action of the needle and thereby tend to hold it to normal speed of action. I am enabled to maintain the needle movement at a virtually constant moderate speed in spite of the large voltage fluctuations common in trolley car circuits. The operation of the form of needle shown in Fig. 12 is similar to that of the form shown in Fig. 2, with the exceptions noted. The needle restoring magnet 34<sup>a</sup> is energized when the motor mechanism has completed its action and all of the mechanisms are ready to be restored to normal position.

I will now explain the mechanical features of the motor mechanism, and of the relay mechanism which may be operated in conjunction therewith; and I will first explain a relay mechanism which I have used in connection with indicator mechanisms of various types, and will then explain the form of mechanism in which the indicator motor mechanism and the relay mechanism are all combined into one complete piece of machinery. Referring particularly to Figs. 5, 6 and 7, I have shown a self contained relay mechanism which is operated from, and is in combination with, a form of switch mechanism shown in Figs. 2, 3, and 4 which in turn is directly connected with an indicator or other mechanism, causing its operation. In this form of relay mechanism, designated generally by the numeral 70 in Fig. 1, 71 designates the base plate upon which I have mounted the magnets and switches of the mechanism. I provide a suitable main switch 72 which remains normally closed in the position shown in Fig. 5. This switch is operated by a pivoted switch arm 73 whose free end hangs over a longitudinally movable armature 74 contained within and actuated by two solenoids 75 and 76. Normally, both these solenoids are energized and the core 74 is held in a central position, which position allows the switch arm 73 to fall and the switch 72 to be closed. Upon the beginning of the actuation (this is one of the first results of the operation of the primary switch 45), the solenoid 76 is deenergized and the armature 74 is consequently drawn upwardly, moving the switch arm 73 and opening the switch 72. One of the effects of opening switch 72 is to energize a small switch holding magnet 77, which acts to attract armature 78 on the end of switch arm 73 and to hold the switch 72 open until the magnet 77 is deenergized. The solenoid 75 remains energized con-

stantly, being simply a means to constantly magnetize the armature 74 so that it will act with great speed and precision. Mounted upon the base plate 71 is another solenoid 80 operating a switch 81 which I may term the time switch of my device. The opening of switch 72 causes the energization of solenoid 80 and causes its armature core 82 to be drawn upwardly. This core may be arranged in the form of a piston loosely fitting within a cylinder 83 so that the air resistance to its upward movement will cause that movement to be slow. A stem 84 projects upwardly through the solenoid and carries contact 85 on its upper end adapted to engage a contact 86 at the end of its movement. The movement of the armature 82 may be regulated to take either a short or long time; and in this form of mechanism I arrange to have sufficient time between the initial energization of solenoid 80 and the closing of switch 81 to allow the indicator mechanism time for complete actuation. The closing of time switch 81 causes the beginning of the action which restores all of the different parts to their normal condition; it first causes the suitable action of magnets 34 and 35 to return the needle to its normal position; and the return of the needle to its normal position immediately causes the switch 72 to be closed. At the same time that current is supplied to solenoid 80 by the opening of switch 72 current is also supplied to a small magnet 90 which serves to close a normally open switch 91. How this is accomplished will be hereinafter explained. This switch 91 has its two contacts connected with binding posts 92 and 93, and the indicator mechanism connected thereto may be of any preferred character; it may take a longer or shorter period for its actuation and the time switch 81 will be regulated accordingly. When the time switch closes it cuts off the current from magnet 20 and allows the switch 91 to open thus discontinuing current to the relay mechanism. I have also shown in Fig. 5 a relay comprising a relay magnet 95 and a relay switch 96. It will be hereinafter explained how this relay is used to merely retard the deenergization of magnet 77 and to consequently retard the final closing of switch 72.

From the foregoing the fundamental operations of my indicator actuating mechanism will be seen. There is first the operation of the primary switch, causing the beginning of operation of a mechanism which causes the operation of the indicator; next there is the operation of an arrangement which allows the indicator sufficient time in which to be completely operated; and finally there is the restoring operation for all of the mechanisms. I have described the mechanical features of a form of device in

which the indicator mechanism is mechanically independent of the switch or relay device; but I shall now describe a form of device in which the indicator motor mechanism and the relay or switch mechanisms (not the primary or needle switch) are combined mechanically into one machine. I will refer now particularly to Figs. 8, 9, 10 and 11, wherein I have shown a form of mechanism which I prefer for simplicity over the form before described. In these figures 100 designates a suitable base plate upon which the complete mechanism may be mounted, 72<sup>a</sup> designates a switch which corresponds in action and function to switch 72 just described, and 101 designates the motor mechanism which actually moves the indicator or other device. The time switch corresponding to time switch 81 is designated by the numeral 81<sup>a</sup> and its action will be hereinafter described. The switch 72<sup>a</sup> is operated in the same manner as that in which switch 72 is operated but the solenoids and magnets are differently mechanically arranged. The solenoids 75<sup>a</sup> and 76<sup>a</sup> are arranged practically as before described, the core 74<sup>a</sup> being operated in the same manner as core 74. Switch arm 73<sup>a</sup> is raised by core 74<sup>a</sup>, the arm being pivoted medially at 73<sup>b</sup> and the switch 72<sup>a</sup> opening by downward movement of its contact mounted on the arm. The holding magnet 77<sup>a</sup> is arranged beneath the switch arm 73<sup>a</sup> and has a small armature core 77<sup>b</sup> connected by a chain 77<sup>c</sup>, or otherwise, to arm 73<sup>a</sup>. The electrical operation of these parts is as before described. In this form of device now being described the time switch is operated directly by the indicator motor instead of being operated by a device which is regulated to act synchronously with the indicator. In the form shown in Fig. 5 the time switch is regulated so that it will not close until the indicator has had ample time in which to completely operate; but in the form shown in Fig. 8 the indicator motor 101 itself operates the time switch when it reaches the end of its travel. The motor mechanism includes any suitable form of field magnets 103 having field windings 104 and having poles 105. A bi-polar armature 106 has windings 107 (forming in effect a single winding) and normally stands with its poles in a horizontal plane while the field poles are in a vertical plane. The armature is normally held in this position by a suitable weight; and in practice I have made this armature so easily movable that a small lug 108, which I use for attraction purposes to register the armature in position, is sufficient to throw the armature back to its normal position. This lug 108 is mounted on the normally under side of a two ring commutator 109 and is adapted to be attracted by a magnet 110, the armature being thus held securely in

its normal position without any mechanical stops. The armature and commutator are mounted on a sleeve 111 which normally is rotatable upon the main shaft 112. The armature may rotate without rotating the shaft 112. On commutator 109 I have provided two switch operating pins 113 which are set at different radial distances from the shaft 112. These pins are each adapted to engage the suitably positioned end 114 of one of spring switch pieces 115. These spring switch pieces are mounted so that their ends are normally in contact and so that a slight movement of one of them away from the other will break that contact. A rotation of the armature through a quarter revolution will cause one of pins 113 to engage one of the ends 114 of contacts 115 and to move that one of the contacts away from the other. This will cause an opening of the switch 81<sup>d</sup> and cause a restoration of all of the parts of the mechanism to their original normal positions after a complete operation of the motor mechanism 101. The operation of these parts will be hereinafter described.

In the form of mechanism herein shown I have provided a clutch member 120 which is slidable upon shaft 112 but rotatably locked thereto. This member 120 has four magnetic clutch pins or studs 121 engageable with two magnetic studs 122 which are mounted upon the armature 106. Normally, the clutch member 120 is held to the right in Fig. 9 by the action of a magnet 123, the magnet attracting it in that direction. This, however, is only one function of this magnet, its other function being to normally hold open a switch 124 which, by its closure, deenergizes the magnet 110 which is normally energized. The opening of switch 72<sup>a</sup> causes the energization of the armature and the deenergization of the magnet 123. The clutch member 120 is attracted by the armature to the left in Fig. 9 until two of its studs 121 engage the two studs 122, being magnetically held in contact therewith. The magnet 110 is energized and holds the armature accurately in position until the clutch member 120 has completed its movement and the clutch studs 121 and 122 are engaged. The switch 124 then closes and causes the deenergization of magnet 110. This magnet, in addition to holding the armature normally in position, also normally holds closed a switch 130 which controls by its opening admission of current to the field coils of motor mechanism 101. This switch 130 is operated by having one of its contacts mounted on a spring switch arm 131 which also carries an armature 132 normally attracted by the lower pole of magnet 110. When the magnet is deenergized, this switch 130 opens and throws current through the field coils.

The armature is then rotated through a quarter revolution until its poles come opposite the field poles. Commutator 109 is of the simple ring sort, a pair of brushes 109<sup>d</sup> sufficing for carriage of current to the rings of the commutator and thence to the armature, the passage of current through the armature coils being always in the same direction. The armature in making its quarter revolution carries with it the clutch member 120 which rotatively carries the shaft 112, this shaft being the primary shaft of the indicator mechanism. In Fig. 8 I have shown shaft 112 equipped with a worm 112<sup>d</sup> for engagement with a worm wheel of the indicator mechanism. When the armature has completed its quarter revolution—its entire stroke—the time switch 81<sup>d</sup> is opened and this causes current to be supplied, in a manner hereinafter described to magnet 34<sup>a</sup> (see Fig. 12) and causes the needle 26<sup>a</sup> to immediately return to its normal position. This throws switch 45<sup>a</sup> to its normal position and causes the switch 72<sup>a</sup> to be immediately closed.

I will now explain the operations of the different forms of device which I have described, showing their electrical connections, and explaining further what is fundamental and what is less important in the complete device. For sake of simplicity in description I will begin with Fig. 16, which shows diagrammatically the electrical connections of the form of device shown in Figs. 1, 2, and 7. In this figure I have described the different parts by the same numerals as given them in the other figures. Current passes first from any suitable source, say the trolley, through wire 150 to magnet 20. After passing through the magnet the current continues through wire 151 to solenoid 75 and thence by wire 152 to energizing coil 28. The current is then carried by wire 153 to solenoid 80, then by wire 154 to magnet 90 and thence by wire 155 to magnets 35. Between magnets 35 and 34 a wire 156 connects and then a wire 157 leads to switch holding magnet 77. From this magnet wire 158 leads to solenoid 76 and thence a wire 159 leads to relay magnet 95. From relay magnet 95 a wire 160 leads to ground 161. This circuit connects in series all the magnets and solenoids and coils in the complete device; and for purposes of illustration I have shown this circuit heavier than the showings of other wires, but this is not to be taken to illustrate that the wires of the series circuit are heavier than the others. I have shown the switch 45 in this view and have shown that contact 38 is connected by a wire 165 to wire 159 between solenoid 76 and magnet 95; while contact 40 of switch 45 is connected by a wire 166 to ground wire 160. Contacts 38 and 40 being normally in engagement, it will be seen that the normal

path of the current will be around the magnet 95, leaving magnet 95 normally deenergized. The magnet 95 when deenergized leaves its relay switch 96 normally closed. Relay switch 96 is connected by wires 172 and 173 around holding magnet 77 and thus normally deenergizes the holding magnet 77. Whenever relay magnet 95 is deenergized, holding magnet 77 is consequently deenergized; and the object of this relay arrangement is simply to provide a time element between the movement of switch 45 and the energization or deenergization of magnet 77. For purposes of simplicity the magnet 77 may be connected in circuit in place of the magnet 95, and I have shown such an arrangement in some of the other views and will hereinafter describe it. The other contact 39 of switch 45 connects by wire 167 to wire 158 so that, when the contacts 38 and 39 are in engagement the current will flow from wire 158 through wire 167, contact 39, contact 38, wire 165, wire 159, magnet 95 and wire 160 to ground 161. It will thus be seen that the action of switch 45 is merely to cause the alternate energization of the solenoid 76 and magnet 77; and from the foregoing description of the mechanical features of this device it will be remembered that this will cause the immediate opening and closing of switch 72. Switch 72 is connected on one side by wire 170 to wire 158 between relay magnet 95 and solenoids 76; and on the other side is connected by wire 171 to wire 153 between magnetizing coil 28 and time switch solenoid 80. Switch 72 is normally closed and it will be seen that the current will thus be normally cut out from solenoid 80, indicator switch magnet 90, magnets 35 and 34, and holding magnet 77; and, upon the opening of switch 72 as hereinbefore described, the current will immediately be sent through all of these parts. The sending of current through switch magnet 90 will immediately cause the operation of switch 91 and cause the supply of current to the indicator, or other device, to start its operation. The supply of current to solenoid 80 will immediately start the time operation of the time switch 81. This time switch 81 is connected on one side by wire 175 to wire 156 between magnets 34 and 35 and on the other side by wire 176 to wire 154 between solenoid 80 and magnet 90. Ordinarily switch 81 is open; but when it is finally closed, current will pass through it in preference to passing through magnets 90 and 35. The result of this action will be to cut current off from the switch magnet 90 and cause the opening of switch 91, to cut off current from coils 35 and cause the return of needle 26 as will be described. When the needle first moves from the position illustrated to the position oppositely

inclined, neither the magnets 35 nor the magnets 34 are supplied with current, as the switch 72 is closed and current flows around through its circuit rather than through either of these magnets. The immediate effect of the movement of the needle has been described to be the opening of switch 72. This immediately causes current to flow through both magnets 34 and 35. The needle then stands in the position inclined oppositely to that shown in Fig. 2; and magnets 34 and 35 are so wound that their resultant magnetic action is to hold the needle in this abnormal position. The magnets 34 are so wound that they tend to move the needle back to its normal position; while the magnets 35 are so wound that they tend to hold the needle in its abnormal position. But the effect of magnet 35 is much greater than that of magnets 34, so that, when all the magnets are energized the resultant magnetic force will hold the needle in its abnormal position. Taking the polarities of the needle as indicated, this arrangement would require the right hand magnet 34 to have a north upper polarity to repel the adjacent end of the needle, and the left hand magnet 34 to have a north upper polarity to attract the adjacent end of the needle; and while right hand magnet 35 would have a north lower polarity to repel the north end of the needle, and left hand magnet 35 would have a north lower polarity to attract the south end of the needle. When the needle is in its abnormal position and current is supplied to all of the magnets then the needle will be held in that position until current is cut off from magnets 35 by the closing of switch 81. When this is done and current still flows through magnets 34, the needle will be returned to its normal position. In returning to its normal position it will throw switch 45 so that contacts 38 and 40 will engage and thus cause the cutting off of current through the relay magnet 95. Cutting off current through the relay magnet 95 causes the immediate closure of relay switch 96 which causes the cutting off of current from holding magnet 77. Cutting off current from holding magnet 77 immediately allows the switch arm 73 to drop; and, solenoids 76 having been energized by the movement of switch 45, the core 74 is drawn downwardly to its position as shown in Fig. 6 and the main switch 72 is allowed to close. The parts are then all in their normal positions ready for another actuation.

It will be seen that, if relay magnet 95 and switch 96 are omitted there would be a tendency for magnet 77 to immediately drop the switch arm 73 without any time element entering into the operation; and that the switch 72 would be closed practically simultaneously with the completion of movement

of the needle 26 and switch 45. In some cases where there has been this sort of synchronism between switch 72 and needle 26 there has been caused a rebounding effect of the needle 26, causing it not to stop when it had again reached its normal position but to move back toward its abnormal position again. This, although it does not always occur when the relay 95 is omitted, is entirely done away with by the inclusion of this simple relay.

In the foregoing I have described my complete device with all the details of structure and with all of the minor subsidiary parts.

It will be seen that certain portions of the device may be omitted, at least so far as the fundamental operation is concerned; and I have shown in Figs. 13, 14 and 15 fundamental forms of electrical arrangements omitting the minor details. For instance, in Fig. 15 I have omitted the magnets 34 and 35 which act to hold the needle in position during the stroke of the indicator. Although, in practice, these magnets are very necessary, it may be conceived that they may be omitted if the track plate were made long enough to keep the needle in its abnormal position throughout the indicator operation. In this figure the wire 153<sup>f</sup> leading from the magnetizing coil 28<sup>f</sup> leads directly to the indicator switch magnet 90<sup>f</sup> and thence a wire 154<sup>f</sup> leads to the time switch solenoid 80<sup>f</sup>. The connections of the two switches 72<sup>f</sup> and 81<sup>f</sup> will be seen to be the same as before, switch 81<sup>f</sup> merely bridging the indicator switch magnet 90<sup>f</sup> and also the magnetizing coil 28<sup>f</sup>. When the time switch 81<sup>f</sup> closes it thus cuts out current from the magnetizing coil and allows the needle to be moved back to its normal position by the spring arm 37. Thus, under these conditions, the operation of the needle becomes this: It is moved to its abnormal position by magnetic traction through the track plate and is there held in that position by the track plate influence or is held in that position by the influence of its own magnetizing coil as has been previously explained for the form shown in Fig. 12. Spring arm 37 has a constant tendency to bring the needle back to its normal position; and when the magnetic attraction on the needle ceases either by reason of the needle passing away from the track plate or by its de-magnetization by de-energizing coil 28<sup>f</sup>, the needle will be returned to its normal position by the spring arm 37 acting on the cam 36.

In Fig. 14 I have shown practically the same arrangement as is shown in Fig. 15 excepting that therein I have omitted the relay magnet 95 and switch 96 and have placed the holding magnet 77<sup>e</sup> in the position formerly described as being occupied by the relay magnet. It has been described how

the relay simply acts as a time element between the switch 45 and the holding magnet 77, and how the magnet 77 is always supplied with current when the relay magnet is substituted with current. Consequently the substitution of the magnet 77<sup>e</sup> for the magnet 95 merely means a difference in time of action and not in fundamental operation. In Fig. 14 this makes the wire 157<sup>e</sup> connect directly with the wire 158<sup>e</sup>.

In Fig. 13 I have shown the simplest form of all the forms of mechanism explained embodying the fundamentals of my device. As compared with Fig. 14 there is an omission of the switch solenoid 75 and of the indicator magnet 90. This leaves only the magnetizing coil 28<sup>b</sup> bridged by the time switch 81<sup>b</sup> and only the time switch solenoid 80<sup>b</sup> bridged by main switch 72<sup>b</sup>. In the operation of this fundamental arrangement the needle would be held in position either by magnetic attraction from the track plate or by the action described with relation to its magnetizing coil. Upon cessation of either the track plate influence or the magnetizing influence, the needle would immediately resume its normal position under the action of its spring switch arm. The solenoid 75 is omitted from this diagram as I have found it possible to omit it from the actual machine. The function of solenoid 75 is, as before stated, merely to magnetize the core 74 so that it may act more positively than it would otherwise; but this is not absolutely essential to the operation of the device. The magnet 90 has been omitted merely for purposes of simple illustration and a member 90<sup>b</sup> has been inserted. This member may illustrate any part or whole of an indicator mechanism, and it will be seen that it will have current for its operation for a length of time depending on the time taken by time switch 81<sup>b</sup> to close. In fact, the indicator switch magnet 90 might be described as a part of an indicator; it is largely for convenience of arrangement that the magnet 90 and switch 91 are mounted on the base board with the relay mechanism rather than in the indicator itself. Fig. 13 thus best illustrates the fundamentals of my arrangement and the operation thereof. It will be seen that there is never a time at which the circuit through the device is opened. Current is normally flowing through the magnet 20<sup>b</sup> the magnetizing coil 28<sup>b</sup>, and the solenoid 76. When the switch 45 moves from its normal position it only breaks that voltage which is the difference in potential on the opposite sides of magnet 77<sup>b</sup>; when switch 72<sup>b</sup> opens it only breaks a voltage which is the difference in potential on the opposite sides of the two parts 80<sup>b</sup> and 90<sup>b</sup>; and when the time switch 81<sup>b</sup> breaks after being temporarily closed, it only breaks that potential which is the difference in voltage at the points on opposite

sides of members 90<sup>a</sup> and 28<sup>a</sup>. I have thus arranged that the voltage broken by any of the switches shall be very small; in practice I have been able to thus provide for very long switch life. In fact, throughout the mechanism described I have provided for almost indefinite life, as there are very few parts subjected to any degree of wear. I wish to emphasize the simple electrical connections of this device, especially the series connections of all of the parts and the simple feature of cutting out those parts by merely making a by-path or shunt around them.

In Figs. 17 and 18 I have shown the electrical connections for the form or device shown in Figs. 8, 9, 10 and 11 and for the form of switch mechanism shown in Fig. 12. I will refer first to the diagram of Fig. 18. Here I have shown a magnet 20<sup>d</sup> to which current is led through wire 150<sup>d</sup> and from whence a wire 151<sup>d</sup> leads to coil 75<sup>d</sup>. A wire 152<sup>d</sup> then leads to the magnetizing coil 28<sup>d</sup>, which coil may either correspond to coil 28<sup>a</sup> of Fig. 12 or to coil 28 of Fig. 2. Thence a wire 153<sup>d</sup> leads to the compensator magnet 50 and thence a wire 200 leads to magnet 110. Thence a wire 201 leads to field coils 104 from which wire 202 leads to armature coil winding 107. From this armature coil winding wire 203 leads to needle restoring coil 34<sup>d</sup> (corresponding to coil 34<sup>a</sup> in Fig. 12) whence a wire 204 leads to coil 76<sup>d</sup> corresponding to coil 76 of the first described mechanism. From here on to the ground 161<sup>d</sup> the connections are the same as described for Fig. 13, the wire 167<sup>d</sup> connecting with wire 204 on one side of coil 76<sup>d</sup> and the wire 165<sup>d</sup> connecting with wire 159<sup>d</sup> on the other side of coil 76<sup>d</sup>. Wire 159<sup>d</sup> leads from coil 76<sup>d</sup> to clutch holding magnet 77<sup>d</sup> and from thence the wire 160<sup>d</sup> leads to ground 161<sup>d</sup>. The switch 45<sup>d</sup> corresponds with the switch 45<sup>a</sup> of Fig. 12, having stationary contacts 40<sup>d</sup> and 39<sup>d</sup> and having a movable contact 38<sup>d</sup>.

In the operation of this device the switch 45<sup>d</sup> is moved in the manner hereinbefore described and the needle 26<sup>a</sup> (see Fig. 12) is held in its abnormal position by the action of coil 28<sup>a</sup>. The switch holding magnet 77<sup>d</sup> is energized and the switch solenoid 76<sup>d</sup> is deenergized, causing the opening of switch 72<sup>d</sup>. This switch 72<sup>d</sup> is connected by wires 170<sup>d</sup> and 171<sup>d</sup> so as to bridge around the armature holding magnet 34<sup>d</sup> the armature winding 107 and the field coils 104, preventing them normally from receiving current. The magnet 123 may be placed in the circuit of wire 171<sup>d</sup> so that it receives current only when the switch 72<sup>d</sup> is closed. Immediately upon the beginning of operation of the motor mechanism the switch 72<sup>d</sup> opens and the magnet 123 is deenergized. As hereinbefore explained, the only

function of the magnet 123 is to normally hold the clutch member 120 to the right in Fig. 9 and hold the switch 124 open. I prefer to employ a magnet 123 instead of a spring or other device for normally holding these parts as shown in Fig. 9, the magnetic action being more positive and allowing of free movement when the magnet is deenergized. The closure of switch 124 causes the deenergization of magnet 110, the switch 124 being connected by wires 205 and 206 to form a shunt around the magnet 110. Magnet 110 when deenergized immediately releases the switch 130 and allows it to open. Switch 130 is normally closed and is connected by wires 207 and 208 to normally form a by-path around the field coils 104. Immediately this switch 130 opens the field coils are energized and the armature is started in its rotation. When the armature has rotated its full quarter revolution then the switch 81<sup>d</sup> (the same as switch 81<sup>a</sup> in Fig. 9 and corresponding to the time switch 81 in Fig. 16) is opened and current is thereby passed through needle returning magnet 34<sup>d</sup>. Switch 81<sup>d</sup> is connected by wires 209 and 210 to normally form a by-path around the magnet 34<sup>d</sup>. When current is supplied to this magnet it immediately restores the needle to position and this causes the closing of switch 72<sup>d</sup> and the deenergization of all the mechanisms paralleled by that switch. The armature immediately resumes its normal position, and is held in position by the traction of magnet 110. The magnet 123 is energized and draws the member 120 away from the armature so that it is not rotated backward with the armature, and the switch 124 is opened at the same time. This opening of switch 124 causes the energization of magnet 110.

In Fig. 17 I have illustrated a simplified form of the diagram of Fig. 18, omitting the compensator 50, the switch solenoid 75<sup>d</sup>, the armature holding magnet 110 and its corresponding switch 124, the magnet 123, and the switch 130 which is operated by the holding magnet 110. The operation of the needle and switch mechanism remains as before, the magnet 34<sup>a</sup> returning the needle to place after operation. The current in Fig. 17 is simultaneously admitted to the armature and field windings and the switch 81<sup>a</sup> is operated by the armature after it has turned a quarter revolution. This causes the return of the needle to its normal position and causes the closing of switch 72<sup>a</sup>, which allows the armature to resume its normal position. For this purpose it is only necessary to assume that the armature is loaded or over-balanced (which it is) to return to its normal position when acting under gravitational influence alone. So far as the devices which go to make the mechani-

cal connection between the armature 176 and the shaft 112, they might be made in any suitable manner—but, at any rate, they have little to do with the fundamental electrical operation of the device.

I have shown the diagram of Fig. 17 particularly with a view to making comparison between it and the diagram of Fig. 13. It will be seen that the arrangement of the switch and needle mechanism is the same in both diagrams; that the main switch 72 bridges a time element in each of the diagrams—for it bridges the time switch solenoid 80 in Fig. 13 and it bridges the armature and field windings in Fig. 17—and that the time switches in each case control the return of the needle to position, in Fig. 13 merely cutting off the magnetic influence and allowing the needle to return to position under spring action, and in Fig. 17 mechanically forcing the needle back into place. The parallel between the two forms of device is thus easily seen; and it will be noted that the fundamental of connection of the different elements in a main series circuit and of shunting around certain elements is common to all of the forms described.

In Figs. 19 and 20 I have shown modified forms of needle mechanisms. In Fig. 19 there is shown a needle 26<sup>n</sup> within magnetizing coil 28<sup>n</sup>. Needle returning magnet 34<sup>n</sup> is of a design different from those before described. It is in nature a consequent pole magnet, presenting a south polarity at each pole 34<sup>n</sup>; and thereby attracting the north and repelling the south end of the needle to move to its normal position.

In Fig. 20 I have shown a needle 26<sup>m</sup> which is in effect a coreless magnet, the body 26<sup>m</sup> being preferably a thin mica strip which carries magnet coils 28<sup>m</sup>. The action of this form of needle may be the same as of the other forms described, excepting that it is held in any position by its own inertia—it has no preference for any position over any other.

Having described my invention, I claim:

1. In combination, switch mechanism mounted on a moving object, said switch mechanism comprising a primary switch having a normally closed position, magnetic means for opening said switch, electro magnetic means for causing the return of said switch to closed position, a limited movement electro-motor, means controlled by the primary switch to electrically energize the motor when the switch is opened, means controlled by the operation of the motor to electrically energize the switch closing means together with a stationary means located in the path of movement of the moving object for controlling the magnetic switch opening means.

2. In combination, switch mechanism

mounted on a moving object, a track member located in the path of said object, said switch mechanism comprising a primary switch, magnetic means for moving said switch, said magnetic means becoming operative when passing over said track member, electro-magnetic means for returning said switch, a limited movement electro-motor, means controlled by the movement of the primary switch to electrically energize the motor and means controlled by the motor to electrically energize said switch returning means.

3. In combination, switch mechanism mounted on a moving object, said switch mechanism comprising a primary switch having a normally closed position, a limitedly movable magnetic needle adapted to remain in either of its extreme positions and cooperating with the primary switch to close it when in one extreme position and to open it when in the other, magnetic means to move the needle from one position to the other, electro-magnetic means for returning the needle, a limited movement electro-motor controlled by the primary switch to electrically energize said needle returning means and a stationary member over which and in spaced relation to which said magnetic means moves and by which said magnetic means is controlled.

4. In combination, a switch mechanism mounted upon a moving object and comprising a primary switch, a limitedly movable magnetic needle adapted to remain in either of its extreme positions and cooperating with the primary switch to close it when in one extreme position and to open it when in the other, electro-magnetic means for returning the needle, a limited movement electro-motor controlled by the primary switch and a switch operated by the electro-motor at the end of its movement, said switch controlling the needle returning means together with a stationary member over which and in spaced relation to which said movable magnetic needle moves and by which the same is actuated to open the primary switch.

5. In combination, a primary switch, a limitedly movable magnetic needle adapted to remain in either of its extreme positions cooperating with the primary switch to close it when in one extreme position and to open it when in the other, magnetic means acting through a relatively short time period to move the needle from its position in which the primary switch is closed to its position in which the primary switch is open, electro-magnetic means for returning the needle to its position in which the primary switch is closed, a limited movement electro-motor requiring time for its operation, a normally closed switch opened by the electro-motor at the end of its movement, a series circuit

including the electro-motor and the electro-magnetic needle returning means, a shunt circuit from said series circuit around the electro-motor and including the primary switch, and a shunt circuit from said series circuit around the electro-magnetic needle returning means and including said normally closed motor operated switch.

6. In combination, a primary switch, a limitedly movable pivoted magnetic needle adapted to remain in either of its extreme positions and cooperating with the primary switch to close it when in one extreme position and to open it when in the other, magnetic means acting upon the needle through a relatively short time period to move it from its position in which the primary switch is closed to its position in which the primary switch is open, an electro-magnet adapted when energized to return the needle to its position in which the primary switch is closed, a limited movement electro-motor requiring a relatively long time for its operation, a normally closed switch opened by the motor at the end of its movement, a series circuit including the electro-motor and the needle returning electro-magnet, a shunt circuit from the series circuit around the electro-motor and including the primary switch, and a shunt circuit from the series circuit around the needle returning electro-magnet and including the motor operated switch.

7. In combination, switch mechanism mounted upon a moving object, said switch mechanism comprising a primary switch having a normally closed position, a pivoted limitedly movable magnetic needle cooperating with the primary switch to close it when in one extreme position and to open it when in the other, magnetic means to move the needle from one position to the other, a limited movement electro-motor controlled by the primary switch and electro-magnetic means controlled by the movement of the electro-motor to impart a return movement to said needle.

8. In combination, a primary switch having a normal closed position, means acting through a relatively short interval to open said switch, electro-magnetic means for closing said switch, a limited movement electro-motor, a normally closed switch opened by the motor at the end of its movement, a series circuit including said switch closing means and said motor, a shunt circuit from the series circuit around the motor and including the primary switch, and a shunt circuit from the series circuit around the switch closing means and including the motor operated switch.

9. In combination, a primary switch having a normal closed position, magnetic means for opening said switch, electro-magnetic means for magnetically causing the

return of said switch to closed position, a limited movement electro-motor, a switch opened by said motor at the end of its movement, a series circuit including said electro-magnetic switch returning means and said electro-motor, a shunt circuit connected to said series circuit around said switch returning means and including the motor operated switch, and a shunt circuit from said series circuit around said electro-motor, said shunt circuit adapted to be caused to be opened and closed by the operation of the primary switch.

10. In combination, a primary switch having a normal closed position, magnetic means for opening said switch, electro-magnetic means for returning said switch to closed position, a normally closed main switch, electro-magnetic means for operating said main switch, a limited movement electro-magnetic mechanism, a normally closed switch operated by said electro-magnetic mechanism at the end of its movement, a main series circuit including the primary switch returning means the main switch operating means and the limited movement electro-magnetic mechanism, a shunt circuit from the main series circuit around the switch returning means and including the switch operated by the limited movement mechanism, a shunt circuit from the main primary circuit around the main switch operating means and including the primary switch, and a shunt circuit from the main primary circuit around the limited movement mechanism and including the main switch.

11. In combination, a primary switch, a pivoted magnetic needle cooperating with said switch and adapted by its movement to open and close the switch, a magnetizing coil surrounding said needle, magnetic means acting through a relatively short period to move said needle to open the primary switch, electro-magnetic means to return said needle to close the primary switch, a limited movement electro-motor requiring a relatively long period for its operation, normally closed switch opened by said motor at the end of its movement, a series circuit including the electro-motor the needle returning means and the needle magnetizing coil, a shunt circuit from the series circuit around the motor and including the primary switch, and a shunt circuit from the series circuit around the needle returning means and including the motor operated switch.

12. In combination, a primary switch, a pivoted magnetic needle cooperating with said switch and adapted by its movement to open and close the switch, a magnetizing coil surrounding said needle, magnetic means acting through a relatively short period to move said needle to open the pri-

mary switch, electro-magnetic means to re-  
turn said needle to close the primary switch,  
a limited movement electro-motor requir-  
ing a relatively long period for its opera-  
5 tion, a normally closed switch opened by  
said motor at the end of its movement, a  
normally closed main switch electro-mag-  
netic means for opening said switch, a series  
circuit including the electro-motor said  
10 main switch opening means said needle re-  
turning means and the needle magnetizing  
coil, a shunt circuit from the series circuit  
around said switch opening means and in-  
cluding the primary switch, a shunt circuit

from the series circuit around the electro- 15  
motor and including the main switch, and a  
shunt circuit from the series circuit around  
the needle returning means and including  
the motor operated switch.

In witness that I claim the foregoing I 20  
have hereunto subscribed my name this 24th  
day of May 1912.

EDGAR J. PACE.

Witnesses:

JAMES T. BARKELEW,  
CHAS. M. JILLSON,  
ELWOOD H. BARKELEW.