July 6, 1948. J. P. BOSTON 2,444,421

TEMPERATURE MEASURING SYSTEM WITH MAXIMUM OR MINIMUM SELECTOR

Filed Dec. 2, 1944

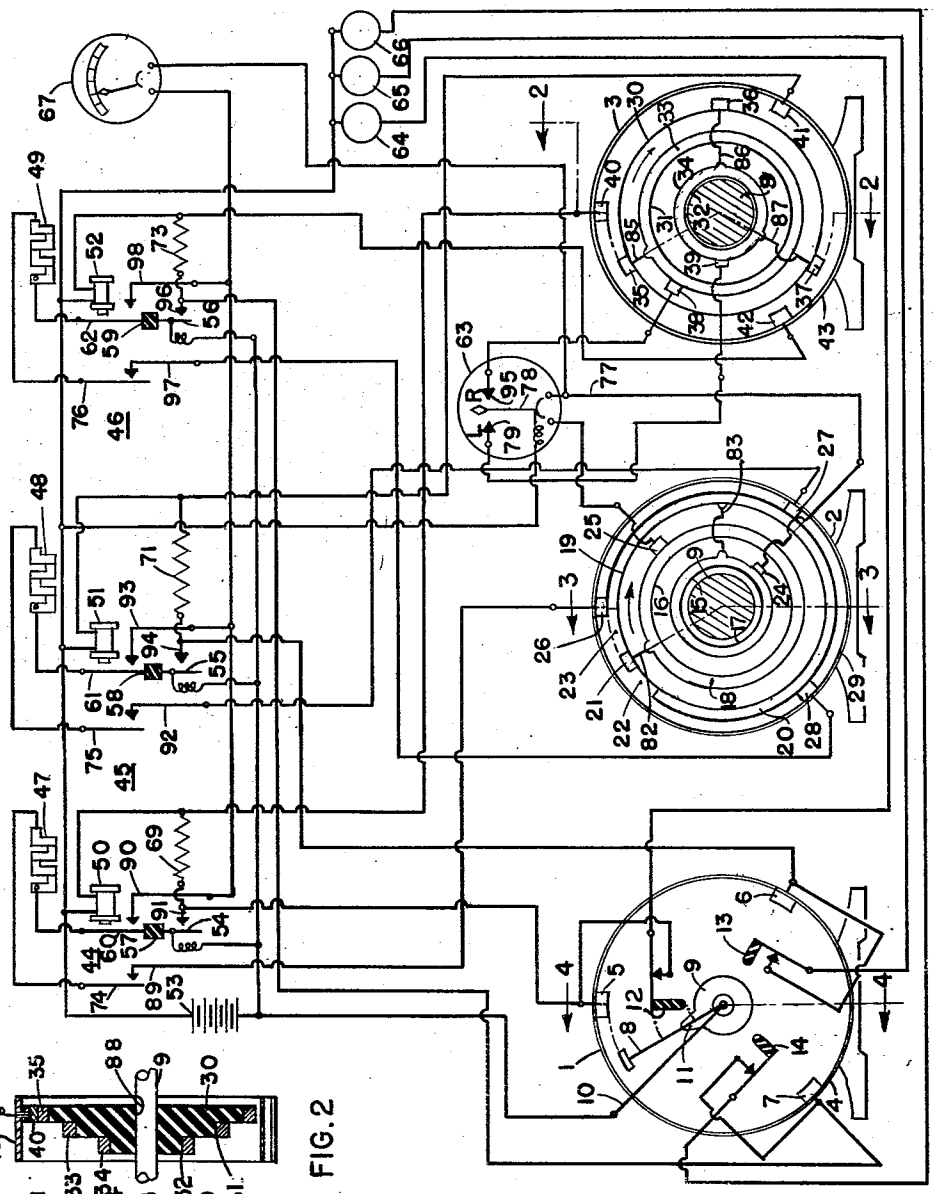

FIG. 1

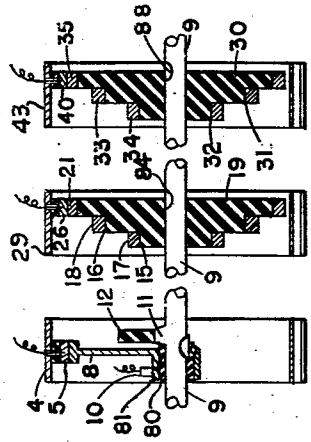

FIG. 2

FIG. 3

FIG. 4

INVENTOR.

JOHN P. BOSTON

BY

ATTORNEY

Patented July 6, 1948

2,444,421

UNITED STATES PATENT OFFICE

2,444,421

TEMPERATURE MEASURING SYSTEM WITH MAXIMUM OR MINIMUM SELECTOR

John P. Boston, United States Navy

Application December 2, 1944, Serial No. 566,381

5 Claims. (Cl. 73—341)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

1

This invention relates to selecting devices and more particularly to an apparatus that selects the maximum or minimum variations of potential effects, corresponding in magnitude of a condition, of a plurality of sources.

The principal object of this invention is to provide means for selecting the maximum or minimum temperature of a plurality of thermal sources.

Another object of this invention is to provide means for selecting, indicating and/or identifying the maximum or minimum temperature of a plurality of thermal sources.

Another object of this invention is to provide means for selecting, indicating and/or identifying, the maximum or minimum potential effect of a plurality of sources.

Another object of this invention is to provide means for selecting the maximum or minimum potential effect of a plurality of sources.

Another object of this invention is to provide means for selecting the maximum or minimum potential effect from a plurality of sources and applying said potential effects to control means.

Similar devices disclosed to date are of a type that merely indicate successively a series of temperatures of a plurality of sources, but none disclose automatic means for selecting, indicating, and identifying the maximum or minimum temperature of a plurality of sources, as provided for by this invention, and the application thereof to a control device.

This invention is not limited to thermal indications, but obviously may be adapted to select maximum or minimum light indications by merely substituting photo-electric generators for the embodied thermo-electric generators.

This invention will now be described with reference to the accompanying drawing, in which:

Fig. 1 is a wiring diagram in which is embodied several 3-way rotary switches diagrammatically disclosed;

Fig. 2 is a section on line 2—2 of selector switch of Fig. 1;

Fig. 3 is a section on line 3—3 of rotary switch of Fig. 1; and

Fig. 4 is a section on line 4—4 of distributor of Fig. 1.

Distributor switch 1 consists of a stator housing 4 which carries fixed contacts 5, 6 and 7, circumferentially equally spaced, and a distributor arm 8 rotatively rigid with drive shaft 9 and insulated at 80 therefrom. Fixed contacts 5, 6 and 7, are likewise insulated from the stator

2

housing. Distributor arm 8 successively engages said fixed contacts, thereby making and breaking successively selected relay coil circuits. Element 10 is any means that will transmit current to distributor arm 8 such as a brush engaging conductor ring 81 cast integral with arm 8. Shaft 9 is provided with cam 11 which actuates circuit interrupters 12, 13 and 14, thereby making and breaking successively selected lamp circuits.

Rotary switch 2 consists of a non-conducting rotor 19 with reduced diameter portions 15 and 16. On the peripheries of said reduced diameter portions are mounted conductor rings 17 and 18, respectively. On the outer periphery of the rotor 19 are mounted two arcuate shorting bars 20 and 21. Shorting bar 20 is substantially a complete ring except for a gap within which is mounted arcuate shorting bar 21 leaving a small space 22 and 23, on each side thereof. Shorting bar 21 is connected to conductor ring 18 through means of conducting element 82. Shorting bar 20 is connected to conductor ring 17 through means of conducting element 83. Brushes 24 and 25 are suitably mounted and slidingly engage with conductor rings 17 and 18, respectively. Fixed contacts 26, 27 and 28, circumferentially equally spaced, and carried by and insulated from stator housing 29, slidingly engage shorting bars 20 and 21 and cooperate therewith to make and break selected circuits. The rotor is rotatively rigid with shaft 9 through means of key 84.

Selector switch 3 consists of a non-conducting rotor 30, with reduced diameter portions 31 and 32. On the peripheries of said reduced diameter portions 31 and 32 are mounted conductor rings 33 and 34, respectively. On the outer periphery of the rotor 30 are mounted three rotating contacts 35, 36 and 37, circumferentially equally spaced. Rotating contact 35 is connected to conductor ring 33 through means of element 85. Rotating contacts 36 and 37 are connected to conductor ring 34 through means of elements 86 and 87, respectively. Brushes 38 and 39 are suitably mounted and slidingly engage conductor rings 33 and 34, respectively. Fixed contacts 40, 41 and 42, circumferentially equally spaced, and carried by and insulated from stator housing 43, slidingly engage rotating contacts 35, 36 and 37 and cooperate therewith to make and break selected circuits. Rotor 30 is rotatively rigid with shaft 9 through means of key 88.

Distributor arm 8, rotor 19, and rotor 30 are all fixed rotatively rigid to drive shaft 9, and are all in phase relationship with each other, so that at the instant distributor arm 8 completes

circuit through fixed contact 5, rotating contact 21 engages fixed contact 26, and rotating contact 35 engages fixed contact 40, simultaneously.

Relay switches 44, 45 and 46, and their associated thermocouples 47, 48 and 49, respectively, are connected to switches 1, 2 and 3 by circuits as hereinafter described.

Relay operating coils 50, 51 and 52 are connected in parallel to battery 53, with one side of each of said parallel coil branches being completed through 3-way distributor switch 1. The function of these circuits is primarily to energize said relay coils.

The 3-way distributor switch 1 is shunted through moving contacts 54, 55 and 56, with one side of each of said shunts being completed hrough relay coils 50, 51 and 52, respectively. Shunt contacts 54, 55 and 56 are secured to relay moving contacts 60, 61 and 62 of relay switches 44, 45 and 46, through insulation means 57, 58 and 59, respectively. As a result thereof, the shunt contacts 54, 55 and 56, are closed simultaneously with the relay moving contacts 60, 61 and 62, respectively, and the relays are held closed by these shunt circuits after the selector switch arm has left its primary energizing contacts 5, 6 and 7, respectively. Said shunts comprise movable contacts 54, 55 and 56 and fixed contacts 91, 94, 96, respectively, circuited across distributor switch 1.

Relay operating coils 50, 51 and 52, are shorted-out through selector switch 3, with one side of each of said shorting-out circuits being completed through said 3-way selector switch 3. A galvanometer 63 is connected between selector switch 3 and the relay coils. The function of the galvanometer in this circuit is merely to act as a single pole double throw switch by utilizing the deflection of its needle to make a circuit contact to the left or right. Fixed contacts 79 and 95 coact with deflecting needle 78 to perform said switching action. Said deflection is responsive to the action of the separately energized coil of the galvanometer. These circuits and the hereafter described thermocouple circuits are completed through the galvanometer and cooperate to effectuate an automatic shorting-out of the relays.

Incandescent identifying lamps 64, 65 and 66, are connected in parallel to relay operating coils 50, 51 and 52, respectively, with one side of each of said parallel lamp branches being completed through distributor 1 circuit breakers 12, 13 and 14, respectively. It is understood that any type of signalling means, other than incandescent lamps, can be used.

The thermocouple circuit consists of thermocouples 47, 48 and 49, connected to the normally open movable contacts, or armatures 74, 60, 75, 61, 76, 62, of relays 44, 45 and 46. Armatures 74, 75 and 76 are connected to the constantan side of their associated thermocouples; and armatures 60, 61 and 62 are connected to the iron side of their associated thermocouples. Said relays' fixed contacts 89, 90, 92, 93, 97, 98, with the associated armatures and thermocouples complete a circuit in parallel, for selection purposes, across the temperature indicating device 67, the galvanometer moving coils, and the 3-way rotary switch 2, in series.

Resistors 69, 71 and 73 should be of a magnitude that prevents excessive current from flowing through the deflecting needle contacts 79 and 95.

The minimum temperature may be selected by reversing the connections to the coils of galvanometer 63. This is simply reversing the direction of current flow through the galvanometer coils for a given temperature couple, and the resulting reverse action of the galvanometer needle rejects the relay contacting the higher temperature thermocouple rather than that of the lower temperature thermocouple.

Thus far, this disclosure covered a means of selecting and indicating the maximum temperature of a number of thermal sources. The same circuit may be expanded to include temperature control by replacing the temperature indicating instrument 67 with a maximum-minimum temperature control instrument as is manufactured by Weston. Such a control device could be used to maintain the hottest cylinder of an air-cooled aircraft engine within certain temperature limits by actuating the cowl flaps. There are, of course, control applications other than for aircraft engines. The principle for other uses would be the same, however, the details would be dependent on the method of regulating the flow of the cooling medium.

Operation

Any plurality of thermocouples can be used, but for purposes of this description three thermocouples will be considered. As the distributor arm 8 engages contact 5, for the first "sampling," relay coil 50 becomes energized by battery 53 and actuates relay 44 moving contacts 74 and 60 to a closed position with fixed contacts 89 and 90. The circuit by which relay 44 is actuated to a closed position is traced as follows: battery 53, element 10, distributor arm 8, fixed contact 5, resistance 69, relay coil 50, and back to battery 53. When the relay is closed it is held closed after the distributor arm breaks its primary energizing contact because the distributor became shunted through movable contact 54 engaging fixed contact 91 simultaneously with actuation of relay 44. Said shunt comprises movable contact 54, fixed contact 91, and resistor 69 circuited across distributor switch 1. The circuit by which relay 44 is held closed is traced as follows: battery 53, movable contact 54, fixed contact 91, resistor 69, relay coil 50, and back to battery 53.

Thermocouple-identifying lamp 64 becomes connected in parallel with relay coil 50 through breaker 12 mounted on distributor switch 1. This identifying lamp 64 is lit during the time its associated relay 44 is closed, except for the small period that the distributor arm 8 is contacting, at which time cam 11 lifts the breaker 12 and opens said identifying lamp circuit. (The identifying lamp associated with the higher thermocouple will remain lighted, while the lower temperature thermocouple's identifying lamp will be rejected immediately upon being introduced into the circuit, as will be hereinafter more fully described.)

The closed relay contacts allow the thermocouple 47 current to energize the temperature indicator 67 and galvanometer 63 circuit through the engagement of rotating contact 21 with fixed contact 26 of rotating switch 2.

The temperature indicating instrument 67 remains in circuit with the selected thermocouple 47, after rotating contact 21 breaks with fixed contact 26, through means of conductor line 77 and the connected shorting bars 17 and 20 of rotary switch 2, until the next sampling is effected, except for a negligible period of time represented by gap 22. (The temperature reading

is a function of the highest thermocouple current communicated to the temperature indicating instrument 67, as will be hereinafter more fully explained.)

The moving coil of galvanometer 63 is in circuit with the thermocouple for only the small interval of time that rotating contact 21 is successively engaged with fixed contacts 26, 27 and 28. At other times the galvanometer coil needle 78 is in a free vertical position ready to respond to the next selective action.

As the distributor arm 8 moves to the next contact for the second sampling, and engages contact 6, relay coil 51 is also battery energized and actuates relay 45 moving contacts 75 and 61 to a closed position with fixed contacts 92 and 93. When relay 45 is closed it is held closed, after the distributor arm 8 breaks its primary energizing contact 6, because the distributor 1 became shunted through moving contact 55 engaging fixed contact 94 simultaneously with actuation of relay 45. Said shunt comprises movable contact 55 and fixed contact 94, circuited across distributor switch 1. The closing of relay moving contacts 75 and 61 connects thermocouple 48 in parallel with thermocouple 47 through the engagement of rotating contact 21 with fixed contact 27, and allows the thermocouple 48 current to additionally energize the temperature indicator 67 and galvanometer 63 circuit. The parallel association of thermocouples 47 and 48 continues for but a very short interval of time, for one or the other is shorted out almost immediately by the action of galvanometer needle 78 explained in the following paragraph.

The direction in which the galvanometer needle 78 is deflected depends on which of the selected thermocouples is at the higher temperature. Suppose thermocouple 48 is at the higher temperature, then the galvanometer needle 78 will move to the left, make contact with galvanometer fixed contact 79, and short out the hold-down coil 50 of relay 44, through engagement of rotating contact 37 and fixed contact 40. Thus relay 45 remains closed and relay 44 is thrown open thereby rejecting thermocouple 47. The temperature-indicating device 67 will now indicate the temperature of the larger and only remaining thermocouple in circuit with the said temperature-indicating device, through means of conductor line 77, the connected shorting bars 17 and 20, and fixed contact 27, until the next sampling is effected. The left or right direction in which the galvanometer needle 78 is deflected is determined by the net direction of current flow from the opposed connected thermocouples and their associated circuits. The flow of current in a thermocouple is from the constantan side to the iron side through the hot junction. These thermo-electric generators can be incorporated in circuits so that they either buck each other or reinforce each other. In this particular embodiment, the thermocouples are connected in circuits so that they buck each other during the comparing interval. Therefore, since the hottest thermocouple generates the greatest current, and since it bucks the lesser current from the colder thermocouple, the current from the hottest thermocouple will dominate the circuit, and its direction will determine the polarity of the galvanometer 63 coils at any given operation. Thermocouples 47 and 48 do buck each other with the galvanometer 63 in series between them when both relays 44 and 45 are closed as during the comparing interval. Since

thermocouple 48 is the hotter of the pair, its current will dominate the circuit and be directed through the galvanometer 63 in a direction that will cause the needle to deflect to the left and reject the lower temperature thermocouple 47 from circuit association with said higher temperature thermocouple 48. The remaining thermocouple 48 then bucks thermocouple 49 in the same manner when the contact 21 moves to contact 28, relay 46 being closed by the action of rotary switch 1. Thermocouple identifying lamp 65 becomes connected in parallel with relay coil 51 through breaker 13 mounted on distributor 1. This identifying lamp 65 also became lighted when its associated relay 45 was closed, except for the small period of time that the distributor arm 8 is contacting at which time cam 11 lifts the breaker 13 and opens said identifying lamp circuit. However, one or the other of said lamps will be rejected depending upon which of their associated thermocouples is at the lower temperature. This rejection is effectuated by the galvanometer needle 78 action hereinbefore described, shorting out hold-down coil 50 and its associated identifying lamp 64. The light circuit is opened during the interval that the distributor is contacting to prevent extra lighting of a lamp when each relay is sampled. The function of the lamp circuit is to identify only the thermocouple that is at the highest temperature. Thus relay 45 remains closed, thermocouple identifying lamp 65 is lighted and the temperature indicating device 67 will now read the temperature of thermocouple 45, it being the larger temperature of the two thus far sampled thermocouples.

Had thermocouple 47 temperature been greater than thermocouple 48 temperature, the galvanometer needle 78 would have been deflected to the right, make contact with galvanometer fixed contact 95, thereby "kicking out" relay 45, and consequently thermocouple 48. Consider the part of the cycle before, during, and after, the selection period when thermocouple 48 is compared with thermocouple 47. Contact 21 has left contact 26 and is approaching contact 27. Relay 44 is closed and the constantan side (so called for the sake of descriptive convenience) of thermocouple 47 is connected to contact 26, and through rings 20 and 17 to the right terminal of galvanometer 63. No current flows through the galvanometer because contact 21 is out of the circuit. Meter 67 is indicating the temperature of thermocouple 47, connection to the constantan side being through contact 26, rings 20 and 17, wire 77, and the wire joining 77 to the right terminal of meter 67. Arm 8 moves on to contact 6 to close relay 45, and simultaneously, contact 21 forms an electrical connection with contact 27, which action connects the constantan side of thermocouple 48 to the left terminal of galvanometer 63 through relay arm 75, relay contact 92, contacts 27 and 21, ring 18, and contact 25. The constantan side of thermocouple 47 is still connected to the right terminal of galvanometer 63 through wire 77, rings 17 and 20, contact 26, and relay 44. Now the energizing coil of galvanometer 63 has the constantan side of thermocouple 47 connected to its right terminal and the constantan side of thermocouple 48 connected to its left terminal in bucking relation, since current flows from the constantan side to the iron side through the hot junctions of both thermocouples. A current now flows through galvanometer 63, the direction of which is de-

termined by which thermocouple, 47 or 48, is at the higher temperature. Suppose 48 is higher. The polarity of the galvanometer is so arranged that needle 78 moves to the left under these circumstances, and relay 44 is opened through the action of needle 78 making connection through contacts 73, 39, ring 34, contacts 37 and 40 to resistor 69. If thermocouple 47 had been higher, the needle 78 would have moved to the right and shorted out relay 45, through contacts 95, 38, ring 33, contacts 35 and 41 and resistor 71. But 48 is the higher, and relay 44 has opened. Now the right terminal of galvanometer 63 is no longer connected to the constantan side of thermocouple 47, and for a brief instant until contact 21 moves away from contact 27, galvanometer 63 is in series with the constantan sides of thermocouple 48 and that of meter 67 and deflection of the needle 78 to the left is maintained until 21 leaves 27. The meter 67 takes up the correct reading of thermocouple 48 when ring 20 moves to contact 27, and maintains it until the next comparison period when thermocouple 49 is introduced into the circuit. When contact 21 leaves contact 27, galvanometer 63 is out of the circuit and remains so until contact 21 touches contact 28.

It should be further understood that coil 50 is not shorted out by the action of the galvanometer needle 78 when thermocouple 47 is connected. If the instrument is turned on with rotary switches 1, 2, and 3 in a position where relay 44 is the first to be energized, the first temperature comparison will be between thermocouple 47 and the cold junction thermocouple of meter 67. Unless circumstances are very unusual, thermocouple 47 will be at a temperature higher than that of the thermocouple of meter 67. The needle will move to the left (see below), and the action will be such as to connect one side of resistors 71 and 73 to the battery but with coil 50 not shorted out. Thus relay 44 would remain closed until rejected as "low" in the subsequent normal comparison periods with thermocouples 48 and 49. The statement that the needle would be deflected to the left because thermocouple 47 is at a higher temperature than the thermocouple of meter 67, may appear in conflict with a statement in the preceding description of the specification, but that it is not the case. In the latter instance, the constantan side of thermocouple 47 was connected to the right terminal of galvanometer 63 due to the position of switch 2; in other words, contact 26 was bearing on ring 20 since 21 was contacting 27. It is the purpose of switch 2 to insert the galvanometer into the circuit so that the left terminal always is connected to the constantan side of the thermocouple last brought into the circuit. This is necessary to prevent the action of a higher thermocouple rejecting itself.

As distributor arm 8 moves on fixed contact 7, the third sampling relay 46 closes, and again the galvanometer needle 78 "kicks out" the relay associated with the lower temperature thermocouple, and so on around to relay 44 again. Thus, only the thermocouple having the maximum temperature will be finally selected, identified by its associated lamp, and its temperature indicated on the temperature indicating instrument. The operation is continuous and the speed of the cycle depends on the speed of the driving motor which is limited only by the time required to operate the relays and galvanometer.

If it should happen that two or more temperatures are the same, and higher than the remainder of the temperatures, the galvanometer will not release the relays of the two or equal highest thermocouples, and the lamps will indicate this condition by identifying both said sources.

If a flickering of the needle of the temperature-indicating meter, during the short interval when two thermocouples are being compared, is objectionable, a mechanical or electrical needle locking device may be used during that interval.

If it is desired to indicate, select, and identify the minimum temperature, it may be effected by reversing the connections to the galvanometer 63 coils. This is simply reversing the direction of current flow through the galvanometer coils for a given temperature couple, and the resulting reverse action of the galvanometer needle rejects the relay contacting the higher temperature thermocouple rather than that of the lower temperature thermocouple.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. An apparatus of the character described, comprising: a source of current; a plurality of electromagnetically operated switch means; a first mechanism for successively and individually associating said source of current with the electromagnetic operating means of said switch means; means controlled by said switch means when operated for continuing said association independent of said mechanism; a plurality of means for producing electrical effects respectively corresponding with variations in magnitudes of a plurality of conditions; common means for making measurements of said electrical effects; deflecting means responsive to electrical effects; a second mechanism acting synchronously with said first mechanism for severally associating said electrical effects producing means with said measurement making means through the operated switch means and for associating temporarily two of said electrical effects producing means in opposition to said deflecting means through the operated switch means; and a third mechanism acting synchronously with said second mechanism during said temporary association for providing short circuits for the operating means of said two switch means then effective on said effect producing means through said deflecting means in oposite directions, whereby one of the switch means will be released depending upon the direction of deflection of the deflecting means, and whereby only one of the effect producing means will remain in association with the measuring means, and indicating means individual to and controlled by the operative condition of the electromagnetically operated switch means.

2. The apparatus as set forth in claim 1 in which said means for producing electrical effects is a thermocouple.

3. The apparatus as set forth in claim 1 in which said deflecting means is a galvanometer.

4. An apparatus of the character described, comprising: a source of current; a plurality of electromagnetically operated switch means; a first mechanism for successively and individually associating said source of current with the electromagnetic operating means of said switch means; means controlled by said switch means

when operated for continuing said association independent of said mechanism; a plurality of means for producing electrical effects respectively corresponding with variations in magnitude of a plurality of conditions; common means for making measurements of said electrical effects; deflecting means responsive to electrical effects; a second mechanism acting synchronously with said first mechanism for severally associating said electrical effects producing means with said measurement making means through the operated switch means and for associating temporarily two of said electrical effects producing means in opposition to said deflecting means through the operated switch means; and a third mechanism acting synchronously with said second mechanism during said temporary association for providing short circuits for the operating means of said two switch means then effective on said effect producing means through said deflecting means in opposite directions, whereby one of the switch means will be released depending upon the direction of deflection of the deflecting means, and whereby only one of the effect producing means will remain in association with the measuring means.

5. An apparatus of the character described, comprising: a source of current; a plurality of electromagnetically operated switch means; a first mechanism for successively and individually associating said source of current with the electromagnetic operating means of said switch means; means controlled by said switch means when operated for continuing said association independent of said mechanism; a plurality of means for producing electrical effects respectively corresponding with variations in magnitude of a plurality of conditions; common means for making measurements of said electrical effects; deflecting means responsive to electrical effects; a second mechanism acting synchronously with said first mechanism for severally associating said electrical effects producing means with said measurement making means through the operated switch means and for associating temporarily two of said electrical effects producing means in opposition to said deflecting means through the operated switch means; and a third mechanism acting synchronously with said second mechanism during said temporary association for providing short circuits for the operating means of said two switch means then effective on said effect producing means through said deflecting means in opposite directions, whereby one of the switch means will be released depending upon the direction of deflection of the deflecting means, and whereby only one of the effect producing means will remain in association with the measuring means, and indicating means individual to and controlled by the operative condition of the electromagnetically operated switch means.

JOHN P. BOSTON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,496,101	Schmitt	June 3, 1924
1,775,540	Taylor	Sept. 9, 1930
2,266,185	Fillo	Dec. 16, 1941