May 30, 1933. W. VAN BENSCHOTEN 1,911,656

ELECTRIC CONTROL DEVICE

Filed June 23, 1928

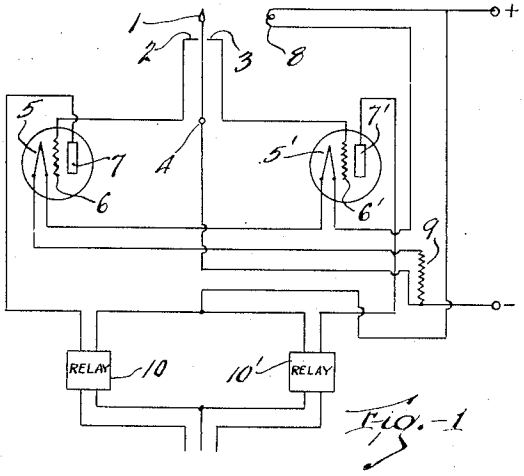


Fig.-1

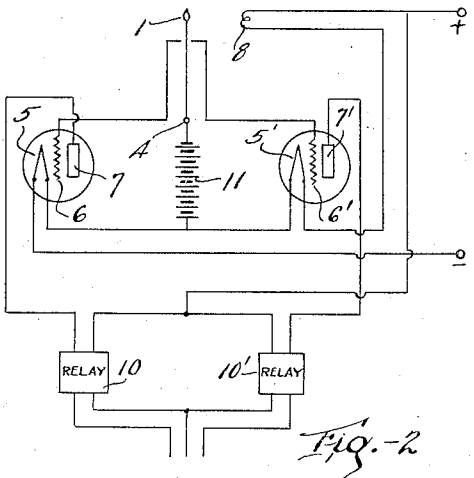


Fig.-2

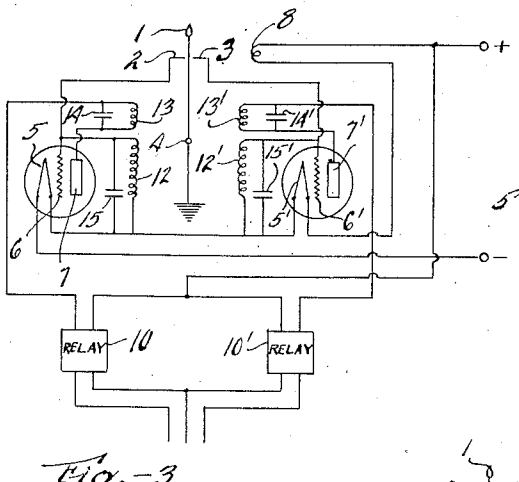


Fig.-3

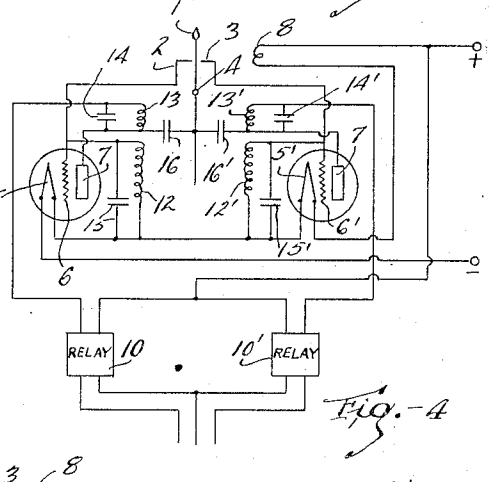


Fig.-4

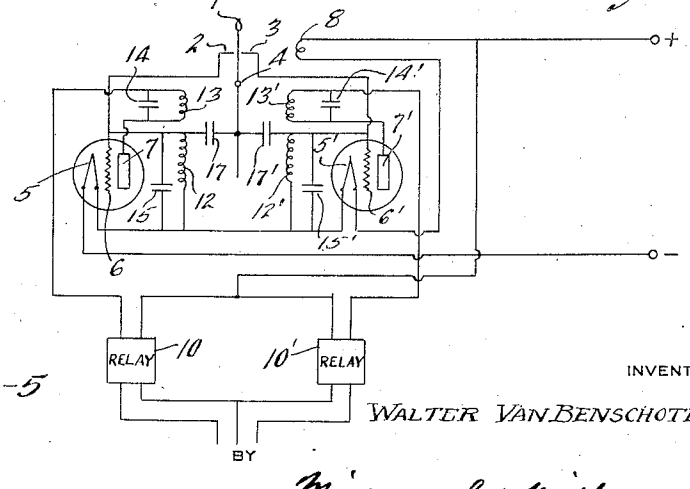


Fig.-5

INVENTOR

WALTER VAN BENSCHOTEN

BY

Milburn & Milburn.

ATTORNEYS

Patented May 30, 1933

1,911,656

UNITED STATES PATENT OFFICE

WALTER VAN BENSCHOTEN, OF FISHKILL, NEW YORK

ELECTRIC CONTROL DEVICE

Application filed June 23, 1928. Serial No. 287,872.

This invention relates to improvements in electrical control devices.

The object of the present invention is to devise means for rendering extremely feeble contacts more readily distinguishable or more impressive so as to either facilitate the ascertainment or recording of information embodied in such contacts or to permit the performance of some further operation by such contacts.

For instance, in the automatic closing of electric circuits in the operation of various forms of meters, the pressure between the metallic contacts is extremely light and delicate; in fact, in such cases, the electric current which can pass such contacts without causing pitting or sticking is practically immeasurable, that is, approximately .000001 ampere. Whenever, in the past, it has been desirable to render such electric contact distinguishable or to cause the same to perform some other mechanical or electrical operation, it has been considered necessary to provide mechanically more pronounced metallic contact pressure permitting passage of current that is capable of measurement.

With the present invention, however, it is intended to render possible the performance of any auxiliary operation or the operation of any other device by the very light or delicate contact, this result to be accomplished by the use of a supplemental combination which may assume various specific forms, as will appear from the following.

Thus, the present object may be said to consist in controlling an electric relay by means of an extremely delicate electric contact which would otherwise be incapable of effecting such control.

Further and more specific objects of the present invention will appear from the following description and claims.

Fig. 1 shows diagrammatically one combination for carrying out the present invention; Fig. 2 shows diagrammatically a modified combination; Fig. 3 shows diagrammatically another form of the same invention; and Figs. 4 and 5 show modifications of the form shown in Fig. 3.

Referring first to Fig. 1 of the drawing, the meter needle 1 is adapted to make contact with either of the contactor points 2 and 3 according to certain conditions which are supposed to control the movements of the needle. This needle is indicated as being pivotally mounted at the point 4 and the contact points or contactors, 2 and 3 are included in an electrical control system to be hereinafter more fully described.

Associated with each contact point 2 and 3, there is a vacuum tube, the cathode, control electrode, and anode of which are indicated by reference numerals 5, 6, 7, and 5′, 6′, 7′, respectively. The cathode, or filament circuit is shown as having a pilot light 8 which is located in sufficiently close proximity to assist also in the observation of the meter needle and the contactors. This pilot 8 is in series with the cathodes, or filaments 5, 5′ and is of proper wattage to provide sufficient filament current, and sufficient resistance to lower the voltage to the proper operating point for the filaments. It is understood, of course, that the lighted condition of the pilot will serve as an indication that the filaments 5, 5′ are lighted. Thus, the pilot, in the present arrangement, serves a triple purpose. There is also included in the filament circuit the bias resistor 9.

Included in the plate or anode, circuits are the relays 10, 10′, respectively, which are intended for the control of other independent electric circuits or apparatus which might be thus employed for the performance of any desired function, in accordance with the closing of the corresponding contact at 2 or 3. For the purpose of the present disclosure, it is deemed unnecessary to illustrate the apparatus which is controlled by the relays. The form of this apparatus may vary and the present invention is intended to comprehend any and all such forms of apparatus capable of use in the combination and arrangement herein set forth.

A control switch may be inserted in the line, if so desired, so as to be able to cut the present system in or out at any time. It is to be understood also that this system may be employed with either direct or alternat-

ing current, with the necessary provision, as for instance the selection of suitable tubes for alternating current, and a rectifier tube so as to convert the current to direct for the plate and grid of the vacuum tubes. Also, it is to be understood that there will be impressed upon the vacuum tubes the proper filament and plate voltages to permit the operation now to be more fully explained.

Under the conditions hereinbefore described, and with the contactors 2 and 3 open, there will be sufficient plate current flow in each of the plate circuits to hold both of the relays 10 and 10′ open or in idle condition. That is, as above stated, there is provided proper filament and plate voltage to hold the relays open when the control electrode, or grid circuits through the contacts at 2 and 3 are open.

When, however, the needle, or indicator, 1 makes contact with one of the contactors 2 or 3, which means that the corresponding one of the grid circuits is then closed, the abnormal flow of current through the plate 7 or 7′ corresponding to the particular grid circuit closed is reduced by impressing a negative charge on the corresponding grid, or control electrode as will be understood from Fig. 1, and this flow is decreased to such an extent that the corresponding relay is no longer held open but is permitted to close and to thereupon perform its function through the electric circuit which is controlled thereby. The plate current flow in each plate circuit is controlled by its own particular contact at the needle and the closing of one of these contacts will affect the plate current flow through only its own corresponding plate circuit since the closing of one of these contacts is effective in closing only one of the grid circuits, that is, the one corresponding thereto. This continues, however, only so long as the particular contact remains in such closed condition, and as soon as this contact again opens, the grid circuit which was closed is opened and the former condition is thus restored, that is, the reduction of current by the grid being negatively charged is discontinued and the former plate current flow is restored so as to hold the relay open.

The above operation will take place in spite of the lightest or most delicate engagement between the needle 1 and the contactors 2 or 3, and thus there may be produced any form of function which a relay system is capable of effecting.

The arrangement shown in Fig. 2 is the same as in Fig. 1 except that the bias resistor is omitted and there is employed a battery for bias, connected in the direction indicated in Fig. 2; that is, the positive end is connected with the filament. This battery 11 is connected between the filament circuit and the end of the needle 1. Thus, upon closing of the contact between the needle 1 and either of the contactors, 2 or 3, the plate current flow is reduced by the particular arrangement of the potential in the grid circuit, with the result that the corresponding relay is automatically closed so as to actuate the electric circuit controlled by the relay.

In the systems illustrated in Figs. 3, 4, and 5, the vacuum tubes are arranged in tuned oscillating circuits. That is, while the plate and grid circuits are in tune, the plate current flow is sufficient in each case to hold the relays open; but when the tuned condition is disturbed, the plate current flow will be automatically reduced in each case corresponding to the particular contact which is closed, and as a result, the corresponding relay is automatically closed so as to actuate the circuit which it controls.

As will be seen from Fig. 3, each tube has associated with it the necessary inductance and capacity for an oscillating condition. The coils 12, 12′ of the grid and the coils 13, 13′ of the plate circuits are of the same number of turns, respectively, and they are arranged the proper distance apart; and the condensers are connected at any desired points, the present arrangement of condensers 14, 15, and 14′, 15′ being only for purposes of illustration. In Fig. 3, the needle is grounded either directly or indirectly in any convenient manner. With this arrangement, and with the contacts open at the needle, the oscillating circuits, in which are included the vacuum tubes, are tuned, and the plate current flow, in each case, is sufficient to maintain the relays open. Then when the movement of the needle closes one of the contacts, the grid circuit of the corresponding tube is grounded and there is a disturbance of the tuned condition, with the result that the plate current flow is reduced and the corresponding relay is automatically closed so as to actuate the circuit controlled thereby. It follows, of course, that some portion of the oscillating circuits must be grounded in some manner, such as, for example, at the filaments, in order that the grounded needle may affect the oscillating current.

Fig. 4 shows a modification of the system illustrated in Fig. 3. Instead of grounding the needle, as in Fig. 3, the needle is connected electrically to the plate coil, in each case, through the condensers 16, 16′. With the contacts open, the plate current flow will hold the relays open; but when one of the contacts is closed, the circuits are detuned, with the result that the plate current flow is diminished to such an extent that the relay corresponding thereto is permitted to close and to actuate the circuit under the control thereof. In this modified arrangement, as in those illustrated in Figs. 3 and 5 as well,

the de-tuning of the vacuum tube circuits causes a material decrease in the plate current flow, as above explained, but the oscillating condition of the circuits continues and the flow of current through the plate of the other tube continues sufficiently strong to maintain its particular relay open until the needle contact corresponding thereto is closed. Then the conditions with respect to plate current flow in the two tubes is reversed.

In Fig. 5, the system is similar to that shown in Fig. 4, except that the needle is connected in circuit with the grid coil of each vacuum tube. Here, as in the other systems herein illustrated, the number and arrangement of the condensers 17, 17′ may be varied. The operation of this system shown in Fig. 5 will no doubt be understood from the explanation of Fig. 4 and further description at this point would seem to be unnecessary.

Thus, I have devised a system whereby extremely weak contacts can be rendered easily perceptible and can be caused to effect operation of another device. Furthermore, my system can be installed as an attachment to the present indicating devices without requiring reconstruction or even modification of the indicating device itself. Accepting the existing condition of extremely feeble pressure at the points of needle contact, my present invention renders possible the performance of other mechanical or electrical operations by the closing of such contacts. Even though there should be an electrical resistance approximating 10,000,000 ohms at the point of needle contact, still my present system can be depended upon to produce the result herein set forth.

Viewed from another angle, it will be seen that my invention renders possible the control of a relay by an extremely delicate contact which would otherwise be wholly incapable of exercising such control.

It is to be understood that various modifications can be made in the present disclosure without departing from the spirit of my invention. For instance, in case it should be desired to employ an indicating means having only one contact, the same general system might be employed with suitable modification. In which case, the result might be obtained by disturbing the oscillating condition of the circuit so as to produce a marked difference in the plate current flow of the tube in the circuit. Thus, this invention is not limited to the use of the particular number of contacts shown in the present illustration.

Not only can this invention be employed in connection with electric contacts, but this same system can be used also in connection with any elements or parts which are closed together or have movement towards and from each other, it merely being necessary to provide such parts with metallic contacts. In any and all such cases, my system can be employed as a means of causing such comparatively feeble contacts to cause the actuation of other circuits by which practically any work can be performed or any effect produced.

Applicant is aware of prior systems involving the use of vacuum tubes in which the grid is active at all times; but, in the present case, the grid is of zero potential, or floating, and hence wholly inactive while the needle-controlled contacts are open, and is rendered active only when the corresponding contact is closed by movement of the needle, whereupon there is effected a negative grid potential, with the result above set forth.

Any and all modifications coming within the spirit of the present disclosure are intended to be comprehended by the following claims.

What I claim is:

1. In an electric control system, a relay, a delicate contacting means having a high contact resistance at least for an interval of time after contact is established, and means for enabling said high resistance contact to operate said relay, said means comprising a vacuum tube having an anode, cathode and control electrode, said relay being connected in a closed circuit including said anode and cathode and being maintained in a normally energized position by a normally steady current flow in said closed circuit, and said contacting means being connected between said cathode and control electrode so that when the contacts of said contacting means are open, said control electrode is unconnected with any other element, whereby when said contacts are closed, even though very lightly, said steady current flow is interrupted and said relay thereby operated.

2. In an electric control system, a relay, a contacting means having a high contact resistance for at least an interval of time after contact is established, and means for enabling said high resistance contact to operate said relay, said means comprising a vacuum tube having an anode, cathode and control electrode, said relay being connected in a circuit between said anode and cathode, and said contacting means being connected in series with a source of potential between said cathode and control electrode so that said contacting means is adapted to impress said potential in a negative sense upon said control electrode with respect to said cathode upon closure of the contacts of said contacting means, said control electrode being unconnected to any other element when said contacts are open, whereby closure of said contacts, even though very lightly, produces

a reduction of said anode current and thereby causes said relay to operate.

3. In an electric control system, a relay, a contacting means and a vacuum tube system for enabling said high resistance contact to produce operation of said relay, said system comprising a vacuum tube having an anode, cathode and control electrode, said relay being connected in the anode circuit of said tube and said contacting means being connected in series with a battery between said grid and cathode in such a manner that closure of said contacts biases said control electrode negatively with respect to said cathode, the control electrode-cathode circuit being unconnected to any other element when said contacts are open, whereby closure of said contacts produces immediate operation of said relay even when said contact resistance is extremely high.

4. In an electric control system, a relay, a contacting means having a high contact resistance for at least a length of time, and a vacuum tube system including said relay and said contacting means, said system comprising a vacuum tube having an anode, cathode and control electrode, said relay being connected in said anode-cathode circuit and said contacting means being connected to said control electrode, a source of current for energizing said cathode and a resistance in series with said source and said cathode across which resistance a voltage is produced which is negative relative to the potential of said cathode, and a connection between said contacting means and said resistance for applying said negative potential to said control electrode when said contacts are closed, said control electrode being unconnected to any other element when said contacts are open.

5. In an electric control system a vacuum tube having an anode circuit and a control circuit, a relay connected in said anode circuit and operable by said anode current, a source of potential and a pair of closable electric contacts in series in said control circuit, said control element being unconnected to any other element when said contacts are open, the closure of which contacts immediately produces a bias in the control circuit of sufficient magnitude, regardless of the slightness of the contacts, to vary said anode current sufficiently to immediately operate said relay.

6. In an electric-control system a vacuum tube having an anode, cathode and control electrode, a relay connected between said anode and cathode actuated by said anode current, a pair of closable electric contacts situated in series with a source of potential in a circuit between said cathode and control electrode, said control electrode being unconnected to any other element when said contacts are open, and means for closing said contacts, upon closure of which said potential is applied upon said control electrode in a negative sense and said anode current is thereby reduced to such an extent as to cause said relay to be released.

7. In an electric control system, for operation at minimum and maximum positions, an indicator movable between a pair of electric contactors which lie at said minimum and maximum positions, said contactors having an extremely high contact resistance for at least an interval of time after contact is established, a pair of vacuum tubes each having an anode, cathode and control electrode, and a pair of relays, one of said relays being connected in the anode circuit of each of said tubes, one of said pair of contactors being connected in the control circuit of each of said tubes, and a source of potential which applies a negative bias to the control electrode of each tube when said indicator comes into contact with the corresponding contactor, said control electrodes being electrically unconnected to any other element when the corresponding contactors are open, whereby a very slight contact of the indicator with either of said contactors produces a sudden decrease of the anode current of the corresponding tube and a consequent operation of the associated relay.

8. In an electric control system, a contacting indicator movable between two contactors in accordance with an applied force due to a variation of an external body, the resistance between either of said contactors and said contacting indicator being extremely high for at least an interval of time after contact is established, a pair of vacuum tubes each having an anode, cathode and control electrode, a source of potential and a pair of relays, one of said relays being connected in the anode-cathode circuit of each of said tubes, one of said contactors being connected with the control electrode of each of said tubes and said indicator being connected with said source of potential in such a manner that upon the making of contact between said indicator and one of said contactors said potential is impressed upon the associated control electrode in a negative sense relative to the cathode, said control electrodes being unconnected to other portions of the vacuum tube circuit when the associated contactor is not in contact with said indicator, whereby any contact, however slight, causes the relay in the anode circuit of the associated tube to be operated.

9. In an electric control system, a relay, a contacting means having a high contact resistance for at least an interval of time after contact is established, and means for enabling said high resistance contact to operate said relay, said means comprising a

vacuum tube having an anode, cathode and control electrode, and a circuit system associated with said electrodes adjusted to be in a state of oscillation, said relay being connected in said oscillating system, and said contacting means being arranged to connect two points of said oscillating system upon closure of said contacts, whereby closure of said contacts interrupts the steady state of said oscillations and thereby causes said relay to be de-energized.

10. In an electric control system, a relay, a contacting means having high contact resistance at least for an interval of time after contact is first established, and means for enabling said high resistance contact to operate said relay, said means comprising a vacuum tube having an anode, cathode and control electrode, an oscillating system comprising a pair of tuned circuits coupled together, one of said circuits being associated with the anode and the other with the control electrode, and said relay being held in a normally open position by the current in said oscillating system, said contacting means being adapted to connect two points of said oscillating system, whereby closure of said contacts detunes said circuits and thereby causes said relay to close.

11. In an electric control system, a relay, a contacting means having a high contact resistance at least for an interval of time after contact is established, and means for enabling said high resistance contact to operate said relay, said means comprising a vacuum tube having an anode, cathode and control electrode, a circuit including said anode and cathode and a circuit including said control electrode and cathode, means for producing a transfer of energy between said circuits in a manner to produce sustained oscillations, said relay being connected in said anode-cathode circuit and said contacting means being connected between said cathode and control electrode, whereby closure of said contacts interrupts the sustained oscillations and thereby produces operation of said relay.

12. In an electric control system, a contacting indicator movable between a pair of contactors by means of an applied force due to the variation of an external body, a pair of vacuum tubes each having an anode, cathode and control electrode, and a pair of relays, each of said tubes having associated therewith an oscillatory circuit, each of which includes one of said relays, the control electrode of each of said tubes being connected to one of said contactors and said indicator being connected to the said oscillatory circuits, whereby any contact, however slight, causes the relay in the oscillatory circuit of the associated vacuum tube to be operated.

13. In an electric control system for operation at maximum and minimum values of control, a pair of contactors corresponding to said maximum and minimum values, an electric control means movable between said contacts, a pair of vacuum tube oscillators each having an oscillating circuit and a control electrode, a relay operated by the oscillating circuit of each of said tubes, a connection from the control electrode of each of said tubes to one of said contactors and a connection from said movable control means to each of said oscillating circuits, whereby a very slight contact of said contact means with either of said contactors produces a cessation of oscillation of the corresponding tube and consequent operation of the associated relay.

In testimony whereof, I hereby affix my signature.

WALTER VAN BENSCHOTEN.