March 30, 1948. W. H. BRUNS 2,438,535

ELECTRIC CIRCUIT

Filed July 26, 1945 2 Sheets-Sheet 1

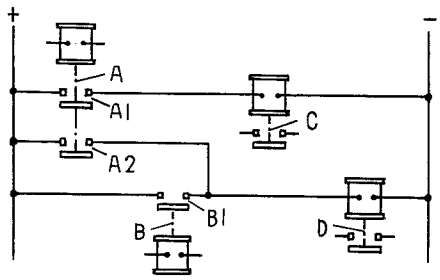

FIG. 1a

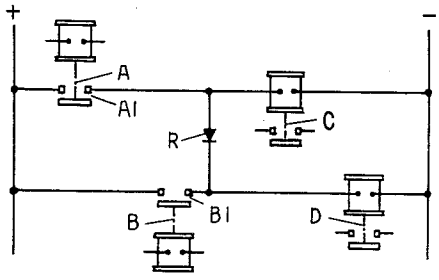

FIG. 1b

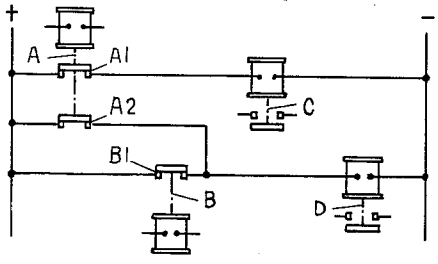

FIG. 2a

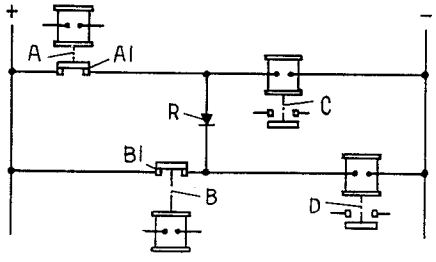

FIG. 2b

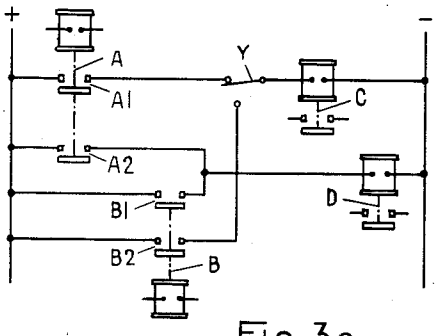

FIG. 3a

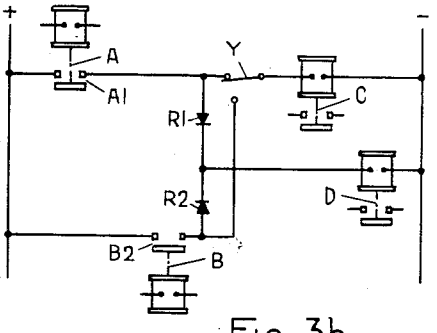

FIG. 3b

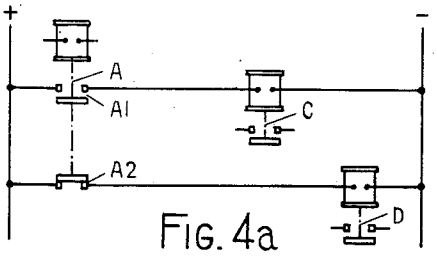

FIG. 4a

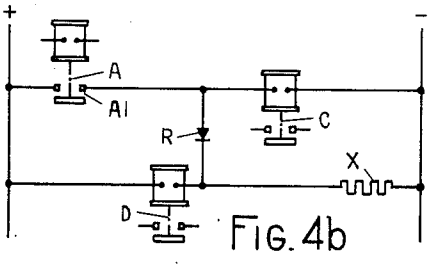

FIG. 4b

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March 30, 1948. W. H. BRUNS 2,438,535

ELECTRIC CIRCUIT

Filed July 26, 1945 2 Sheets-Sheet 2

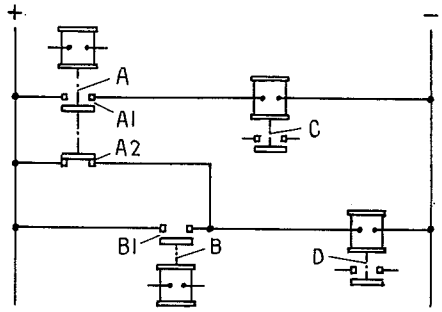

FIG. 5a

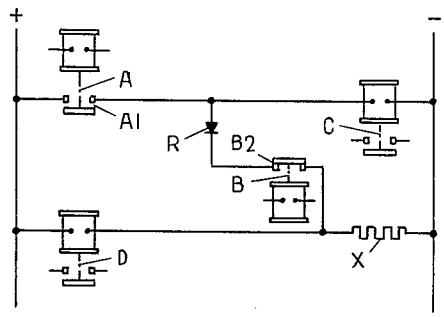

FIG. 5b

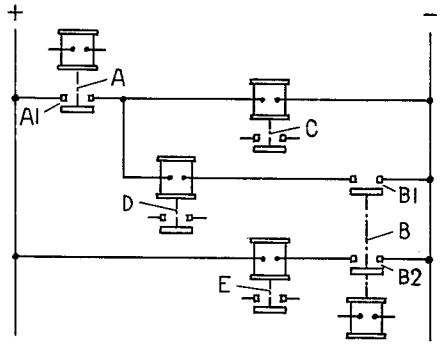

FIG. 6a

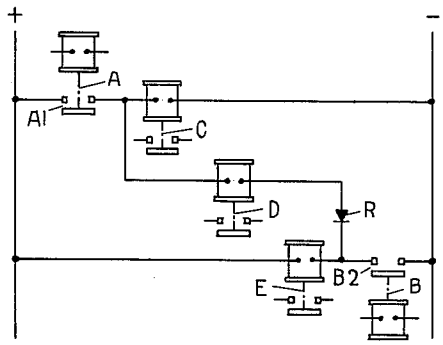

FIG. 6b

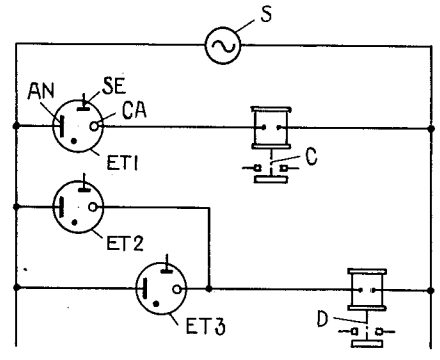

FIG. 7a

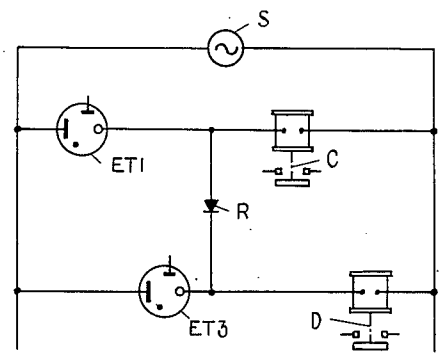

FIG. 7b

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UNITED STATES PATENT OFFICE

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ELECTRIC CIRCUIT

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Application July 26, 1945, Serial No. 607,121

7 Claims. (Cl. 171—97)

1

The invention relates to the control of electric circuits.

In the control of electric circuits, it often happens that several circuits are subject to the same control operation. To obtain the operation desired in certain circuit arrangements in which two or more circuits are subject to the same control operation, it has been the practice to separately control each such circuit in response to the control operation. For example, it has been the practice where an electromagnetic switch controls two circuits, one of which is controlled by another switch, to provide contacts thereon in each circuit. When electronic tubes are used as switches, separate tubes or multi-anode tubes have been utilized.

The object of the invention is to control a plurality of interrelated circuits in a desired manner with a minimum number of contacts or other circuit controlling means such as electronic tubes.

The invention involves connecting circuit controlling means for one circuit through unidirectional current conducting means to control another circuit and is applicable to circuits having direct current supply or to those in which direct current is caused to flow in the particular circuits involved as when they are controlled by electronic tubes as switches. The invention is of especial utility in low power circuits.

Features and advantages of the invention will become apparent from the following description and appended claims.

In the drawings:

Figures 1*a*, 2*a*, 3*a*, 4*a*, 5*a* and 6*a* are simplified wiring diagrams of various known circuit arrangements in which separate pairs of contacts of an electromagnetic switch are utilized to control separate circuits;

Figures 1*b*, 2*b*, 3*b*, 4*b*, 5*b* and 6*b* are simplified wiring diagrams, respectively corresponding to Figures 1*a*, 2*a*, 3*a*, 4*a*, 5*a* and 6*a*, in which a single pair of contacts of an electromagnetic switch serves to control the separate circuits in accordance with the invention;

Figure 7*a* is a simplified wiring diagram of a circuit arrangement under electronic tube control in which separate tubes are utilized to control separate circuits; and

Figure 7*b* is a simplified wiring diagram corresponding to Figure 7*a* in which a single electronic tube serves to control the separate circuits in accordance with the invention.

2

Referring first to Figures 1*a*, 1*b* to 6*a*, 6*b*, + and — indicate direct current supply lines. A and B are electromagnetic switches having contacts for controlling electric circuits. The contacts of switch A are designated A1 and A2 and those of switch B are designated B1 and B2. The operating coils of these switches may be controlled in any desired manner. C, D and E are electromagnetic switches having their operating coils in the circuits controlled by switches A and B, as illustrative of translating devices subject to the control of switches A and B. All electromagnetic switches are illustrated in deenergized condition.

Referring to Figure 1*a* the circuits are arranged so that the operation of switch A to engage contacts A1 and A2 completes circuits for the coils of switches C and D, whereas the operation of switch B to engage contacts B1 completes a circuit for only the coil of switch D. Referring to Figure 1*b* the same operation is provided as in Figure 1*a* except that a single pair of contacts on switch A, namely contacts A1, control both the coil of switch C and the coil of switch D. Contacts A1 are connected to the coil of switch D through a rectifier R. This enables current to pass from contacts A1 to the coil of switch D but not from contacts B1 to the coil of switch C.

The contacts on switches A and B may be breaking contacts instead of making contacts. Such an arrangement is illustrated in Figure 2*a*. With this arrangement, upon the operation of switch A the separation of contacts A1 deenergizes the coil of switch C but the separation of contacts A2 does not deenergize the coil of switch D unless switch B also is operated to separate contacts B1. In Figure 2*b* a single pair of contacts on switch A, namely contacts A1, controls both the coil of switch C and the coil of switch D while providing the same operation as is had in Figure 2*a*. Contacts A1 are connected to the coil of switch D through a rectifier R. Contacts B1 cannot prevent the deenergization of the coil of switch C upon the operation of switch A inasmuch as the rectifier blocks the flow of current through contacts B1 to the coil of switch C.

In Figure 3*a* contacts A1, A2 and B1 control the circuits for the coils of switches C and D.

Contacts B2 are additional making contacts on switch B for controlling the circuit for the coil of switch C. A switch Y is provided for rendering the coil of switch C subject to either contacts A1 or contacts B2. The same operation is had in Figure 3b utilizing only one pair of contacts on each of switches A and B. Contacts A1 and B2 control the circuits for the coils of both switches C and D, switch Y determining whether the coil of switch C is subject to contacts A1 or contacts B2. Rectifier R1 blocks the control of the coil of switch C by contacts B2 when switch Y is in position to render this coil subject to contacts A1 while rectifier R2 blocks the control of the coil of switch C by contacts A1 when switch Y is in the other position.

In Figure 4a switch A is provided with making contacts A1 for controlling the coil of switch C and with breaking contacts A2 for controlling the coil of switch D. The arrangement is such that upon the operation of switch A a circuit is completed for the coil of switch C to cause this switch to operate, whereas the circuit for the coil of switch D is broken causing this switch to drop out. The same operation is had in the circuit arrangement of Figure 4b utilizing only one pair of contacts on switch A, namely making contacts A1. These contacts control the circuit for the coil of switch C in the same way as in Figure 4a, whereas they establish a short circuit for the coil of switch D through rectifier R. X is a resistance which enables switch D to be operated when switch A is not operated but obviates a short circuit on the line when switch A is operated. The rectifier blocks the flow of current from line + through the coil of switch D and thence through the coil of switch C.

The circuit arrangement of Figure 5a is similar to that of Figure 4a except that making contacts B1 on switch B are connected in parallel with contacts A2. To enable the same operation to be had with only one pair of contacts on switch A for controlling both the coil of switch C and the coil of switch D while enabling contacts on switch B to prevent the deenergization of the coil of switch D upon the operation of switch A, breaking contacts B2 of switch B are arranged in series with the rectifier R in the circuit shunting the coil of switch D as illustrated in Figure 5b. With this arrangement, switch A upon operation causes energization of the coil of switch C and, if switch B is not operated, the deenergization of the coil of switch D.

A circuit arrangement is illustrated in Figure 6a in which making contacts A1 and B1 of switches A and B respectively are arranged in series to control the energization of the coil of switch D. Contacts A1 are also utilized for controlling the energization of the coil of switch C. Switch B is provided with making contacts B2 for controlling the energization of the coil of switch E. The same operation is had in the circuit arrangement of Figure 6b utilizing only contacts A1 and B2 by connecting the coil of switch D through rectifier R to be subject to contacts A1 and B2. With this arrangement the rectifier blocks the energization of the coils of switches E, D and C in series, thus enabling the same control of switches C, D and E to be had with only one pair of contacts on switch B as well as on switch A.

So far, circuit arrangements have been described in which the circuits are controlled by contacts of electromagnetic switches. The invention is also applicable to circuit arrangements

in which the circuits are controlled by other types of switching arrangements or by other circuit controlling devices such as electronic tubes. A circuit arrangement utilizing electronic tube control in which separate tubes are provided to control separate circuits is illustrated in Figure 7a. ET1, ET2 and ET3 are gas tubes, each of which has an anode AN, cathode CA and starting electrode SE as designated for tube ET1. S is a source of alternating current for applying alternating current voltage to the supply lines. The controlled translating devices are illustrated as before as the coils of electromagnetic switches C and D. The coil of switch C is subject to the control of electronic tube ET1 while the coil of switch D is subject to the control of electronic tubes ET2 and ET3, the anode-cathode circuits of which are connected in parallel.

To provide an operation similar to that of the circuit arrangement of Figure 1a, the starting electrodes of tubes ET1 and ET2 could be connected together and subject to voltage controlling means to raise the potential of their starting electrodes with respect to their cathodes sufficiently to fire the tubes. The starting electrode of tube ET3 could be similarly subject to voltage controlling means to raise its potential with respect to the cathode of tube ET3 sufficiently to fire the tube. Thus upon the firing of tubes ET1 and ET2 sufficient voltage is applied to the coils of switches C and D to cause these switches to operate. The firing of tube ET3 instead of tubes ET1 and ET2 causes sufficient voltage to be applied only to the coil of switch D to cause this switch to operate.

The same operation is provided in Figure 7b except that tube ET2 is omitted and tube ET1 is utilized to control both switches C and D. Tube ET1 is connected to the coil of switch D through rectifier R. This enables current to pass through tube ET1 to the coil of switch D but not through tube ET3 to the coil of switch C. Thus, upon the firing of tube ET1 both switches C and D are operated. The firing of tube ET3, however, causes only switch D to operate, the rectifier R blocking the energization of the coil of switch C by tube ET3.

An operation similar to that of Figure 2a may be had with the arrangement of Figure 7a by having the tubes normally conducting and controlling their starting electrodes to shut off the tubes instead of firing them. The circuits of Figure 7b could provide the same operation with tube ET2 eliminated, with tubes ET1 and ET3 normally conducting and with their starting electrodes controlled to shut off the tubes. Tubes ET1 and ET2 of Figure 7a, when controlled to produce the operation of the arrangements of Figures 1a and 2a, could be a single multi-anode tube.

An operation similar to that provided in Figure 5a may be had in the circuit arrangement of Figure 7a by having tubes ET1 and ET3 normally shut off and tube ET2 normally conducting with the starting electrodes controlled in such a way that tube ET1 is fired and tube ET2 is shut off simultaneously and tube ET3 is fired independently. The same operation as provided in Figure 5b may be had with electronic tubes by substituting tube ET1 for contacts A1 and tube ET3 for contacts B2.

It is believed that it will be seen from the above description that the same operation as provided in each of Figures 3b and 6b may be had by substituting for contacts A1 and B2

electronic tubes which are normally shut off and whose starting electrodes are independently controlled to fire the tubes. Also, the same operation as provided in Figure 4b may be had by substituting for contacts A1 an electronic tube which is normally shut off with its starting electrode controlled to fire the tube.

It will be apparent that there are many other circuit arrangements in which unidirectional current conducting means may be utilized in lieu of switch contacts, electronic tubes or anodes of multi-anode tubes, those shown being for the purpose of illustration. It will also be apparent that instead of switch coils, other translating devices such as impedances may be controlled by the electronic tubes or by switches A and B. Many control systems are very complex and in applying the invention to such systems changes may be made to readily adapt the invention to such systems. Other changes may be made which do not depart from the spirit and scope of the invention. It is therefore intended that all matter contained in the above description and shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In combination; an electric circuit; circuit controlling means for controlling said circuit; a second electric circuit; additional circuit controlling means for controlling said second circuit; and a connecting circuit from the circuit controlling means for controlling one of said circuits to the other of said circuits to enable such circuit controlling means also to control said other circuit, said connecting circuit including unidirectional current conducting means for blocking the control of said one circuit by the other circuit controlling means.

2. In combination; a source of current; a translating device; a circuit for connecting said translating device to said source; circuit controlling means in said circuit; a second translating device; a second circuit for connecting said second translating device to said source; circuit controlling means in said second circuit; a third circuit connecting the first and second mentioned circuits at points in said circuits to enable the control of said second translating device by the first mentioned circuit controlling means; and unidirectional current conducting means in said third circuit to block the control of said first mentioned translating device by the second mentioned circuit controlling means.

3. In combination; a source of current; a translating device; a circuit for connecting said translating device to said source; circuit controlling means in said circuit between said translating device and one side of said source; a second translating device; a second circuit for connecting said second translating device to said source; circuit controlling means in said second circuit between said second translating device and said one side of said source; a third circuit for connecting said second translating device through the first mentioned circuit controlling means to said one side of said source, paralleling the connection thereto through the second mentioned circuit controlling means; and unidirectional current conducting means in said third circuit to permit the flow of current to said second translating device through said first mentioned circuit controlling means but to block the flow of current from said second circuit to said first mentioned translating device.

4. In combination; a source of current; a translating device; a circuit for connecting said translating device to said source; circuit controlling means operable to connect one side of said circuit to one side of said source; a second translating device; a second circuit for connecting said second translating device to said source; additional circuit controlling means operable to connect one side of said second circuit to said one side of said source; a third circuit for connecting said second translating device through the first mentioned circuit controlling means to said one side of said source, paralleling the connection thereto through said second circuit controlling means; and unidirectional current conducting means in said third circuit to permit the flow of current to said second translating device through said first mentioned circuit controlling means but to block the flow of current from said second circuit to said first mentioned translating device.

5. In combination; a source of current; a translating device; a circuit for connecting said translating device to said source; circuit controlling means in said circuit between said translating device and one side of said source; a second translating device; a second circuit for connecting said second translating device to said source; resistance in said second circuit between said second translating device and the other side of said source; a third circuit connecting a point in the first mentioned circuit between the first mentioned translating device and the first mentioned circuit controlling means with a point in the second circuit between said resistance and said second translating device; and unidirectional current conducting means in said third circuit to permit the flow of current from said first mentioned circuit to said second circuit but to block the flow of current from said second circuit to said first mentioned circuit.

6. In combination; a source of current; a translating device; a circuit for connecting said translating device to said source; a second circuit for connecting said translating device to said source; a switch for connecting said translating device in either of said circuits; circuit controlling means operable to connect one side of the first mentioned circuit to one side of said source; additional circuit controlling means operable to connect one side of said second circuit to said one side of said source; a second translating device; a third circuit for connecting said second translating device to said source either by a path through the first mentioned circuit controlling means or by a path through said additional circuit controlling means; and unidirectional current conducting means in each of said paths to permit the flow of current to said second translating device through either of said circuit controlling means but to block the flow of current through said first mentioned circuit controlling means to the first mentioned translating device when such device is connected by said switch in said second circuit or through said additional circuit controlling means to said first mentioned translating device when such device is connected by said switch in said first mentioned circuit.

7. In combination; a source of current; a translating device; a circuit for connecting said translating device to said source; circuit controlling means operable to connect one side of said circuit to one side of said source; a second translating device; a second circuit for connecting said second translating device to said source; additional circuit controlling means operable to con-

nect one side of said second circuit to the other side of said source; a third translating device; a third circuit for connecting one side of said third translating device to said one side of said source through the first mentioned circuit controlling means and the other side to said other side of said source through said additional circuit controlling means; and unidirectional current conducting means in said third circuit to permit the flow of current to said third translating device through said first mentioned circuit controlling means but to block the flow of current from said

second circuit to said first mentioned translating device.

WILLIAM HENRY BRUNS.

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