

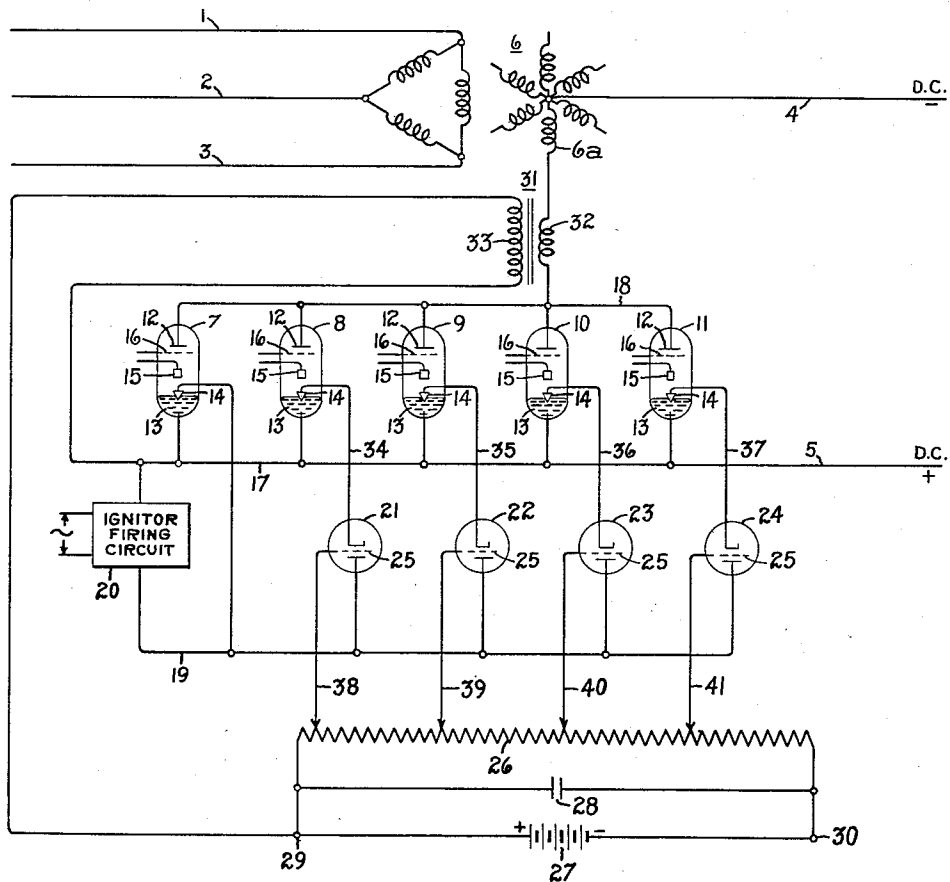
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ELECTRIC CONTROL SYSTEM

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ELECTRIC CONTROL SYSTEM

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3 Claims. (Cl. 321-27)

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This invention relates to electric control systems and more particularly to a control system for use in conjunction with a plurality of parallel-connected devices, the system being effective to cause conduction of current through a variable number of the devices the actual number being dependent upon the magnitude of a control quantity derived from some variable quantity such as total load current, rate of transfer of energy, or any desired variable quantity.

Electric devices of the ionizable medium type such as ignitron type valves, having an anode and a cathode disposed within an enclosing envelope, are particularly adapted for automatic connection or disconnection from service due to the fact that they are readily controlled by controlling the energy supplied to a control electrode. Furthermore, electric valves of the ignitron type do not in general lend themselves to a scaling-up procedure, i. e., the procedure whereby building larger valves decreases their cost per ampere. Thus it is desirable to be able to load a group of parallel-connected ignitrons to their maximum output or efficiency and to increase or decrease the number of valves in response to increases or decreases in the magnitude of load. An ignitron valve connected in circuit ready for use but not "fired" is not using up any more of its useful life than if it is in a storage cabinet.

A principal object of this invention is to provide an improved arrangement for controlling the operation of parallel-connecting electric devices.

Another object of this invention is the provision of an improved control system for parallel-connected electric valves which causes a number of valves to conduct current dependent upon the magnitude of the current.

Still another object of the invention is to provide an arrangement wherein certain valves are caused to remain nonconductive if the current to be carried is below a predetermined value. Thus a means is provided to make available for instant use tubes which otherwise would be in a spare tube storage cabinet.

In accordance with one form of the invention as applied to parallel-connected ignitrons, each of a plurality of circuits, such as the circuits used for energizing the ignitors of parallel connected ignitron valves, is controlled by a control valve usually a thyatron supplied with a bias of different magnitude. An opposing bias, such as might be dependent upon the magnitude of total load current through the ignitrons, is used to render a number of the control valves conductive thereby to energize their associated ignitrons.

The invention both as to its organization and method of operation will be better understood from the following description taken in connection with the accompanying drawing in which

the single figure thereof is a schematic representation of the invention as applied to a plurality of parallel-connected ignitron valves.

With reference to the drawing, the alternating current circuit comprising conductors 1, 2 and 3, is interconnected with a direct current circuit comprising conductors 4 and 5 by means of a transformer 6 and a plurality of electric valves 7-11. It will be understood that the tubes 7-11 are connected in parallel with each other and that these valves carry the current from only one phase of the secondary winding of transformer 6 such as the phase 6a. Thus, a similar arrangement to that comprising the valves 7-11 would be connected to each of the five other windings of the secondary of transformer 6. For simplicity, these additional circuits have been omitted from the drawing.

Each of the valves 7-11 is provided with an anode 12, a mercury pool cathode 13, a control element 14 commonly known as an ignitor, or some other device for initiating the arc cycle by cycle, an auxiliary or holding anode 15, and a control grid 16. Holding anodes 15 merely maintain for a desired period a cathode spot established on the cathodes 13 by the action of current through ignitors 14. Since the circuits for controlling the energization of holding or auxiliary anodes 15 and control grids 16 form no part of the present invention, these have been omitted from the drawing for the sake of simplicity. Circuits of the tube disclosed in U. S. Patent 2,544,345—Mittag, granted March 6, 1951, or in U. S. Patent 2,517,129—Mulhern, granted August 1, 1950, both of which are assigned to the assignee of this invention, could be used to control the control grids 16 and the auxiliary or holding anodes 15. The cathodes of the valves 7-11 are all connected to a common bus 17 while the anodes 12 of valves 7-11 are all connected to a common bus 18.

The ignitor 14 of valve 7 is connected to a control bus 19 which is energized from a schematically represented ignitor firing circuit 20 which normally would be energized from a source of alternating current. Ignitor firing circuit 20 could be of any known type such, for example, as is disclosed and claimed in U. S. Patent 2,523,027—Kellogg et al., granted September 19, 1950, and assigned to the assignee of this invention.

The ignitors 14 of the valves 8-11 are respectively connected to the control bus 19 through the control valves 21-24. Each of the devices 21-24 is provided with a cathode and an anode as well as a control grid. The control grids of control valves 21-24 are indicated by the numeral 25. Thus it will be seen from the drawing that the ignitors 14 of the ignitron valves 8-11 can be energized only if the control valves 21-24 are

respectively rendered conductive by the action of their control grids 25.

In accordance with one aspect of the invention, the control grids 25 are supplied with a predetermined negative bias from potentiometer 26 which is energized by any suitable source of direct current voltage such as is indicated by the battery 27. Connected across potentiometer 26 and battery 27 is a smoothing capacitor 28. Since the terminal 29 of potentiometer 26 is positive with respect to the terminal 30 thereof, the grids of control valves 21-24 are provided with progressively increasing negative bias from left to right. Thus the negative bias on the grid 25 of control valve 22 is greater in magnitude than the negative bias supplied to the grid 25 of control valve 21. Likewise, the negative bias on the grid valve 23 is greater than such bias on the grid of valve 22, and the negative bias supplied to grid 25 of control valve 24 is greater in magnitude than the negative bias supplied to the grid of control valve 23. It will thus be understood from the description thus far that a greater potential is needed to overcome the bias of the valve 22 than is needed to overcome the bias of valve 21, for example.

Since the arrangement shown in the drawing is responsive to variations in load conditions, a current transformer 31 is provided for deriving a signal dependent on the magnitude of current. Transformer 31 is provided with a primary winding 32 and a secondary winding 33. Primary winding 32 as will be seen from the drawing is in series with the secondary winding 6a of transformer 6 and with the parallel connected ignitron valves 7-11. Thus it will be understood that a predetermined magnitude of current through the primary winding 32 will derive a predetermined magnitude of voltage which when applied to the potentiometer 26 can be sufficient to overcome the negative bias on the grid 25 of valve 21. Should the load current increase through the primary winding 32 of transformer 31, the signal derived by the secondary winding 33 will be proportionately greater and can be sufficient to overcome the bias of the grid 25 of valve 22. Thus it will be seen that an increase in current through transformer 31 will cause a progressively greater number of the control valves 21-24 to be rendered conductive so that current may flow through one or more of the circuits 34-37 which interconnect the valves 21-24 with the ignitrons 14 of the ignitrons 7-11. It will, furthermore, be understood that the action of control valves 21-24 is dependent upon the resultant voltage which is supplied to each of the control circuits 38-41 which in turn is dependent upon the magnitude of current flow through the transformer 31.

It will be understood that some other means than the transformed 31 could be utilized to regulate the number of the ignitrons 7-11 which are rendered conductive at a particular instant. For example, it would be possible to utilize the voltage between the buses 17 and 18 or the magnitude of current in the direct current conductors 4 or 5 as the source for a control signal which would be equivalent to the transformer 31. The position of the taps on potentiometer resistor 26 will determine when each tube cuts in or out with change of load.

It will also be understood that my invention is not limited to the use of control valves having control grids such as the devices 21-24. For

example, a magnetic amplifier or amplistat having main windings and a control winding could be used for this purpose.

While I have shown and described a particular embodiment of my invention, I do not wish to be limited thereto and intend in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A control system for a plurality of circuits arranged for traverse by current comprising an electric valve connected in each of said circuits, each of said valves having a control grid supplied with a negative bias voltage tending to prevent the flow of current therethrough, the magnitude of bias supplied to each control grid being different from the magnitude of bias supplied to every other control grid, and means for simultaneously supplying a variable control voltage to each of said control grids which opposes the bias voltage of said grids so as to render a number of said control valves and their associated circuits conductive, the number of said valves and of said circuits so rendered conductive being dependent upon the magnitude of said variable control voltage.

2. In combination a plurality of electric devices each having an anode, a cathode and a control element, said devices having their anode-cathode circuits connected in parallel between an alternating current circuit and a direct current circuit, a circuit for energizing the control elements of said devices, a separate control valve interconnected between said circuit and certain of said control elements, said control valves each having a control grid, said control grids being supplied with a different negative bias, and means for simultaneously supplying a voltage to said control grids which opposes the negative bias supplied to each of said control grids, the magnitude of said voltage being variable as a function of the rate of transfer of energy between said alternating current circuit and said direct current circuit.

3. In combination a plurality of electric devices each having an anode, a cathode and a control element, said devices having their anode-cathode circuits connected in parallel between an alternating current circuit and a direct current circuit, a circuit for energizing the control elements of said devices, a separate control valve interconnected between said circuit and certain of said control elements, said control valves each having a control grid, said control grids being supplied with a different negative bias, and means for simultaneously supplying a voltage to said control grids which opposes the negative bias supplied to each of said control grids, the magnitude of said voltage being variable as a function of the total current flowing between said alternating current circuit and said direct current circuit.

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