Nov. 5, 1963 J. E. JACOBSEN 3,109,975

TAP CHANGER MOTOR CONTROL SYSTEM WITH THERMAL TIME DELAY RELAY

Filed Sept. 20, 1960

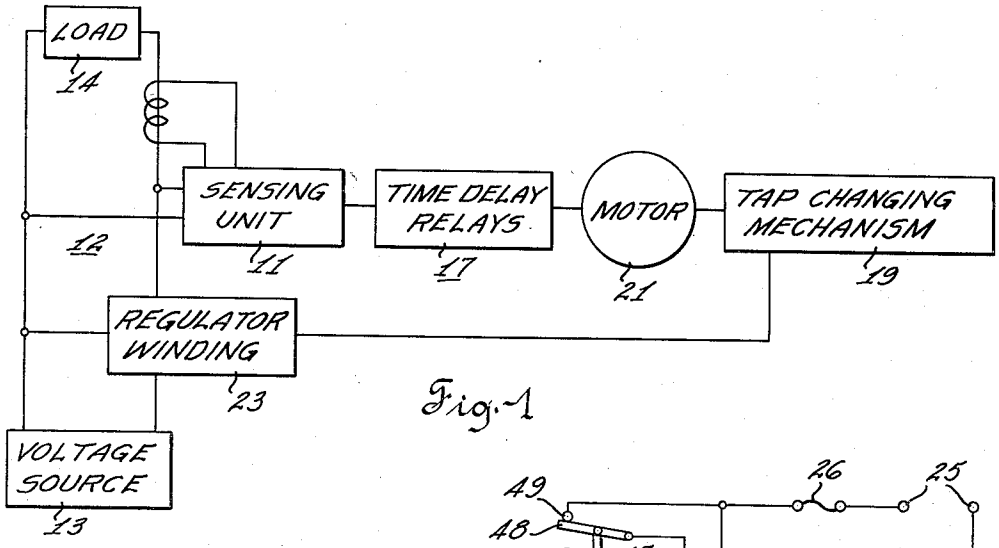


Fig. 1

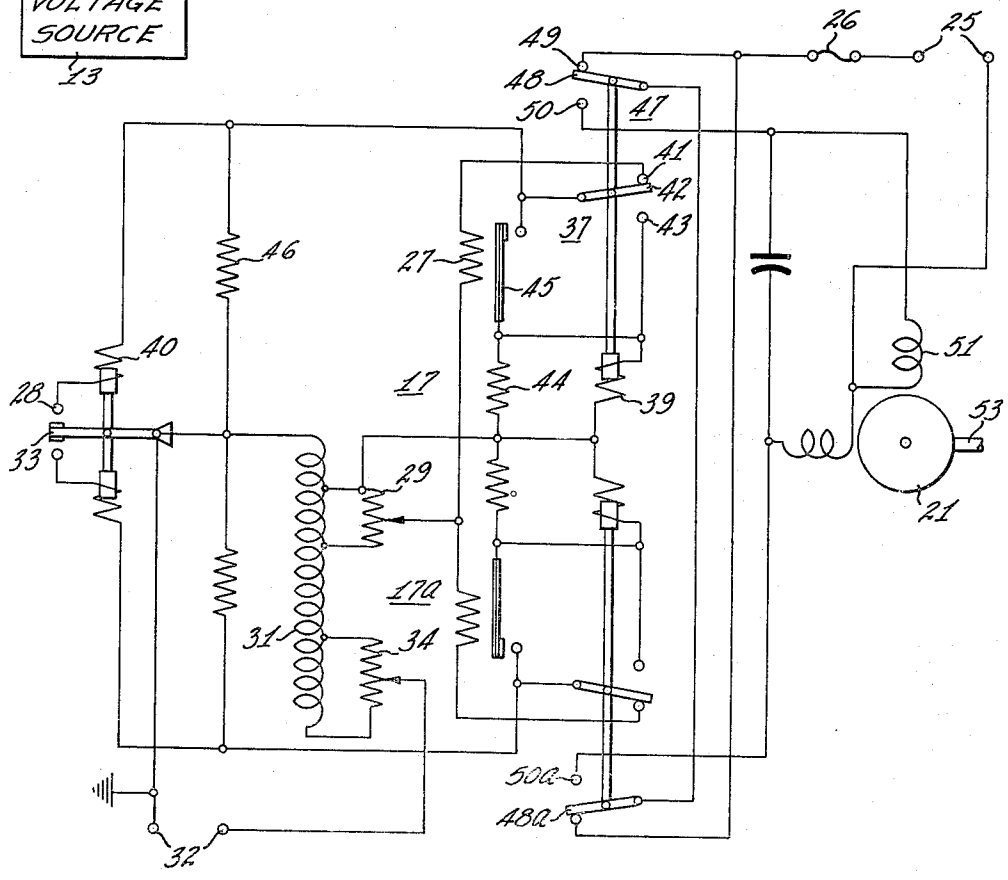


Fig. 2

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3,109,975

Patented Nov. 5, 1963

3,109,975

TAP CHANGER MOTOR CONTROL SYSTEM WITH THERMAL TIME DELAY RELAY

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Filed Sept. 20, 1960, Ser. No. 57,268
5 Claims. (Cl. 318—207)

This invention relates in general to an improved motor control system which is operable in response to a predetermined change of condition, and in particular to an improved motor control system for a step type voltage regulator.

In step type regulators the load voltage is sought to be maintained between predetermined limits by the system, the voltage being normal when it is between these limits. When the voltage is abnormal the regulator attempts to correct this condition by making a tap change to either increase or decrease the load voltage, depending on the need.

In many of the prior art devices, a means is provided in the control system for distinguishing between momentary abnormal voltages and abnormal voltages of sufficient duration to require a tap change. Such means usually comprise a time delay device. Generally speaking, most of these time delay devices were not of an integrating type. That is, if a time duration delay device was set for three seconds and a momentary abnormal voltage was only two seconds, the time delay device would operate through two-thirds of its cycle but not actuate the voltage regulating tap changing mechanism. Then, if a second momentary abnormal voltage of approximately two seconds immediately followed the first abnormal voltage, the time delay mechanism would still not actuate the tap changer because it had returned to its original neutral position and failed to integrate the previous impulse. One means for overcoming this undesirable feature is disclosed in U.S. 2,713,142, W. C. Sealey. The structure in this patent includes a mechanically operated time delay means. While such an arrangement gives satisfactory performance, it is desirable to have a structure which has a minimum number of moving parts in order to avoid points of mechanical contact. In U.S. 2,713,141, W. C. Sealey, a mechanical time delay is avoided through the use of a thermal element. However, the circuit disclosed in the Sealey patent does not permit the thermal element to cool immediately after the tap changing mechanism is energized without interrupting the current to the tap changing motor. Consequently, a second time delay might occur although the line voltage is such as to require the tap changing mechanism to continue operating.

The motor control system of this invention includes an improved time delay relay means which has a minimum of moving parts and also integrates preceding time delays. In addition, this system includes an interlocking feature for preventing the tap changing motor from operating in two direcitons at once in the event that a contact becomes faulty or sticks.

It is therefore an object of the present invention to provide a new and improved control system for operating a motor in two different directions.

Another object of this invention is to provide a new

and improved control system for a tap changing voltage regulator having a minimum number of moving parts.

Another object of this invention is to provide a new and improved thermal time delay relay means coupled to a motor through an interlocking switching arrangement.

Objects and advantages other than those mentioned above will become apparent from the following description when read in connection with the drawings in which:

FIG. 1 is a schematic showing of a step type voltage regulating system; and,

FIG. 2 is a diagrammatic showing of the improved time delay relay means and interlocking switching arrangement.

As shown in the block diagram of FIG. 1, a voltage and current sensing device 11 which may be static or mechanical unit such as a voltage regulating relay is connected to a load circuit 12 for determining when the voltage of the load circuit either exceeds or is less than a desired voltage band width. The load circuit includes a voltage source 13 and load 14. Connected to the voltage sensing device 11 are thermal time delay relays 17 and 17*a* which are respectively provided for the lower and raise operations of a tap changing mechanism 19. Although the illustrated circuit shows two time delay means one may be omitted if a selective relay is incorporated to switch the delay means to either the raise or lower circuits. Connected to the other end of the time delay relays is a motor 21 for operating the tap changing mechanism to vary the output of a regulator winding 23 in either its bucking or boosting positions.

Referring to FIG. 2 a conventional 120 volt power supply 25 is used to energize the tap changing motor 21. A conventional fuse 26 or circuit breaker is associated with the power supply for protection of the unit. Each time delay relay is identical, and to avoid repetition only the lower operating circuit 17 will be described.

The lower operation time delay relay 17 includes a heater coil 27 that is normally connected to a stationary beam contact 28 on the voltage sensing device 11. The other end of the heater coil 27 is connected to a rheostat 29 which is across a portion of the secondary winding of an auto-transformer 31. A power supply 32 which is preferably the voltage sensing supply but can also be obtained from another source is connected across the auto-transformer and to movable contact 33 of the voltage sensing device. A voltage level adjustment rheostat 34 may be connected between the power supply and auto-transformer to compensate for variations in the power supply. The heater coil 27 is connected to lower operation beam contact 28 of the voltage sensing device through a heater switch 37 which may be of a conventional clapper type relay actuated by a relay coil 39. In addition to a first stationary contact 41 that is connected to the heater coil 27 and which usually makes contact with a movable member 42 of the heater switch 37, a second stationary contact 43 is provided which is connected to a heat responsive switch 45 closely associated with the heater coil 27. The stationary end of the heat responsive switch 45 is connected to the movable member 42 of the heater switch and to the lower operation beam contact 28 of the voltage sensing device. Connected in series with contact 28 is stabilizing winding 40 which adds a compounding voltage to the main sensing device 11 when heater 27 or relay coil 39 is energized. For the lower

operation this compounding voltage is added to the sensing voltage and for the raise operation is subtracted. Connected across the movable contact 33 and stationary contact 28 is a resistor 46 which serves as an arc suppressor for these contacts and also serves to provide a small continuous current supply through heater 27 to prevent condensation forming on thermal element 27 and contact 45 during ambient temperature changes. Resistor 44 may also be placed in the circuit across relay coil 39 to adjust for proper stabilizing current through coil 40 to give a desired compounding voltage when relay coil 39 is energized.

Linked to the heater switch 37, such as by mechanical means, is a main switch 47 which connects voltage supply 25 to the motor. The main switch, similar to the heater switch, has a movable member 48 and two stationary contacts 49 and 50 to which the movable member selectively connects. The corresponding stationary contact 50 of each of the raise and lower main switches is connected to a winding of the motor 21. In like manner, second corresponding stationary contacts 49 of each circuit are connected to one side of the motor power supply 25. The movable contacts 48 of each main switch are connected together for purposes to be explained later.

In operation assume that the voltage sensing device detects that a voltage decrease should be made in the voltage regulating tap changing mechanism. Thus, the beam contact 28 of the lower operating portion will make contact with the center movable contact 33 of the voltage sensing device 11. This connection transmits current from the time delay power supply 32 to the heater coil 27 of the lower operation circuit. Depending upon the amount of time delay which may be adjusted by the time delay rheostat 29, the heat responsive switch 45 closes shortly after closing of the beam contact. Upon closing, the heat responsive switch connects the heater switch relay coil 39 to the power supply 32. The relay coil 39 of the heater switch 37 is then energized causing the movable contact 42 to drop down to stationary contact 43. This disconnects the current supply to the heater coil 27 and preferably within one second the heat responsive switch 45 opens.

Although the heat responsive switch opens, the relay coil 39 of the heater switch 37 remains energized as it is still connected to the power supply. Thus, cooling and opening of heat responsive switch 45 does not affect switch 37. Simultaneous with the action of the heater switch 37 the main switch 47 is moved to connect the motor power supply 25 to motor winding 51, thereby causing the motor 21 to drive the tap changing mechanism 19 through shaft 53. The main switch 47 and the heater switch 37 continue to stay in their lower operation position until the tap changing mechanism has operated enough to bring the line voltage back within its desired band width. Upon reaching this point, the voltage sensing device 11 releases the lower operation contact 28 and, consequently, the current supplying the heater switch 37 is interrupted with the result being that the heater switch and the main switch return to their original starting positions.

The heat responsive switch 45 also serves to integrate short and closely spaced impulses created by actuation of the voltage sensing device. In the event that a voltage returns to its proper band width before the heat responsive switch is heated sufficiently to close, and then drops out of the band width again, the tap changing motor will respond with a less than normal delay. This is because the heat responsive switch is still above normal temperature, having integrated the previous voltage drop which had caused partial heating of the switch. Because of current interruption to the heater coil when the tap changing motor is energized, the heat responsive switch can also cool off and be prepared to provide the next desired time delay. However, cooling of this switch does not affect the tap changing operation since current still flows through coil 39 and switch 37.

Similarly, the cooling period for element 45 may be several times the required heating period. This prevents a condition where the sensing device may be near the extremities of the band width and may go in and out of the band width for equal time periods without causing a tap change, thereby causing excess wear of the beam contacts. With the greater cooling period a condition of the type mentioned above repeated a number of times will force a tap change.

It will be noted that the current used to energize the tap changing motor is transmitted through both of the movable members 48 and 48*a* of the main switches. Such a provision enables the control system to have an interlocking feature. In the event that the lower operating portion is called upon to energize the motor, and the movable member 48*a* of the main switch for the raise portion is still in its acutating position on upper contact 50*a*, then the current path from the power supply 25 through members 48 and 48*a* is interrupted. Without this feature, the motor would have attempted to operate in both directions at the same time which is certainly not desirable.

While only one embodiment of the present invention has been illustrated and described, it will be apparent to those skilled in the art that modifications other than those shown may be made without departing from the spirit of the invention or from the scope of the appended claims.

Having now particularly described and ascertained the nature of my said invention and the manner in which it is to be performed, I declare that what I claim is:

1. A control for a voltage regulator having a device that is movable to adjust a voltage and having a motor for moving the device, comprising,

a thermal time delay relay having a heater and having a switch responsive to said heater to operate after a time delay,

a voltage sensor for energizing said heater in response to an undesirable voltage condition,

motor operating responsive to said heater responsive switch after a time delay to operate said motor in a direction to correct the voltage condition,

a heater control switch responsive to said motor operating means to deenergize said heater at the end of the time delay, and

means operable on the energization of said motor by said motor operating means to connect said motor operating means independently of said time delay relay to be responsive to said voltage sensor to operate the motor to correct the voltage condition and operable on the correction of the voltage condition to connect said motor operating means to be controlled by said time delay relay.

2. A control according to claim 1 in which said means connecting said motor operating means independently of said time delay relay comprises means cooperating with said heater control switch to connect said motor operating means to said voltage sensor on the operation of said control switch after a time delay.

3. A control according to claim 1 in which said motor operating means is connected to operate said heater control switch.

4. A control according to claim 1 in which said time delay relay is connected to said voltage sensor to respond only to voltage conditions corresponding to a single predetermined direction of operating the motor to correct the condition.

5. A control for a voltage regulator having a device that is movable to adjust a voltage and having a motor for moving the device, comprising,

a thermal time delay relay having a heater and having a pair of contacts responsive to said heater to close after a time delay,

a voltage sensor responsive to an undesirable voltage condition,

a relay having a coil connected to one of said thermal relay contacts to be energized after a time delay and having main contacts operable when said relay coil is energized to operate the motor in the direction to correct the voltage and having other contacts operable when said coil is deenergized to connect said voltage sensor to energize said heater during an undesirable voltage condition and to isolate said

relay coil from said voltage sensor, said other contacts being operable when said relay coil is energized to disconnect said heater from said voltage sensor to allow said heater to cool and to connect said relay coil to said voltage sensor to keep said coil energized until the voltage condition is corrected.

References Cited in the file of this patent

UNITED STATES PATENTS

2,713,141 Sealey ---------- July 12, 1955

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,109,975 November 5, 1963

Julius E. Jacobsen

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 42, after "operating" insert -- means --.

Signed and sealed this 21st day of April 1964.

(SEAL)
Attest:
ERNEST W. SWIDER

Attesting Officer

EDWARD J. BRENNER

Commissioner of Patents