March 2, 1965 O. T. FARRY 3,172,030

TAP CHANGING DEVICE WITH A STEPLESS VARIABLE CORRECTOR WINDING

Filed July 28, 1960 2 Sheets-Sheet 1

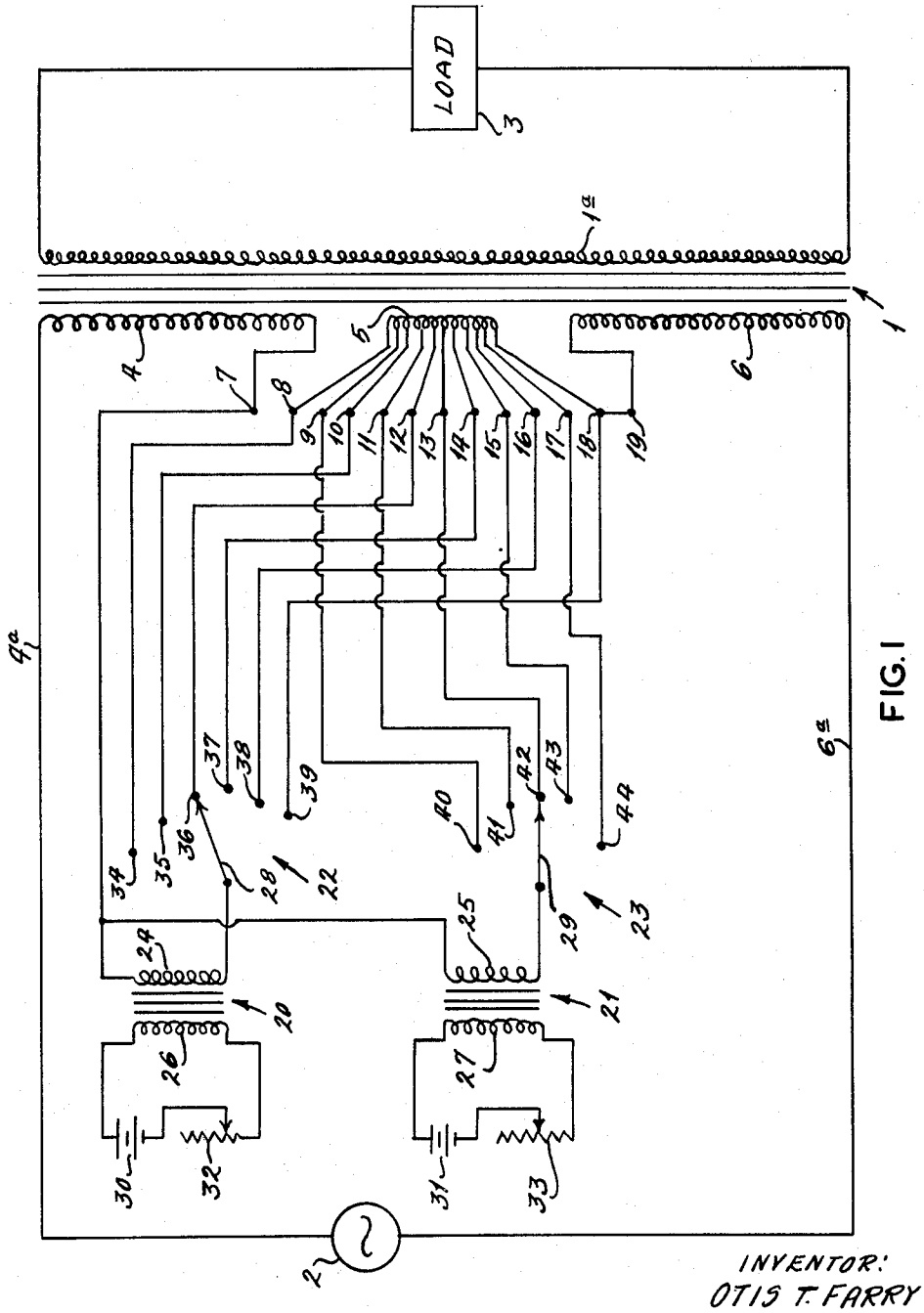


FIG. 1

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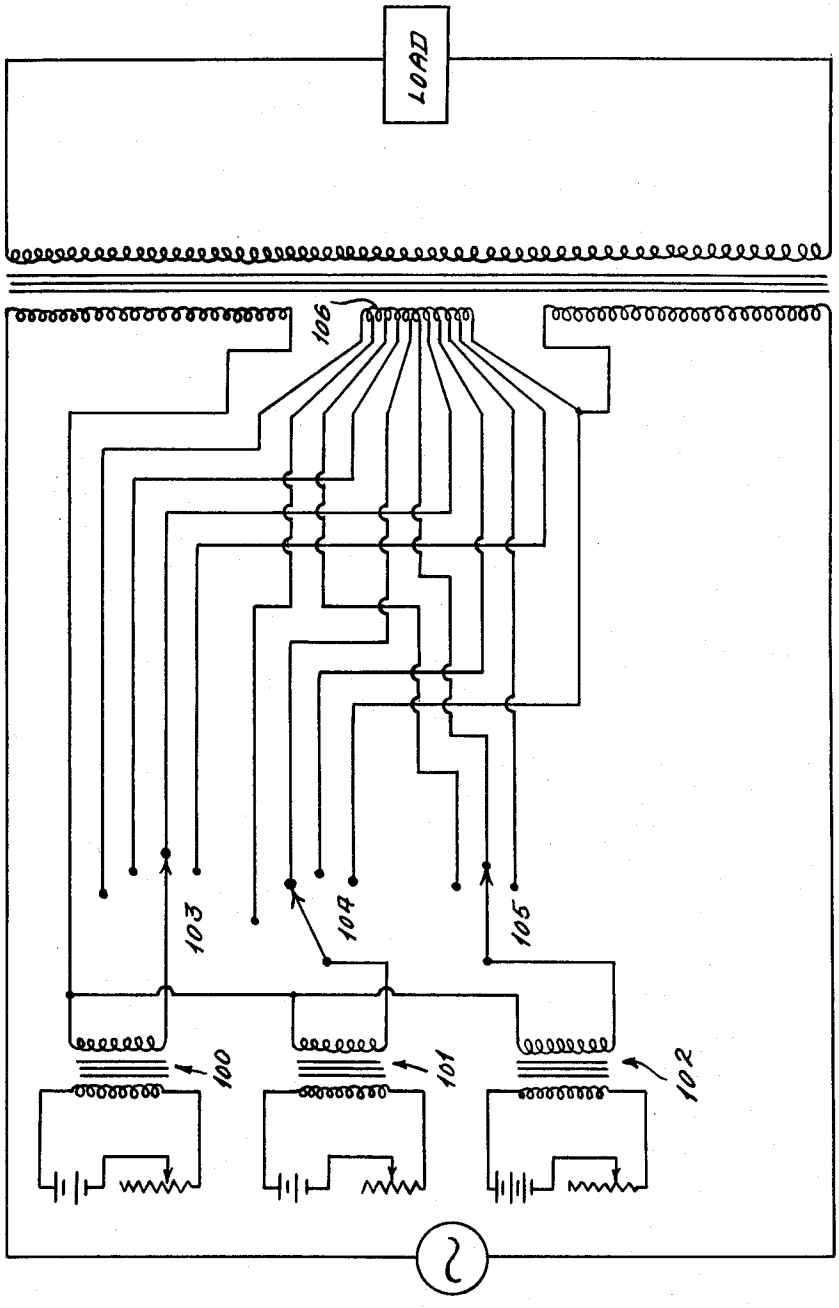


FIG. 2

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TAP CHANGING DEVICE WITH A STEPLESS VARIABLE CORRECTOR WINDING

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The present invention relates generally to the voltage regulator art and more particularly to a novel voltage control device by which the output voltage of an electrical supply system can be held constant or can be varied in any desired manner regardless of variations of the supply or load voltages within a selected range, and which device regulates or controls said output voltage smoothly with demand.

More particularly, this invention relates to voltage control apparatus comprising several impedance devices connected in circuits with selected portions of a corrector winding in a supply system through associated multi-contact switches. The apparatus also comprises means for adjusting the impedances of said impedance devices to vary the current flow in the corrector winding.

At the present time the output voltage of a supply system, such as a transformer, is usually regulated by means of tap changing devices associated with either the primary or secondary windings or by varying the impedance of a device connected in one of the supply leads or in one of the output leads.

The known tap changing devices have the disadvantage that they require numerous switches which are subject to arcing especially under relatively heavy loading, and they are subject to frequent break down and therefore require frequent repair and maintenance. Tap changing is also disadvantageous because it results in stepwise instead of smooth regulation of the output voltage and causes abrupt interruptions of the circuit. Furthermore, even the best available tap changers do not achieve accurate regulation but instead produce error on the order of ⅝ of 1% of normal voltage, and even then the regulation is slow acting, taking effect only after the control voltage has been abnormal for a relatively long time.

Therefore, one of the principal objects of the present invention is to provide a voltage regulator for an electrical supply system such as a transformer system, which maintains the output voltage of the system substantially constant or changed by a desired amount regardless of changes in the supply voltage or load within predetermined limits. More particularly, it is an object to provide a device which maintains load voltage constant or within very narrow limits and is not limited to incremental changes.

Another object of the present invention is to provide a novel voltage control device for regulating the output voltage of a supply system which does not undesirably interrupt any appreciable current.

Another object is to provide means for smoothly varying a control voltage over its full range, and in which the variations are substantially instantaneous as distinguished from "stepwise" or "incremental."

A further object of the present invention is to make a relatively inexpensive control device using a minimum number of relatively small components.

Still another object is to minimize the number of tap positions necessary on a correcting winding used to control or regulate voltage.

These and other objects and advantages of the present invention will become apparent after considering the following specification and accompanying drawings wherein several preferred embodiments of the invention are shown for illustrative purposes.

In the drawings:

FIG. 1 is a schematic wiring diagram of a transformer supply circuit employing voltage control means constructed according to the present invention; and

FIG. 2 is a schematic wiring diagram of another circuit employing a modified form of the control means of FIG. 1.

FIG. 1 shows a transformer 1 having its primary side connected across a source of alternating current 2 and its secondary side or winding 1*a* connected across a load 3. The primary side of the transformer 1 has two main windings 4 and 6 and a corrector winding 5. A tap 7 is located at one end of the winding 4 opposite from its line connection lead 4*a*; the winding 5 has a plurality of tap connections identified as taps 8 through 18 inclusive; and the winding 6 has a tap 19 located at the end thereof opposite its line connection lead 6*a*. The tap 19 is connected to the tap 18 on the control winding 5.

Two impedance devices such as saturable reactors 20 and 21 are provided, as shown, and are connected through multi-contact switches 22 and 23 respectively to selected transformer taps 7 through 18. The switch 22 has a plurality of contact terminals which are connected to the even numbered taps on the corrector winding 5, and the switch 23 has a plurality of contact terminals which are connected to the odd numbered taps on the corrector winding 5. Both of the reactors 20 and 21 have an alternating current winding 24 and 25, respectively, and a direct current winding 26 and 27, respectively. One side of both of the alternating current windings 24 and 25 are connected to the tap 7 on the winding 4, the other side of the alternating current winding 24 is connected to a movable switch blade 28 on the switch 22, and the other side of the alternating current winding 25 is connected to a movable switch blade 29 on the switch 23.

Each reactor 20 and 21 also has a direct current impedance regulating circuit connected to the associated direct current windings 26 and 27. The impedance regulating circuits include batteries 30 and 31 respectively and associated series connected rheostats 32 and 33, respectively. For example, the winding 26 is connected in series with the battery 30 and the rheostat 32 and the winding 27 is connected in series with the battery 31 and the rheostat 33. By adjusting the rheostats 32 and 33 the impedances of the associated reactor windings 24 and 25 can be varied. In this way the output voltage of the transformer 1 or other similar supply system can be maintained constant or can be adjusted to any desired value regardless of variations in the load or supply voltages within the range of the control. Also by means of the switches 22 and 23 it is possible to extend the range of possible adjustment as will be shown.

When the supply voltage is normal, the primary winding of the transformer 1 must have a certain number of effective turns in order to maintain the desired transformation ratio and provide normal output voltage across the load 3. Therefore, each of the primary windings 4 and 6 has 45% of the total number of primary turns required to produce normal output voltage when the input voltage is normal, then the effective turns in the corrector winding 5 should equal to 10% of the total number of primary turns. However, if the corrector winding 5 is to be effective for variations of the input voltage over a range of say from 90% to 110% of normal input voltage, then winding 5 must have total turns equal to approximately 20% of the normal primary turns. Furthermore, if the taps 8 through 18 are spaced at ten equal intervals across the winding 5, there will be ten equal increments of the corrector winding, each representing approximately 2% of the total number of primary winding turns required to cover the range of adjustment.

The switch 22 has six terminal contacts numbered 34,

35, 36, 37, 38 and 39 connected respectively to the even numbered taps 8, 10, 12, 14, 16 and 18 on the corrector winding 5. The switch 23 has five terminal contacts 40, 41, 42, 43, and 44 connected respectively to the odd numbered taps 9, 11, 13, 15 and 17 on the winding 5. These eleven connections divide the corrector winding into the aforesaid ten equal increments.

When normal voltage is impressed across the primary windings of the transformer 1, the movable contact 28 of the switch 22 is set on the terminal 36 (or 37), and the movable contact 29 of the switch 23 is set on the terminal 42 as shown. In this condition the impedance of the winding 25 of the reactor 21 is adjusted to be relatively small, and the impedance of the winding 24 of the reactor 20 is adjusted to be relatively large. These adjustments result in the part of the winding 5 between the taps 13 and 18 being connected in series with the low impedance of the reactor winding 25 and also in series with the primary windings 4 and 6 across the input. Furthermore, that part of winding 5 between taps 8 and 12 is ineffective because it carries no current and that part between taps 12 and 13 is practically ineffective because little current flows through it due to the high reactance of the winding 24 in series therewith. Thus, under normal conditions only approximately one-half of the corrector winding 5 is connected in the primary circuit, and the total number of primary turns is therefore at or near normal since one-half of the corrector winding represents approximately 10% of the total required primary turns.

If the supply voltage rises above normal, the impedance of the reactors 20 and 21 and/or the settings of the switches 22 and 23 must be adjusted in order to maintain normal output voltage. For example, when a rise in the supply voltage of less than 2% of normal supply voltage takes place, regulation can be effected by adjusting only the impedances of the reactor windings 24 and 25 without changing the settings of the switches 22 and 23. However, if the rise in supply voltage is greater than 2% of the normal supply voltage, regulation can be achieved only by making some change in the settings of the switches 22 and 23. Some adjustment of the impedance of the reactors may also be required.

When the supply voltage is normal, as described above, the switches 22 and 23 are in the central adjustment positions described above. Also in this condition the impedance of the winding 25 is adjusted to be relatively low, and the impedance of the winding 24 is adjusted to be relatively high. However, if for any reason the supply voltage rises to some value such as 108% or normal, the following corrective changes must be made to keep the output voltage normal. First, the circuit of the reactor 20 is adjusted so that the winding 24 has relatively low impedance. This is done by adjusting the rheostat 32. Next, the circuit of the reactor 21 is adjusted using rheostate 33, so that the winding 25 has a relatively high impedance. Then the switch blade 29 of the switch 23 is moved from terminal position 42 to position 41. The resetting of switch 23 is done at the time when the impedance of the winding 25 is high because at this time very little current flows through the switch 23 and hence very little arcing occurs. After the switch 23 is adjusted the impedance of the winding 25 is again adjusted to be low and the impedance of the winding 24 is adjusted to again be high. This results in the tap 7 being effectively connected to tap 11 through the low impedance of the winding 25. Now the switch 22 is moved from position 36 to position 35. This operation is accomplished at a time when very little current is flowing through the switch 22 owing to the high impedance of reactor winding 24 in series therewith. Once again the impedances of the reactors 20 and 21 is reversed making the impedance of the winding 25 relatively high and the impedance of the winding 24 relatively low. When this is done, the switch 23 is switched from position 41 to position 40, again causing very little current interruption and arcing. Thereafter the relative impedances of the reactors are again reversed. In the final position, the impedance of the winding 25 is relatively low, the impedance of the winding 24 is relatively high, the switch 23 is in the position 40, and the switch 22 is in position 35. In this position the tap 7 is effectively connected to the tap 9 through the low impedance of the winding 25 by way of the contact 40 on the switch 23. This means that that part of the winding 5 which is between the taps 9 and 18 is connected in series circuit with the main primary windings 4 and 6, and that that part of the winding 5 between taps 8 and 9 is effectively out of the circuit. Thus, there are in this condition 8% more effective turns in the primary of the transformer than previously, and the transformer turns ratio is therefore adjusted to supply normal output voltage even though the supply voltage is 108% of normal. Obviously if the supply voltage had increased to only 106% of normal it would not have been necessary to take as many steps as in the above example, and if the supply voltage increased to 110% of normal it would have been necessary to take even more steps.

If the supply voltage decreases to below normal voltage instead of increases it is necessary to decrease the number of primary turns in order to maintain normal output voltage. This is accomplished using the reverse of the process described above. For example, if the supply voltage decreases to 94% of normal, then three switch movements are required to eliminate 6% of the normal number of primary winding turns. This can be accomplished in steps by moving the switch blade 28 on switch 22 to the terminal 38, and by moving the switch blade 29 on switch 23 to the terminal 43. In this condition, with relatively low impedance in the winding 24, and relatively high impedance in the winding 25, the primary side of the transformer has only that portion of the corrector winding 5 effective between the taps 16 and 18; the portion between the taps 8 and 16 being substantially ineffective because that portion between taps 8 and 15 carries no current and that portion between taps 15 and 16 is connected in series with the high impedance of the winding 25. The switch operations necessary to accomplish this change are made when the impedances are such that minimum arcing occurs.

Between the fixed incremental changes provided by the switches 22 and 23 it also is possible to make additional adjustments by changing the impedances of the reactors 20 and 21. Therefore, the device shown in FIG. 1 is able to compensate for all variations of input and output voltages within the range thereof.

A modification of the circuit of FIG. 1 is shown in FIG. 2. In the modified circuit three variable impedance devices such as reactors 100, 101, and 102 are employed instead of two, and they are connected to operate with three multi-contact switches 103, 104 and 105 respectively. The multi-contact switches 103, 104 and 105 are connected to a plurality of spaced taps on a corrector winding 106. The operation of the three multi-contact switches and the associated three reactors is similar to that described above in connection with FIG. 1.

In the circuit of FIG. 2, one of the switches is preferably operated while the other two switches are determining the voltage. When a switch is operated the impedance of its associated reactor is relatively high or at a maximum value, and the impedances of the reactors associated with the other two switches are usually substantially equal and at some relatively low value. For example, when normal supply voltage exists, the reactor 102 is at a minimum value and the movable contact of the switch 105 is in the position shown. Also the reactors 100 and 101 have relatively high impedance values and the movable contacts of the switches 103 and 104 are positioned as shown. Now if the supply voltage increases by 4% for example, the impedance of the reactor 101 is decreased and the impedance of the reactor 102 is increased. When the impedances of reactors 101 and 102 are substantially equal at some relatively low value, and

the impedance of reactor **100** is maximum, the movable contact of the switch **103** is moved counterclockwise to the next contact. The impedance of reactor **100** is then decreased while that of reactor **102** is increased and the impedance of reactor **101** passes through its minimum and starts to increase again. When the impedances of reactor **102** reaches its maximum value with the other two reactors at some relatively low value the movable contact of the switch **105** is moved counterclockwise to be in a position for further change should the supply voltage increase to more than the 4%. The impedance of reactor **100** is further reduced to a minimum during which time the impedances of reactors **101** and **102** equalize with each other at a relatively high value. These steps compensate for the full 4% increase in the supply voltage.

While the above manner of operation is preferable it is not essential that two of the reactors have equal impedances when switching the third reactor. It is only necessary that a switch position be changed while its associated reactor has a relatively high impedance so that there will be little current to interrupt and consequently little arcing on the contacts.

The above description covers two embodiments of a device each of which is able to compensate for voltage variations over a wide range or adjust the voltage to a desired value. Obviously a greater or lesser number of tap positions, a greater or lesser number of switches and reactors, and different sizes of increments can also be used to change the range and the number and size of steps. If the number of tap positions is varied, and if the size of the increments is changed, it may also be necessary to select different size impedance devices. The present device is also suitable for use with an auto-transformer or other alternating current supply system having a main and a corrector winding.

Thus it is apparent that there has been shown and described a novel device for regulating or adjusting a voltage in an electric supply system such as a transformer or the like by changing the transformation ratio thereof, said supply device including a corrector winding associated with the supply system and having a plurality of spaced connector locations thereon, a plurality of switch means and variable impedance means connected into a plurality of circuits to said corrector winding locations for effectively connecting different selected portions of said corrector winding into the supply system, means for varying the impedance of the impedance means, and means for changing the settings of the switch means.

Many changes, modifications and variations of the present device will become apparent to those skilled in the art after considering this specification. All such changes, modifications and variations which do not depart from the spirit and scope of the invention are deemed to be covered by the invention which is limited only by the claims which follow.

I claim:

1. A voltage regulator for a transformer having a primary winding, a secondary winding, and a corrector winding associated with one of the other transformer windings, said regulator comprising three switches each having a plurality of stationary terminals and a movable switch blade selectively engageable with the associated stationary terminals, means connecting said stationary terminals on said switches to different selected positions on the corrector winding, and a variable impedance device connected between each of said movable switch blades and the transformer winding associated with the corrector winding, each of said impedance devices including an alternating current winding, a direct current winding, and an adjustable source of direct current for varying the current flow through said direct current winding to thereby vary the impedance of the alternating current winding.

2. In a tap changing device for an electrical supply system, the combination therewith comprising a corrector winding, means for selectively connecting different portions of said corrector winding between a pair of circuit terminals in the supply system, said means including a pair of tap changing switches each having a plurality of stationary terminals connected to different preselected positions on the corrector winding, each of said switches having a movable contact selectively engageable with its associated stationary terminals, a saturable reactor associated with each of said switches, each of said reactors including an alternating current reactor winding and a control winding, each of said reactor windings being connected in series with its associated switch between the movable contact thereof and one of said circuit terminals, the other of said terminals being connected to said corrector winding, and means including said control windings for varying the reactance of said reactor windings to vary the effective number of turns of said corrector winding in a substantially stepless manner subsequent to the tap changing movement of one of said switches.

3. In a tap changing device for an electrical supply system having a power input circuit for supplying power to a power output circuit including a corrector winding in one of said power circuits having a plurality of taps at different potential points thereon, the combination therewith comprising means including a pair of selectively operable tap changing switch means movable between said taps to connect different portions of said corrector winding in said supply system, and variable impedance means including impedance control means respectively connected with said pair of switch means to vary the effective number of turns of said corrector winding in a substantially stepless manner subsequent to the tap changing movement of said switch means.

4. In a tap changing device for an electrical supply system having a power input circuit for supplying power to a power output circuit including a corrector winding in one of said power circuits having a plurality of taps at different potential points thereon, the combination therewith comprising means including a pair of selectively operable tap changing switch means movable between said taps to connect different portions of said corrector winding in said supply system, a pair of variable impedance means respectively connected with said pair of switch means in one of said power circuits, and control means for respectively smoothly varying the impedance values of said impedance means to vary the effective number of turns of said corrector winding in a substantially stepless manner subsequent to the tap changing movement of one of said switch means.

5. In a tap changing device for an electrical supply system having a power input circuit for supplying power to a power output circuit including a corrector winding in one of said power circuits having a plurality of taps at different potential points thereon, the combination therewith comprising means including a pair of selectively operable tap changing switch means movable between said taps to connect different portions of said corrector winding in said supply system, a pair of saturable reactors each having a reactor winding and control winding means, said reactor windings being respectively connected in series with said pair of switch means, and means for supplying variable control current to said control winding means of said reactors for varying the reactance values of said reactor windings to vary the effective number of turns of said corrector winding in a substantially stepless manner subsequent to the tap changing movement of one of said switch means.

6. In a tap changing device for an electrical supply system having a power input circuit for supplying power to a power output circuit including a corrector winding in one of said power circuits having a plurality of taps at different potential points thereon, the combination therewith comprising means including a pair of selectively operable tap changing switch means movable between said taps to connect different portions of said corrector winding in said supply system, a pair of variable impedance means

respectively connected with said pair of switch means to transfer current flow from one of said switch means to the other of said switch means in order to permit tap changing movement of said one switch means, and control means for smoothly varying the impedance values of said impedance means to vary the effective number of turns of said corrector winding in a substantially stepless manner subsequent to the tap changing movement of said one switch means.

7. In a tap changing device for an electrical supply system having a power input circuit for supplying power to a power output circuit including a corrector winding connected in said supply system and having a plurality of taps at different potential points thereon, the combination therewith comprising a pair of selectively operable tap changing switch means for connecting different portions of said corrector winding in series in one of said power circuits including a plurality of stationary contacts connected respectively to said taps and a pair of selectively movable contacts engageable with different ones of said stationary contacts, a pair of saturable reactors each including a reactor winding and control winding means, said reactor windings being respectively connected in series with said movable contacts in said one power circuit, means for supplying variable control current to said control winding means for smoothly varying the reactance values of said reactor windings to vary the effective number of turns of said corrector winding in a substantially stepless manner subsequent to the tap changing movement of one of said movable contacts from engagement with one of said stationary contacts to another of said stationary contacts.

8. In a tap changing device for an electrical supply system having a power input circuit for supplying power to a power output circuit including a corrector winding connected in said supply system and having a plurality of taps at different potential points thereon, the combination therewith comprising a pair of selectively operable tap changing switch means for connecting different portions of said corrector winding in series in one of said power circuits including a plurality of stationary contacts connected respectively to said taps and a pair of selectively movable contacts engageable with different ones of said stationary contacts, a pair of saturable reactors each including a reactor winding and control winding means, said reactor windings being respectively connected in series with said movable contacts in said one power circuit, means for supplying variable control current to said control winding means for smoothly varying the reactance values of said reactor windings to vary the effective number of turns of said corrector winding in a substantially stepless manner subsequent to the tap changing movement of one of said movable contacts from engagement with one of said stationary contacts to another of said stationary contacts, said reactors also serving to transfer current flow from one of said switch means to the other of said switch means in order to permit tap changing movement of the movable contact of said one switch means from one of said stationary contacts to another of said stationary contacts.

9. In a tap changing device for an electrical supply system having a power input circuit for supplying power to a power output circuit including a corrector winding in one of said power circuits having a pair of sets of taps, the taps of one of said tap sets being at alternate potential points on said winding relative to the taps of the other of said tap sets, the combination therewith comprising tap changing switch means for connecting different portions of said corrector winding in series in one of said power circuits, including a pair of sets of stationary contacts, the contacts of one and the other of said stationary contact sets being connected with the taps of said one and other tap sets, respectively, a pair of selectively movable contacts engageable with the contacts of said one and other stationary contact sets, respectively, a pair of variable impedance devices respectively connected in series with said movable contacts in said one power circuit, and impedance control means for smoothly varying the relative impedance values of said impedance devices to vary the effective number of turns of the corrector winding in a substantially stepless manner subsequent to the tap changing movement of either of said movable contacts from one of said stationary contacts to another of said stationary contacts.

10. A tap changing device for an electrical supply system having a power input circuit for supplying power to a power output circuit including a corrector winding in said supply system having a pair of sets of taps, the taps of one of said tap sets being at alternate potential points on said winding relative to the taps of the other of said tap sets, the combination therewith of a pair of tap changing switches for connecting different portions of said corrector winding in said supply system, each of said switches having a set of stationary contacts and a selectively movable contact engageable with its associated set of stationary contacts, said sets of contacts being respectively connected to said tap sets, a pair of saturable reactors respectively connected in series with said switches in said supply system, and reactor control means for smoothly varying the reactance values of said reactors to vary the effective number of turns of said corrector winding in a substantially stepless manner.

11. A voltage control device for an electrical supply system having a power input circuit for supplying power to an output circuit comprising a corrector winding having first and second sets of taps thereon, and means for selectively connecting portions of said corrector winding between a pair of circuit terminals in the supply system to control the voltage at the power output circuit, said means including a pair of tap changing switches each having a plurality of stationary contacts and a movable contact selectively engageable with its stationary contacts, said stationary contacts of one of said switches being respectively connected to different preselected ones of said taps, said stationary contacts of the other of said switches being respectively connected to other different ones of said taps which are at alternate potential points on said winding with respect to the potential points of the taps to which said stationary contacts of said one switch are connected, a pair of saturable reactors, one of said reactors being connected in series with said one switch between the movable contact thereof and one of said circuit terminals, the other of said reactors being connected in series with said other switch between the movable contact thereof and said one circuit terminal, means connecting the other of said circuit terminals to said corrector winding, and reactor control means for varying the relative reactance values of said reactors to vary the effective turns of said corrector winding in a substantially stepless manner subsequent to the tap changing movement of either of said movable contacts from one of its associated stationary contacts to another of its associated contacts.

12. In a tap changing device for an electrical supply system including a transformer having main primary and secondary windings and a corrector winding having a plurality of taps thereon, the combination therewith comprising means including a pair of selectively operable tap changing switch means movable between said taps to connect different portions of said corrector winding in series with one of said main windings, a pair of variable impedance means connected respectively in series with said pair of switch means, and impedance control means for smoothly varying the impedance values of said impedance devices to vary the effective number of turns of said corrector winding in a substantially stepless manner subsequent to the tap changing movement of one of said switch means.

13. In a tap changing device for an electrical supply system including a transformer having main primary

and secondary windings and a corrector winding having a plurality of taps thereon, the combination therewith comprising means including a pair of selectively operable tap changing switch means movable between said taps to connect different portions of said corrector winding in series with one of said main windings, a pair of saturable reactors respectively connected in series with said pair of switch means, each of said reactors having control winding means for varying the reactance thereof, and means for supplying control current to said control winding means for varying the relative reactance values of said reactors to vary the effective number of turns of said corrector winding in a substantially stepless manner subsequent to the tap changing movement of either of said switch means, said reactors serving to transfer current flow from one of said switch means to the other of said switch means to permit tap changing movement of said one switch means when the reactance value of the reactor in series with said other switch means is at a relatively low value relative to the reactance value of the reactor in series with said one switch means.

14. In a tap changing device for an electrical supply system having a power input circuit for supplying power to a power output circuit including a corrector winding in one of said power circuits, said corrector winding having a plurality of taps at different potential points thereon, the combination therewith comprising three selectively operable switches each having a plurality of stationary contacts and a movable contact engageable with its associated stationary contacts, means connecting the stationary contacts of said switches to different ones of said taps, three variable impedance devices connected in one of said power circuits respectively in series with the movable contacts of said switches, and impedance control means for selectively smoothly varying the impedance values of said impedance devices to vary the effective turns of said corrector winding in a substantially stepless manner subsequent to the tap changing movement of any one of said movable contacts from one of its associated stationary contacts to another of its associated stationary contacts.

References Cited in the file of this patent

UNITED STATES PATENTS

1,975,176	Sealey	Oct. 2, 1934
2,114,143	Hunter	Apr. 12, 1938
2,374,974	Blume	May 1, 1945
2,547,615	Bedford	Apr. 3, 1951
2,883,612	De Buda	Apr. 21, 1959