

June 28, 1955

W. L. PETERSON
TAP CHANGING UNDER LOAD APPARATUS
FOR QUARTER CYCLE OPERATION

2,712,110

Filed Dec. 21, 1951

2 Sheets-Sheet 1

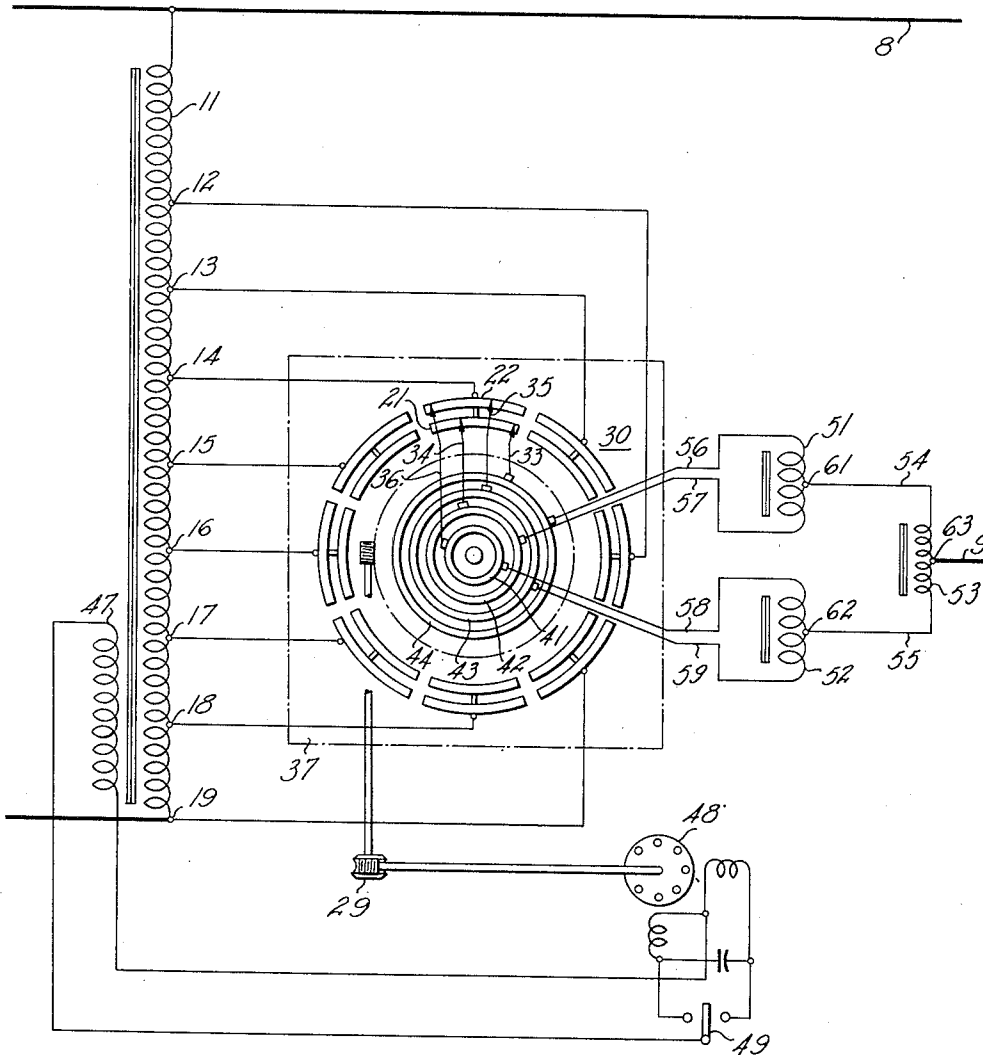


Fig. 1

Inventor
Walter L. Peterson
by Joseph E. Kerwin
Attorney

June 28, 1955

W. L. PETERSON
TAP CHANGING UNDER LOAD APPARATUS
FOR QUARTER CYCLE OPERATION

2,712,110

Filed Dec. 21, 1951

2 Sheets-Sheet 2

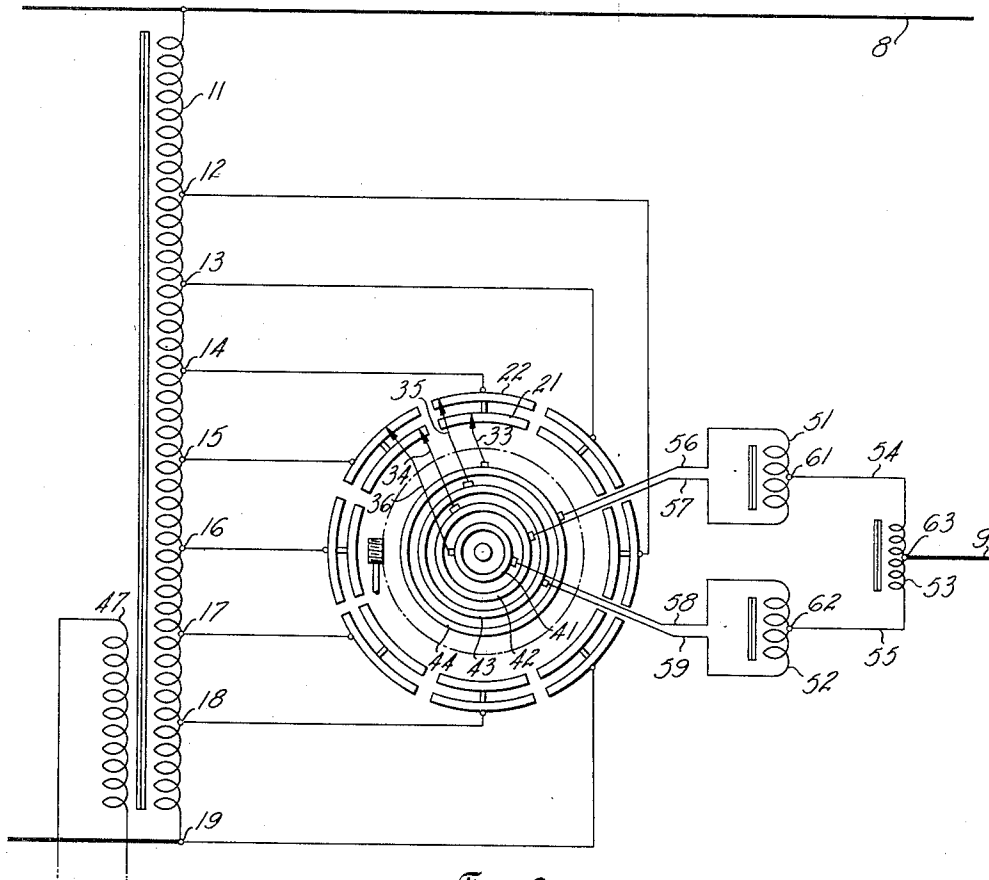


Fig. 2

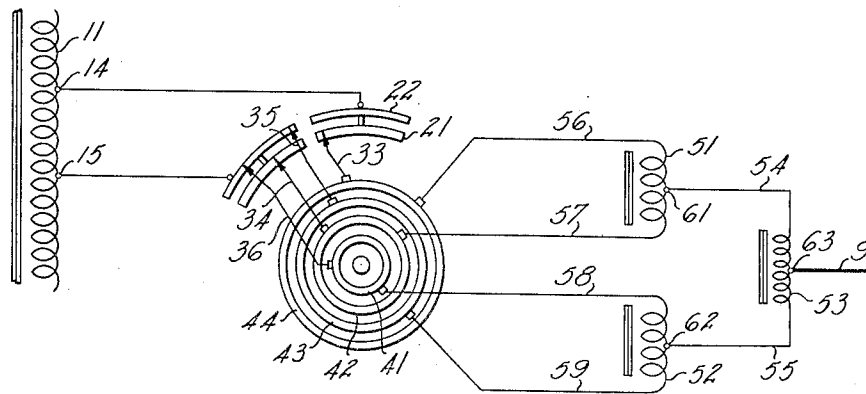


Fig. 3

Inventor
Walter L. Peterson
by Joseph E. Kerwin
Attorney

1

2

2,712,110

TAP CHANGING UNDER LOAD APPARATUS FOR QUARTER CYCLE OPERATION

Walter L. Peterson, New Berlin, Wis., assignor to Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Application December 21, 1951, Serial No. 262,868

1 Claim. (Cl. 323—43.5)

This invention relates to voltage regulating systems including regulating transformers having tap changing apparatus designed for operation while the regulating transformer is under load. The invention is particularly related to improvements in the tap changing circuit for such regulating transformers.

The tap changing under load apparatus of voltage regulating transformers are a considerable factor in the determination of the maximum ratings for which such transformers can be designed, and may even be the determining factor of the maximum rating of the regulator. Because the switching apparatus of such tap changers must operate under load there are practical limitations of their current ratings, and these limitations therefore affected the size and rating on the regulating transformers.

The invention hereinafter described comprises a new under load voltage regulating system in which the number of regulating steps may be doubled and in which the current rating of the tap changing apparatus is considerably increased independently of the type of regulating transformer or the type of tap changing apparatus associated with the regulator. While the invention is adaptable to and described with relation to regulators embodying dial switch tap changing apparatus, it is not limited to such apparatus.

It is an object of the present invention to provide a circuit for reducing the current carried by the tap changing apparatus of step type voltage regulators.

Another object of this invention is to provide an improved circuit for step type under load voltage regulators in order to have a minimum current carried by the individual elements of the tap changing apparatus.

Still another object of this invention is to provide an improved current dividing circuit for the tap changing apparatus of voltage regulators having either half cycle or quarter cycle step regulation.

It is a further object of this invention to provide a circuit by which the current carried by the contacts of tap changer apparatus of step type voltage regulators is reduced and by which the number of regulator steps can be doubled by providing quarter cycle step regulation.

Objects and advantages other than those above set forth will be apparent from a consideration of the following description when read in connection with the accompanying drawings, in which:

Fig. 1 is a diagram of a circuit for a step type voltage regulator embodying this invention, with the regulator shown in a fully cycle position;

Fig. 2 is a diagram of the regulator of Fig. 1 in a half cycle position, and

Fig. 3 is a diagram of the regulator of Fig. 1 in a quarter cycle position.

The voltage regulator illustrated in the drawing is a step type regulating transformer usable for maintaining voltage of a load circuit 8, 9 at a constant value independently of changes in the load. In this instance,

the regulator includes an exciting winding 11 which has a plurality of spaced taps 12 to 19 and dial type under load tap changing equipment 30 with which the load circuit is regulated by changing the position of load winding 11 through the tap changing equipment. Operation of the dial switch tap changing equipment 30 is accomplished through driving gears 29 by a motor 48, which can be caused to operate in either of two directions by switch 49 connecting the motor to its source 47. Operation of the motor in one direction raises the load voltage, and operation of the motor in the other direction lowers the load voltage. Conventional, automatic control mechanism (not shown) may be provided so that the switch 49 responds to voltage changes of the load circuit.

In the dial switch tap changing equipment illustrated there is embodied a pair of tap changing apparatus, each of which includes a pair of movable contacts and a preventive autotransformer. In one of the tap changing apparatus there is an autotransformer 51 which has one of its terminals connected to movable contact 33 through collector ring 44 and which has the other of its terminals connected to movable contact 34 through collector ring 42. The other tap changing apparatus includes autotransformer 52 which has one of its terminals connected to collector rings 43 and to movable contact 35. The other terminal of the autotransformer 52 is connected to collector ring 41 and movable contact 36. All the movable contacts, 33, 34, 35 and 36, preferably are moved substantially simultaneously by common means including a motor 48 and gear drive 29. However, the four movable contacts do not all have to be moved simultaneously nor does the tap changer have to be a dial switch. In fact, conventional cam operated contactors may be utilized as tap changers.

The preventive autotransformers 51, 52 have midtaps 61 and 62, respectively. One terminal of a paralleling reactor 53 is connected to midtap 61 and the other terminal of the reactor 53 is connected to midtap 62, and the midtap 63 of the reactor 53 constitutes the terminal 9 of the system.

The tap changing equipment has fixed contacts which with the movable contacts preferably are arranged to make a dial type switch. Pairs of the fixed contacts are severally connected to the taps of the winding, such as the pair of contacts, 21 and 22, which are electrically connected to tap 14 of the winding 11. The fixed contacts are mounted on an insulating board 37. The pairs of fixed contacts associated with the spaced taps of the winding are supported in circumferentially spaced relation relative to each other. In the preferred form, the contacts of each of the pairs of movable contacts, 33, 34 and 35, 36, are spaced to coordinate with the circumferential length of the fixed contacts and with the circumferential spacing between adjacent fixed contacts so that the contacts of each pair of movable contacts may both be on one fixed contact in a full cycle position (Fig. 1) and so that they may bridge adjacent of the fixed contacts as shown in Figs. 2 and 3, in half cycle or quarter cycle positions, respectively.

The embodiment of this invention for under load regulators provides current division to the four movable contacts for full and half cycle step type regulation, thereby making it possible to avoid some of the limitations imposed upon regulating transformers by their tap changing equipment.

In operation, the load current is always divided equally to each of the movable contacts of the tap changing equipment. In the full cycle position the load current at the system terminal 9 is caused to divide equally

3

by the midtapped paralleling reactor 53 with conductors 54, 55 carrying one half load current. The midtapped preventive autotransformers 51, 52 divide current equally to the conductors 56, 57, 58 and 59 which are connected between terminals of the autotransformers and collector rings 41, 42, 43 and 44 so that one fourth load current is in each of the four circuits to the four collector rings and to the movable contacts 33, 34, 35 and 36.

Fig. 2 shows the equipment in a half cycle position, and it is evident that the load current from terminal 9 is divided by the paralleling reactor 53 between the conductors 54, 55 which are connected to the terminals of reactor 53. The current is again divided by the midtapped autotransformers 51 and 52 so that only one fourth load current is carried in each conductor 56, 57, 58 and 59, in each collector ring and in each movable contact. With one of the preventive autotransformers 51 connected between the contacts 33, 34 of one pair of movable contacts and with the other preventive autotransformer 52 connected between the contacts of the other pair of movable contacts, the bridging position, either half cycle or quarter cycle, is effected with the preventive autotransformers limiting the circulating current through the autotransformers to an inappreciable amount.

With the improved circuit illustrated in the drawings and described above, quarter cycle operation of the step type regulator may be effected, thereby doubling the number of regulating steps while maintaining even step regulation through the entire regulating range of the equipment.

For quarter cycle operation, only one connection from the taps of the winding to the terminals of the midtapped autotransformers is changed during each operational step. When dial switches are utilized as in the illustrated embodiment, such regulation is accomplished by spacing and arranging the movable contacts with respect to each other and with respect to the spacing between adjacent fixed contacts so that a single regulating step operation involves the movement of only one movable contact from one fixed contact to an adjacent fixed contact. The space between the adjacent movable contacts is slightly greater than the space between adjacent fixed contacts, and as soon as one movable contact moves off of one fixed contact and on to an adjacent fixed contact, the tap changer mechanism is stopped.

The improved regulating system functions substantially in the same manner with the regulator in a quarter cycle position as with the regulator in a half cycle position. In either position, there is current limiting means in the form of a preventive autotransformer con-

4

nected between the contacts of the pair of movable contacts that bridge adjacent taps of the winding. Also, there is only one quarter load current at each movable contact because of the current dividing means provided by the midtapped reactors.

Although but one embodiment of the present invention has been illustrated and described, it will be apparent to one skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claim.

Features disclosed but not claimed herein are claimed in copending application Serial No. 262,785 of Louis C. Aicher, filed December 21, 1951, for a Tap Changing Under Load Apparatus With Paralleling Reactors Common to All Taps.

It is claimed and desired to secure by Letters Patent:

A voltage regulating system comprising a system terminal, a transformer having a winding with a plurality of taps and tap changing apparatus including a dial switch mechanism having a plurality of fixed contacts separately connected to said taps with said fixed contacts disposed in circumferentially spaced relation to each other, first and second preventive autotransformers, a midtapped paralleling reactor, four movable contacts cooperative with said fixed contacts to vary the connection of said terminal to said winding, said first preventive autotransformer connected between two of said movable contacts, said second preventive autotransformer connected between the other two said movable contacts, said first autotransformer having a midtap connected to one terminal of said reactor, said second autotransformer having a midtap connected to the other terminal of said reactor, the midtap of said reactor constituting said system terminal, and common means to move said movable contacts to alternately connect all of said movable contacts to any single one of said taps of said winding and move said movable contacts one at a time from connection with said any single one of said taps to connection with an electrically adjacent said tap to cause the voltage at said system terminal to vary in steps equal to one fourth the voltage between said single tap and said adjacent said tap.

References Cited in the file of this patent

UNITED STATES PATENTS

2,560,002 Sealey July 10, 1951

OTHER REFERENCES

"Railway Electrical Engineer," September 1941 (pages 188 and 189 relied on).

"Electrical Engineering," October 1942, vol. 61 (pages 727-732 relied on).