April 25, 1933. F. L. SNYDER 1,905,249

TAP CHANGING UNDERLOAD EQUIPMENT

Filed Dec. 12, 1930

Fig. 1.

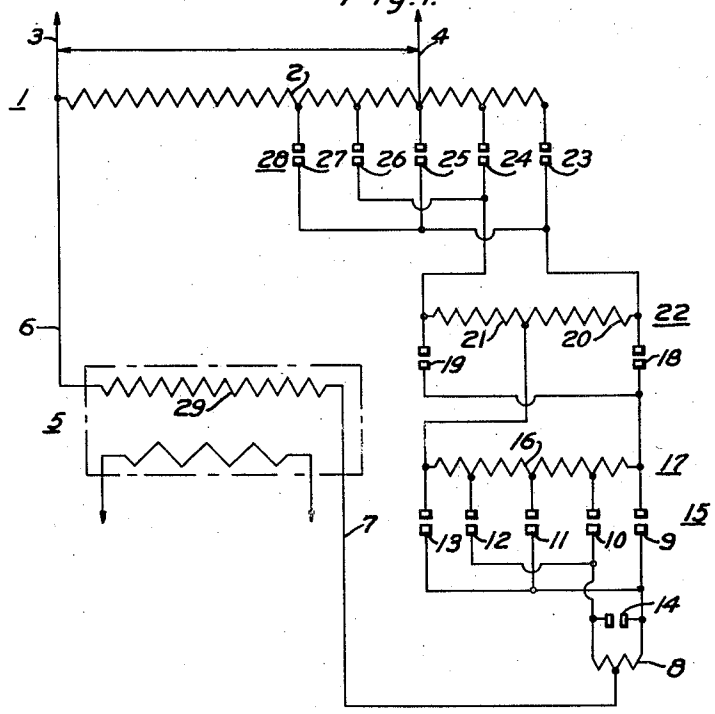


Fig. 2.

SEQUENCE OF OPERATION

Position		1	2	3	4	5	6	7	8	9	9'	10	11	12	13	14	15	16	17	18	19	20	58	59	60	61	62	63	64	65
Switch	9	○	○															○	○	○									○	○
Tap Changer 15	10		○	○	○													○	○	○	○	○					○	○	○	
	11				○	○	○							○	○	○						○			○	○	○			
	12						○	○	○			○	○	○									○	○	○					
	13								○	○	○	○											○							
	14	○		○		○		○		○	○		○		○		○		○		○			○		○		○		○
Tap Changer 28	23	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○											
	24	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○									
	25																			○	○									
	26																						○	○	○	○	○	○	○	○
	27																						○	○	○	○	○	○	○	○
Reversing Switch	19										○	○	○	○	○	○	○	○	○	○	○									
	18	○	○	○	○	○	○	○	○	○													○	○	○	○	○	○	○	○

○ = Switch Closed

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UNITED STATES PATENT OFFICE

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TAP-CHANGING-UNDERLOAD EQUIPMENT

Application filed December 12, 1930. Serial No. 501,871.

My invention relates to tap-changing equipment for transformers and more particularly to the tap-changing under-load equipment for transformers wherein a relatively large number of tap positions are desired.

With many forms of tap-changing equipment used in the past, the number of regulating voltage steps are limited because it is difficult or impractical to provide a large number of tap connections to the main transformer winding.

An object of my invention is to provide a tap-changing equipment having a large number of tap-changing positions that are obtainable with a comparatively few tap-changing switches.

The invention, with additional objects and advantages thereof, will be better understood from the following description, when read in conjunction with the accompanying drawing, in which:

Figure 1 is a diagrammatic view of circuits and apparatus illustrating one preferred embodiment of my invention, and

Fig. 2 is a portion of a sequence chart showing the sequence of operation of the several switches illustrated in Fig. 1.

Referring to the drawing, a transformer, which is illustrated as an auto-transformer 1, is provided for supplying power to a load, such as the furnace transformer 5. The auto-transformer is provided with a primary winding 2 that is connected to power-circuit conductors 3 and 4, and supplies energy to the primary winding 29 of the transformer 5 by means of conductors 6 and 7. The conductor 7 is connected to the winding 2 through a preventive auto-transformer 8 and through an intermediate tap-changing transformer 17 and an intermediate auto-transformer 22. Switches 9, 10, 11, 12, 13 and 14 of tap-changer 15 are connected to tap points on the winding 16 of the intermediate transformer 17. Reversing switches 18 and 19 are provided between one end of the winding 16 and opposite ends of the auto-transformer 22 and are effective to connect the winding 16 across the one or the other of the windings 20 or 21 which comprise the intermediate auto-transformer 22. From the intermediate auto-transformer 22, the circuit to the transformer 1 is completed through two of the operating switches 23, 24, 25, 26 and 27 of tap-changer 28.

The reversing switches 18 and 19 are effective to connect the portion 20 or the portion 21 of the transformer 22 to the winding 16. A voltage will, therefore, be applied to the winding 16 that is one half the voltage between adjacent tap-changing switches 23 to 27, inclusive. The several switches are operated in accordance with the sequence of operation shown in the chart in Fig. 2.

The numerals reading from left to right across the top of the chart of Fig. 2 indicate controller positions having definite voltage-ratio values. The numbers reading from top to bottom at the left of the chart refer to the correspondingly numbered switches shown in Fig. 1. The circles in the chart of Fig. 2 indicate that the switches designated by the numbers at the left of the chart are closed on the controller positions indicated at the top of the chart.

In the controlled position 1 of Fig. 2, it will be noted that switches 9 and 14 of tap-changer 15, reversing switch 18, and switches 23 and 24 of the tap changer 28 are closed. Switch 14, in its closed position, causes the windings of the preventive auto-transformer 8 to neutralize each other, and, in effect, connects the conductor 7 directly to one end of the winding 16 through the switch 9. With the reversing switch 18 closed, a voltage, corresponding to that of the winding 20 of the intermediate auto-transformer 22, is impressed upon the winding 16. The voltage of the primary windings 20 and 21 of the auto-transformer 22 is the same as that impressed between the taps operated by switches 23 and 24 of the tap changer 28.

In position 2 of the controller, switch 14 is in its circuit-opening position, and switches 9 and 10 of tap-changer 15 are in their circuit-closing positions. The opening of the switch 14 and the closing of the switch 10 connects the preventive auto-transformer 8 across one section of the intermediate transformer 17. The preventive auto-transformer

8 is connected to different pairs of adjacent taps of the intermediate transformer 17 to vary the voltage applied to the furnace transformer. The opening of switch 14 and the closing of switch 10 changes the voltage one step and connects the preventive auto-transformer 8 between the switches 9 and 10, thus, in effect, connecting the conductor 7 to a point on the winding 16 that is midway between the two taps connected to switches 9 and 10. The switches 23 and 24 remain closed in controller position 2. In controller position 3, switch 10 of tap-changer 15 remains closed, switch 9 is opened and switch 14 is closed. This changes the taps another step, and a voltage on the mid-tap of the preventive auto-transformer 8 is obtained that corresponds to that of tap 10. The switches 23 and 24 remain closed, as in controller position 2.

It will be noted that, during the first nine controller positions, the reversing switch 18 has remained closed, and the reversing switch 19 has remained open. On the controller position 9, the conductor 7 is connected, through closed switches 14 and 13, to the middle point of the winding 22. In the transition from the controller position 9 to the controller position 10, an intermediate step 9′ appears, wherein the switch 18 is opened and the switch 19 is closed. This intermediate step does not produce a voltage change, since the connection of the conductor 7 to the winding 22 is not altered thereby. During the operation of the controller from position 9′ to 17, inclusive, the tap-changer 15 reverses the sequence of steps from position 1 to 9, inclusive. At the controller position 17, the conductor is connected to the winding 2 through closed switches 14, 9, 19 and 24. Switch 23 is then opened and switch 25 closed, and the tap-changer 15 repeats a similar operation, as described above.

When the switches in the tap-changer 15 have been operated through their sequence of steps, the connection of the winding 16 to the winding 2 is changed either by operation of one of the reversing switches 18 and 19 or by one of the switches of the tap-changer 28, depending upon which step of the complete series is to be made.

The reversing switches 18 and 19 serve to connect one end of the winding 16 to one of the tap switches 23 to 27, inclusive, the other end of the winding 16, being, in effect, connected to a point in the winding 2 that is mid-way between the two switches of the groups 23 to 27, inclusive, that is closed. In a similar manner, the complete sequence of operation of the switches may be followed by further reference to the chart shown in Fig. 2. All switches may be either automatically or manually operated, as desired.

From the above discussion, it may be seen that I have devised means for varying the voltage ratio of a transformer that is easily constructed and operated. My described tap-changing system provides a large number of voltage steps with the use of a relatively small number of tap-changing switches.

Although I have shown and described a certain specific embodiment of my invention, I am fully aware that many modifications thereof are possible. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In a tap-changing system for transformers, a primary power circuit comprising a pair of conductors, a transformer winding energized from said power circuit and provided with a plurality of tap connections, an intermediate transformer energized from said first-named winding, and a tap-changing transformer energized from said intermediate transformer, tap-changing switches for varying the connection of said intermediate transformer to said first-named winding, reversing means for changing the connection of tap-changing transformer to said intermediate transformer, and a plurality of tap-changing switches for varying the connection of said tap-changing transformer to a power-circuit conductor.

2. In a tap-changing system for transformers, a transformer winding connected to a power circuit and provided with a plurality of tap-changing switches, a pair of intermediate transformers connected to said tap-changing switches, means for changing the polarity of one said intermediate transformers with respect to the other, the last-named intermediate transformer being provided with a plurality of tap connections, and means for varying the tap connections of said last-named intermediate transformer.

3. In a transformer-voltage-ratio-control system, a power circuit and a transformer winding energized thereby, two intermediate transformers connected in cascade, means for changing the polarity of one of said intermediate transformers with respect to the other, a plurality of tap-changing switches connected to said first-named transformer winding for connecting one of said intermediate transformers between selected points thereon, and voltage-ratio control means attached to the other of said intermediate transformers, said voltage-ratio control means comprising a plurality of tap-changing switches and a controlled preventive auto-transformer, said preventive auto-transformer being connected to said power circuit.

In testimony whereof, I have hereunto subscribed my name this 4th day of December 1930.

FRANKLIN L. SNYDER.