

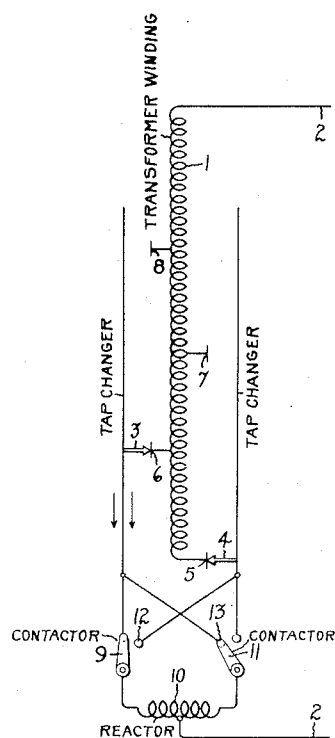
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REGULATOR CIRCUIT

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REGULATOR CIRCUIT

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This invention relates to regulator circuits and more particularly to improvements in load-ratio-control connections of regulating transformers.

By load-ratio-control is meant the control of the voltage ratio of an electric transformer under load. This is often done by tap-changing switches and in large-size power transformers a double-finger ratio adjuster is used in combination with a pair of contactors and a mid-tapped reactor. Each of the two fingers of the ratio adjuster selectively engages various transformer taps and they are electrically connected respectively to opposite ends or terminals of the mid-tapped reactor. The transformer load current usually divides substantially equally between the two fingers and flows through the two halves of the reactor, alternately entering and leaving the reactor at the midpoint. The windings of the two halves of the reactor are well interlaced so that the two halves of the transformer load current flowing in the two halves of the reactor in opposite instantaneous directions will not magnetize the core and the reactive drop due to load current in the reactor will be negligible.

When the contact fingers of the ratio adjuster are not designed for arcing duty, the current interrupting function is performed by a pair of contactors or switches connected respectively in series with the ratio adjuster fingers and mechanically interlocked therewith so that each contactor opens and interrupts the current in its associated ratio adjuster while its contact finger is moving from tap to tap.

When the ratio adjuster fingers engage different taps, a voltage change usually occurs whenever one of the contactors is opened because when both contactors are closed the transformer voltage will, unless a "tickler" winding is used, correspond to the voltage halfway between the taps to which the ratio adjuster fingers are connected whereas when one contactor is open the transformer voltage will correspond to the voltage of the tap to which the ratio adjuster finger is connected through the closed contactor. However, as soon as one contactor is opened all of the transformer current flows through the other contactor and through only one-half of the reactor. This is objectionable because the arcing contact surfaces of the contactors are more sensitive to excessive currents than the non-arcing ratio adjusters. Consequently the margin of safety with respect to short-circuit currents is materially lowered. Also, as there is no neutralizing action in the reactor, a substantial reactive drop in the reactor occurs. This reactive drop varies in

magnitude with the size of the load current and varies in phase in accordance with the power factor of the load current. A result is that operation with one contactor open produces variable voltage steps.

In accordance with my invention I provide a novel and simple switching arrangement for eliminating the above-described objectionable features of what may conveniently be called the one-contactor position. With my invention it is practicable to operate with the same margin of safety on both the one-contactor and the two-contactor positions and with equal voltage steps. Consequently the same taps will give twice as many voltage steps.

In practicing my invention I associate auxiliary switching means with the contactors for short circuiting the reactor through the closed contactor whenever the other contactor is open.

An object of the invention is to provide a new and improved load-ratio-control circuit.

Another object of the invention is to provide novel and simple means for safely obtaining equal voltage steps in the one and two contactor positions of double-finger type ratio adjusting transformer tap changers.

The invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

Referring now to the single figure of the accompanying drawing, which illustrates diagrammatically an embodiment of the invention, there is shown therein a transformer winding 1, variable amounts of which are to be connected in a main alternating current circuit 2 by means of ratio adjusting fingers 3 and 4 which selectively engage taps 5, 6, 7 and 8 in the winding. The winding may be either a primary or a secondary winding. Contact finger 3 is connected to the lower conductor of the main circuit 2 through a contactor 9 and the left-hand half of a mid-tapped reactor 10 and ratio adjusting contact finger 4 is connected to the same side of the circuit 2 through a contactor 11 and the other half of the reactor 10.

Contactors 9 and 11 are provided with an auxiliary contact 12 so that when this contactor is opened a low resistance connection will be completed from what may be described as the contact finger side of contactor 11 to the reactor terminal side of contactor 9. In other words, when the contactor 9 is opened the engagement of auxiliary contact 12 by its movable contact completes a short circuiting connection for the reactor through the

closed contactor 11. In a like manner, the reactor 11 is provided with an auxiliary contact 13 which completes a corresponding connection so as to short circuit the reactor 10 through the closed contactor 9 whenever the contactor 11 is opened.

The operation is as follows. When both contactors 9 and 11 are closed and with the contact fingers 3 and 4 engaging taps 6 and 5 respectively, as shown in the drawing, the voltage of the circuit 2 will be the voltage between the upper end of the winding, as viewed in the drawing, and a point midway between the taps 5 and 6 because the terminals of the reactor 10 are connected across the taps 5 and 6 through the contactors and ratio adjusting fingers and as the load current in dividing through the two halves of the reactor neutralizes the reactance effect of the reactor the voltage of the midpoint of the reactor will correspond to the voltage half-way between the taps 5 and 6. If now it is desired to change the voltage by moving the contact finger 4 (by any suitable means) out of engagement with the tap 5 the contactor 11 is first opened thereby interrupting the current in the contact finger 4 and permitting this finger to disengage the tap 5 without any arcing. The opening of contactor 11 completes a short circuiting connection of the reactor through the auxiliary contact 13 and the closed contactor 9. The load current, all of which now flows through the contact finger 3, will divide, half of it going through the contactor 9 and the left-hand half of the reactor and the other half of it going through auxiliary contact 13 and the right-hand half of the reactor. Consequently there is no reactive drop in the reactor 10 and the circuit voltage will be the voltage of tap 6. If contact finger 4 is now moved into engagement with tap 7 contactor 11 can be closed again, thus providing two-contactor operation and producing a circuit voltage halfway between the voltage of taps 6 and 7.

If, then, it is desired to obtain a voltage corresponding to the voltage of tap 7 contactor 9 is opened, thereby completing by means of the auxiliary contact 12 a short circuit of the reactor 10 through the closed contactor 11.

While there has been shown and described a particular embodiment of this invention, it will

be obvious to those skilled in the art that various changes and modifications can be made therein without departing from the invention and, therefore, it is aimed 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. In a transformer tap-changing-under-load system of the type in which a pair of alternately movable ratio adjusting tap changer contacts are connected respectively to the terminals of a mid-tapped reactor through separate contactor switches which are opened whenever their serially connected tap changer contacts are to be moved from tap-to-tap, the combination with said reactor and contactor switches of means operative in accordance with the opening of either contactor switch for effectively short circuiting the reactor through the other contactor switch whereby neither contactor switch can ever carry substantially more than one-half the transformer load current.

2. In combination, a transformer winding provided with a plurality of taps, a pair of ratio adjusting tap changer contacts for selectively engaging said taps, a mid-tapped reactor, a two-position contactor switch for selectively connecting one end of said reactor to either ratio adjusting contact, and a second contactor switch for selectively connecting the other end of said reactor to either ratio adjusting contact.

3. In a double-finger ratio adjuster type transformer load-ratio-control system, in combination, a reactor having a mid-tap for connection to a main transformer circuit and having a pair of end terminals, first and second contactors serially connected respectively with the fingers of said ratio adjuster for connecting and disconnecting said terminals to and from said fingers, each of said contactors having a terminal side and a finger side, and an auxiliary contact on said first contactor for completing a low resistance connection between its terminal side and the finger side of said second contactor when said first contactor breaks the connection between its associated ratio adjusting finger and reactor terminal.

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