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(54) ON-LOAD TRANSFORMER TAP CHANGER

(71) We, ASEA AKTIEBOLAG, a Swedish Company of Vasteras, Sweden, do hereby declare the invention, for which we pray that a Patent may be grated to us, and the method by which it is to be performed, to be particularly described in and by the following statement:–

This invention relates to an on-load transformer tap changer of the kind comprising a diverter switch, a step selector which is operated by way of two shafts which are rotatable in steps in relation to each other, a plus/minus or coarse/fine switch, and a switch for briefly switching in a damping resistor during a plus/minus or a coarse/fine switching operation, respectively.

In transformers with plus/minus and coarse/fine regulation, respectively, the regulating winding (fine step winding) is usually made in the form of a separate winding part connected to the other windings (base winding and, where applicable, coarse step winding) by way of a so-called plus/minus and coarse/fine switch, respectively. When said switch is operated, the regulated winding will become "floating" during the switching interval, if no particular measures are taken, and thereby adopts a voltage which is determined by its capacitances to earth and to the other windings. The capacitive charging current gives rise to arcs at the contacts in the switch, which results in contact erosion, gas formation and fouling of the transformer oil. In addition to this, there is a risk of direct short-circuiting across the regulating winding if the switch is not capable of breaking the capacitive currents at the high voltages which occur in high-voltage transformers.

To solve the above-mentioned problem, it is known to use high-ohmic damping resistors which, during the above-mentioned switching interval, are connected by way of a special contact system, for example in the form of a one or three-pole switch, between, on the one hand, some point on the regulating winding and, on the other and, the base winding or the neutral point of the transformer. In a previously known construction of this kind (German Patent Specification 1,942,567) the damping resistor switch is operated from the drive means of the plus/minus switch through a separate drive shaft and a Geneva gear. However, such an embodiment is very bulky and costly.

The present invention aims to achieve a simpler driving of the damping resistor switch in an on-load tap changer of the kind referred to, and, in a preferred embodiment to provide a good overlap between the switching intervals of the damping resistor switch and the plus/minus or coarse/fine switch, respectively.

According to the invention, an on-load tap changer of the kind referred to is characterised in that the switch for the damping resistor is operated by way of a cam member which is fixedly mounted on one of the drive shafts of the step selector.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which

Figure 1 is a circuit diagram showing the connection of an on-load tap changer in accordance with the invention connected to a transformer,

Figure 2 illustrates the switching sequence for the on-load tap changer of Figure 1 upon switching between two transformer tappings in the middle of the regulating range,

Figure 3 and 4 are schematic views of an embodiment of the on-load tap changer according to the invention, Figure 3 being a side view and Figure 4 a section along the line A-A of Figure 3,

Figure 5 is a perspective view of a switch for a damping resistor belonging to the on-load tap changer of Figures 3 and 4,

Figure 6 is an exploded view of the drive means for this damping resistor, and

Figure 7 is a plan of the switch of Figure 5.

Figure 1 shows one phase of a Y-connected three-phase transformer provided with an on-load tap changer for coarse/fine regulation. The transformer consists of a basic winding 21, a coarse step winding 22 and a fine step winding 23. One or the other of the tappings 1 and 2 of the coarse step winding may be connected to one terminal 3 of the fine step winding by way of a coarse/fine switch S. The fine step winding is provided with nine tappings 4-12, which together with the tapping 2 on the coarse step winding are connected each to a fixed contact on a step selector TS which has two movable selector arms V and H. Selector arm V coacts

with the contents connected to tappings 4, 6, 8, 10 and 12, whereas selector arm H coacts with the contacts to tappings 2, 5, 7, 9 and 11. The selector arms V and H are each connected to a fixed contact *x* and *v*, respectively, of a diverter switch DS by way of sliding devices, said diverter switch being provided with bridging resistors 24 and 25 connected to intermediate contacts *y* and *u* of the diverter switch. The movable contact 13 of the diverter switch is connnected to the neutral point of the transformer.

The tapping 7 of the fine step winding 23 may be connected to the fixed contact *v* of the diverter switch by way of a damping resistor 26 and a switch K. Also the tappings 7 on the other transformer phases are connected to switch K, which is tree-polar, by way of damping resistors 27 and 28.

With the shown connection, nineteen positions of the on-load tap changer are obtained, of which the tenth position is shown in Figure 1. Figure 2 illustrates the switching sequence when switching from the tenth to the eleventh position, the unbroken line showing the closed contact position. Switching is performed as follows:

Selector contact V opens from tapping 12, and switch K closes and switches in damping resistor 26. Thereafter coarse/fine switch S is switched from tapping 1 to tapping 2, whereafter switch K is again opened and selector contact V closes on tapping 4. Diverter switch DS then completes the switching by transferring the load current from contact *v* to contact *x* by way of resistor contacts *u* and *y*. It is important that switch K closes before and opens after the time interval when switch S is opened. On the other hand, the closing interval of the switch K need not necessarily be shorter than the opening interval of selector contact V, as shown in Figure 2.

Figures 3 and 4 shows shematically how an on-load tap changer according to the invention may be constructed. It consists of a diverter switch DS enclosed in an oil-tight manner in an electrically insulating housing, a step selector TS with coarse/fine switch S and a switch K for a damping resistor. The on-load tap changer is intended to be suspended from the transformer lid. It is operated from a motor operating device (not shown), the movement being transmitted from the upper part 29 of the diverter switch housing through a vertical shaft 30 to a gear 31 for divertor switch DS and selector TS. Certain auxilliary equipment, for example a pressure switch, a position indicator, etc, is mounted on the upper part 29.

Selector TS consists of electrically insulating rods 32, arranged in a circle, with fixed contacts mounted thereon. At the centre there are two concentrally placed drive shafts 33 and 34 which are each driven by a Geneva sheel in gear 31. Each drive shaft supports one selector arm each per phase. The selector arms V of the outer shaft are clamped on the shaft 33, whereas the contact arms H of the inner shaft are journalled on the outer shaft and fixedly connected to the inner shaft 34 by way of a pin which passes through a free-wheel slot in the outer shaft 33. The contact arms move in planes located above one another and each arm cooperates with a set of fixed contacts. The contact arms are connected to the diverter switch DS by way of slip rings and current collector contacts.

The coarse/fine switch S has three fixed contacts 1, 2, 3 per phase, which are each positioned on an electrically insulating rod 35. Changing-over is achieved with a contact bridge 37 which is rotatable about a shaft 36. The shaft 36 is set in motion by a fork arm (not shown) from a drive pin on one of the star wheels of the selector shafts.

Figures 5, 6 and 7 show how the switch K for damping resistors 26-28 is constructed. It has three fixed contacts 39 which are each mounted on an electrically insulating rod 38 and which are intended to be connected to the fine step winding in one phase each by way of damping resistors, as is clear from Figure 1. The movable contacts 40 of the switch are resiliently attached each to one contact arm 41. These arms are supported by a metallic disc 42 which is connected, through a flexible conductor 43, to a point common to the phases with a defined potential. Disc 42 is rotatably journalled on the selector shaft 33 which is connected to selector arms V. The switch is driven directly from this shaft 33 through a guiding disc 44, fixedly mounted on the shaft, with a slot 45 which deviates from the circular shape only in connection with a cam 46 but which is otherwise circular. Guiding disc 44 is mechanically coupled to contact holder disc 42 through a guiding arm 47 which is rotatably journalled on a shaft pin 48 attached to the frame of the switch. Guiding arm 47 is provided with two guiding pins 49 and 50 arranged on opposite sides of the arm, one of the pins 49 projecting into the cam slot 45 of the guiding disc and the other 50 projecting into a radial notch 51 in the periphery of the contact holder disc 42. The guiding pins are provided with rollers to reduce the friction.

When selector shaft 33 and thus guiding disc 44 are rotated, guiding arm 47 – as is best illustrated in Figure 7 – and thus contact holder disc 42 will remain stationary in the shown position until the cam 46 of the guiding disc contacts the guiding pin 49 of the guiding arm. Guiding arm 47 and thus contact holder disc 42 will then be rotated so that the movable contacts 40 of the switch are pressed against the fixed contact 39. When cam 46 has passed guiding pin 49, contacts 40 will swing back to the position shown in Figure 7. The contact arms 41 will thus be caused to make a forward and backward movement briefly in connection with the operation of the plus/minus switch,

as is symbolised by the two-way arrows in Figure 5.

WHAT WE CLAIM IS:—

1. An on-load tap changer comprising a diverter switch, a step selector which is operated by way of two shafts which are rotatable in steps in relation to each other, a plus/minus or coarse/fine switch, and a switch for briefly switching in a damping resistor during a plus/minus or a coarse/fine switching operation, respectively, characterised in that the switch for the damping resistor is operated by way of a cam member which is fixedly mounted on one of the drive shafts of the step selector.

2. An on-load tap changer according to claim 1, in which the cam member consists of a disc with a cam slot.

3. An on-load tap changer according to claim 1 or 2, in which the movable contact members of the damping resistor switch are supported by a contact holder rotatably journalled on said one drive shaft, said contact holder being connected to the cam member through a guiding arm.

4. An on-load tap changer according to claim 3, in which the guiding arm is rotatably journalled at a radial distance from said one drive shaft and is provided with two guiding pins, of which one cooperates with said cam member and the other engages with said contact holder.

5. An on-load tap changer constructed and arranged substantially as herein described with reference to the accompanying drawings.

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3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

Fig. 1

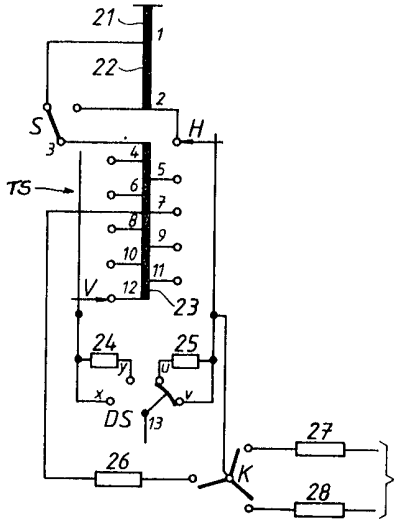


Fig. 3

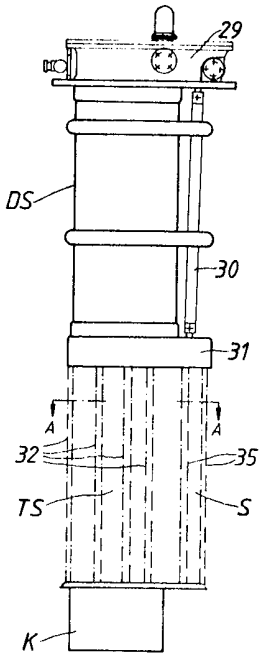


Fig. 2

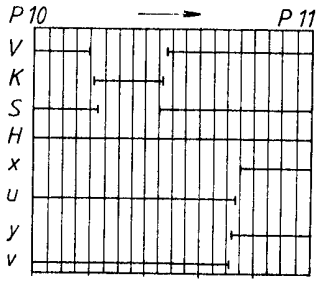
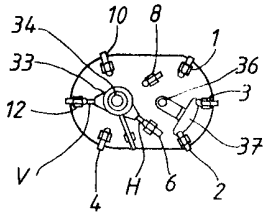


Fig. 4



A - A

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Sheet 2

Fig. 5

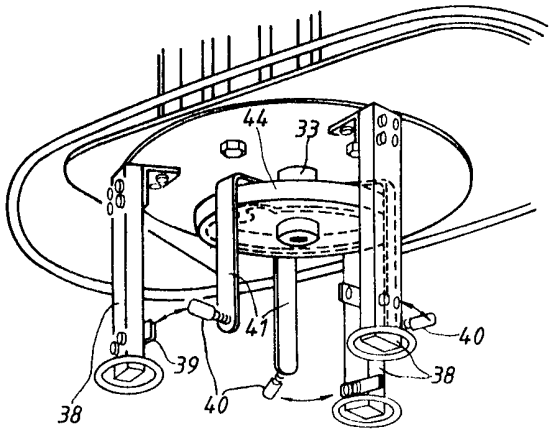
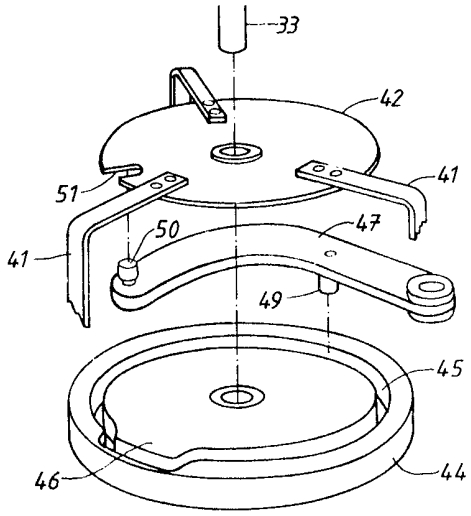


Fig. 6



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Sheet 3

Fig. 7

