

April 27, 1954

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2,677,113

TRANSFORMER PROTECTIVE DEVICE

Filed Jan. 30, 1953

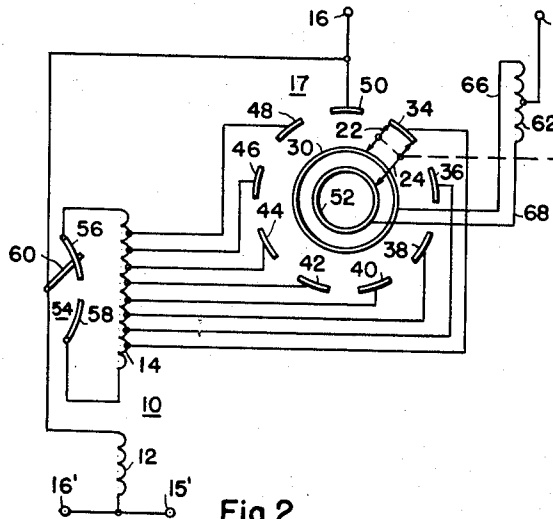


Fig. 1.

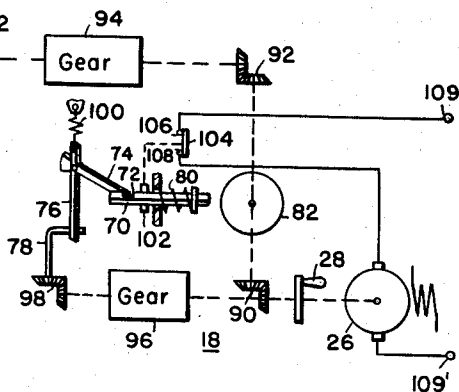


Fig. 4.

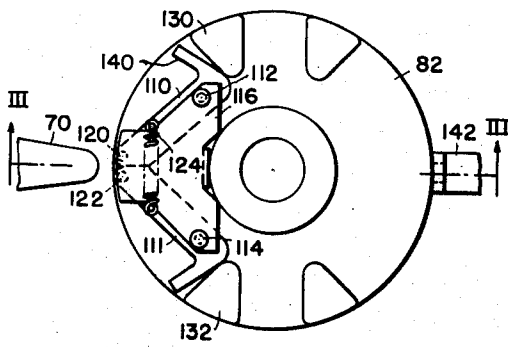
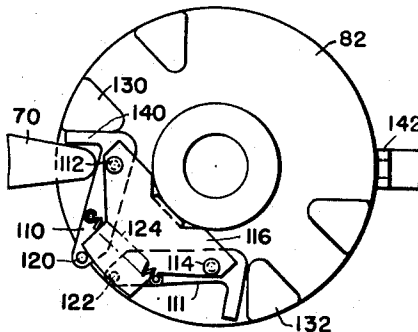
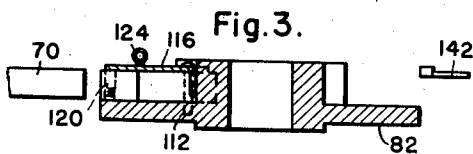
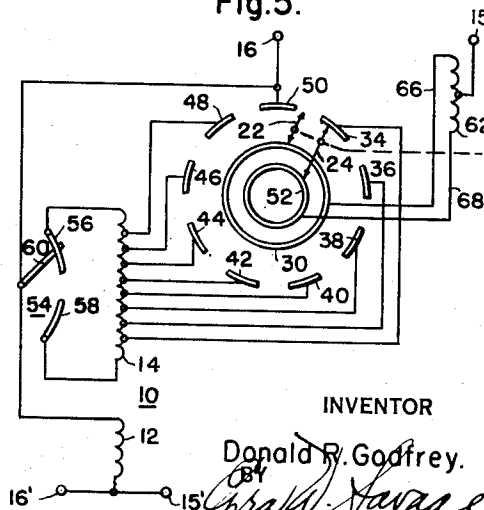


Fig. 5.



WITNESSES:

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2,677,113

TRANSFORMER PROTECTIVE DEVICE

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Application January 30, 1953, Serial No. 334,313

7 Claims. (Cl. 336-150)

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This invention relates to transformers and more particularly to protective means associated therewith.

The output voltage of transformers is oftentimes varied by means of a tap-changer associated therewith. When a tap-changer is used, it must be capable of effecting a change in the output voltage of the transformer without interrupting the input or output circuits of the transformer. In order to accomplish this operation under load, it is necessary to provide at least two moving contact members so that one of the moving contact members will at all times maintain an uninterrupted electrical circuit from the input to the output of the transformer. However, when the movable contact members are in engagement with different stationary contact members, the current flow through these movable contact members would be excessive unless a preventive autotransformer were connected thereto.

When the tap-changer is rotated beyond its minimum or maximum position, the preventive autotransformer is connected across all the tapped portion of the transformer windings, thus causing excessive current to flow through the preventive autotransformer. In most transformers having a tap-changer associated therewith, a stop mechanism is provided to prevent the rotation of the tap-changer beyond these minimum and maximum positions. However, in such stop mechanisms which do not reset themselves automatically, means must be provided to reset the stop mechanism manually. When the stop mechanism is reset manually, it is then possible to continue to change the position of the tap-changer and connect the preventive autotransformer across all of the tapped portion of the transformer winding and thereby damage the transformer.

An object of this invention is to provide for preventing damage to a preventive autotransformer incorporated in a transformer tap-changer, by so coordinating a stop mechanism with the tap-changer that it is impossible to actuate the tap-changer beyond its normal operating range in either a minimum or maximum direction.

A further object of this invention is to provide for automatically resetting a tap-changer stop mechanism once the tap-changer has been actuated to either of its extreme positions and then actuated a predetermined distance in the direction of its normal operating range, by so positioning one of two coordinated cam members by means of a stop bar tripped in response to the extreme positioning of the tap-changer, that the

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stop bar rides the surface of the positioned cam member while the tap-changer is being actuated in its normal operating range to thereby effect a resetting of the stop bar.

Other objects of this invention will become apparent from the following description when taken in conjunction with the accompanying drawing, in which:

Figure 1 is a schematic diagram of apparatus and circuits illustrating an embodiment of the teachings of this invention;

Fig. 2 is a view in elevation of a portion of the stop mechanism illustrated in Fig. 1, which portion is shown in the unactuated position;

Fig. 3 is a view in section of the portion of the stop mechanism illustrated in Fig. 2, the sectional view being taken along the line III-III;

Fig. 4 is a view in elevation of a portion of the stop mechanism illustrated in Fig. 1, which portion is shown in the actuated position; and

Fig. 5 is a schematic diagram showing the position of the transformer tap-changer when the stop mechanism is in the position as illustrated in Fig. 4.

Referring to Fig. 1, there is illustrated an autotransformer 10 having a fixed winding 12 and a tapped winding 14, which receive energy from the supply terminals 15 and 15' and supply energy to the load terminals 16 and 16'. In order to vary the amount of the tapped winding 14 that is connected in circuit relationship with the fixed winding 12, a tap-changer 17 is electrically connected to the tap winding 14 and to the fixed winding 12 of the transformer 10. However, in order to prevent the tap-changer 17 from being actuated beyond the minimum and maximum limits of its operating range to thereby cause damage of the tap-changer 17, a stop mechanism 18 responsive to the positioning of the tap-changer 17 is provided.

Referring more particularly to the tap-changer 17, it is to be noted that the tap-changer 17 includes two movable contact members 22 and 24 which are actuated by either a reversible motor 26 or by a hand crank 28 through suitable mechanical linkages which will be described in greater detail hereinafter. As can be seen from the drawing, one end of the movable contact member 22 remains in electrical contact with a conducting ring 30 when the contact member 22 is being actuated into its various positions around the ring 30 by means of either the motor 26 or the hand crank 28. As the movable contact member 22 is being actuated through its various positions, the other end of the contact member 22 engages

a plurality of stationary contact members 34, 36, 38, 40, 42, 44, 46, 48 and 50, which are electrically connected to the tapped winding 14 of the transformer 18. In like manner, one end of the movable contact member 24 engages these stationary contact members 34, 36, 38, 40, 42, 44, 46, 48 and 50, as it is actuated through its various positions. However, the other end of the movable contact member 24 during these various positions remains continually in electrical contact with a conducting ring 52.

In order to connect the tapped winding 14 so that its turns either aid or buck the turns of the fixed winding 12, a reversing switch 54 is provided. In this instance, the reversing switch comprises two stationary contact members 56 and 58 which are selectively engaged by a movable contact member 60. As illustrated, the stationary contact 56 is electrically connected to one end of the tapped winding 14, and the stationary contact member 58 is electrically connected to the other end of the tapped winding 14.

For the purpose of interconnecting the fixed winding 12 with the tapped winding 14, one end of the fixed winding 12 is electrically connected to the movable contact member 60 of the selector switch 54. As can be seen from the drawing, the load terminal 16 is also electrically connected to the movable contact member 60 as well as to the stationary contact member 50 of the tap-changer 17.

As illustrated, a preventive autotransformer 62 is electrically connected to the conducting rings 30 and 52, through conductors 66 and 68, respectively, in order to prevent an excessive flow of current through the conductors 56 and 68 when these conductors are electrically connected by means of the tap-changer 17 across a portion of the tapped winding 14. The sequence of operation of the movable contact members 22 and 24 of the tap-changer 17, as they move through their various tap-changing positions, will be described hereinafter.

In accordance with the teachings of this invention, the stop mechanism 18 is provided in order to ensure that the tap-changer 17 cannot be actuated beyond its extreme positions of minimum and maximum output for the autotransformer 10, which action would cause damage to the preventive autotransformer 62 since it would then become connected across all of the tapped winding 14. The stop mechanism 18 is also provided so that there is no need to reset the mechanism by hand, which, as hereinbefore mentioned, gives rise to the danger of damaging the preventive autotransformer 62. The stop mechanism 18 automatically resets itself, as will be explained more fully hereinafter.

As illustrated, the stop mechanism 18 comprises a spring-loaded stop bar 70 which has a notch 72 disposed inside thereof. One end 74 of a trip latch 76 is disposed in the notch 72 of the stop bar 70 in order to maintain it in the spring loaded position during the normal tap-changing operation of the tap-changer 17. In this instance, the lower end of the trip latch 76 is actuated by a trip bar 78 in order to disengage the end 74 of the trip latch 76 from the notch 72 of the stop bar 70 to thereby permit the compression spring 80 to actuate the stop bar 70 into engagement with the component parts of a stop disk 82 and thereby prevent the further actuation of the tap-changer 17 in a given direction.

In practice, the stop disk 82, and either the

movable contact member 22 or the movable contact member 24 of the tap-changer 17, are actuated simultaneously by either the hand crank 28, if manual operation is desired, or by the motor 26 if motor operation is desired. In this instance, the hand crank 28 and the motor 26 are mechanically connected to the stop disk 82 through a pair of bevel gears 90, the stop disk 82 in turn being mechanically connected to the movable contact members 22 and 24 of the tap-changer 17 through a pair of bevel gears 92 and suitable gearing 94.

The hand crank 28 and motor 26 are also mechanically connected to the trip bar 78 through suitable gearing 96 and a pair of bevel gears 98, the gearing 94 and 96 being such that when the tap-changer 17 is actuated into one extreme position, such as to give a minimum output voltage from the transformer 10, the trip bar 78 will be in position to actuate the trip latch 76, and the component parts of the stop disk 82 will be in proper position to receive the stop bar 70. The gearing 94 and 96 must also be such that when the motor 26 or hand crank 28 actuates the tap-changer 17 to the other extreme position, such as to give a maximum output voltage from the transformer 10, the trip bar 78 will be again in position to actuate the trip latch 76, and the stop disk 82 will be in proper position to receive the stop bar 70. In practice, a tension spring 100 is connected to the trip latch 76 in order to force the end 74 of the trip latch 76 into engagement with the notch 72 once the trip bar 70 has been actuated to the position shown in Fig. 1.

If the motor 26 is used to actuate the movable contact members 22 and 24 of the tap-changer 17, some means must be provided in order to stop the motor 26 once these movable contact members reach their extreme positions in either a maximum or minimum direction. In order to deenergize the motor 26 once either of these extreme positions is reached, a collar 102 is suitably connected to the stop bar 70. In this instance, the collar 102 is mechanically connected to a movable contact member 104 which is disposed to make electrical contact with stationary contact members 106, 108. When the stop bar 70 is tripped, the movable contact member 104 is actuated to the circuit interrupting position, thereby interrupting the supply of energy to the motor 26 which is received from supply terminals 109 and 109'.

Referring to Figs. 2 and 3 of the drawing, the stop disk 82 and its associated component parts are shown in greater detail. As illustrated, two L-shaped cam members 110 and 111 are pivoted about two predetermined points 112 and 114, respectively, on the stop disk 82. A plate member 116 is suitably secured to the stop disk 82 and is disposed above the cam members 110 and 111 in order to prevent the cam members 110 and 111 from lifting vertically under load. In this instance, the cam members 110 and 111 have disposed therein spring-loaded pin members 120 and 122, respectively, which pin members are held in the spring-loaded position by the plate member 116 when the cam members are positioned, as shown in Fig. 2.

In order to bias the cam members 110 and 111 in a direction towards one another, a spring member 124 is mechanically connected to each of the cam members 110 and 111. Associated with the cam members 110 and 111 are protruding stop members 130 and 132 which prevent the cam

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members 110 and 111, respectively, from being rotated beyond a predetermined position, and thereby prevent the further rotation of the stop disk 82. In this instance, the stop members 130 and 132 are an integral part of the stop disk 82.

The operation of the apparatus shown in Fig. 1 can be more clearly understood by referring to Figs. 4 and 5 in conjunction with Fig. 1. For instance, the output voltage of the transformer 10, as it appears across the load terminals 16 and 16', is at a minimum when the movable contact members 22 and 24 of the tap changer 17 are both in electrical contact with the stationary contact member 48, and the movable contact member 60 of the reversing switch 54 is in electrical contact with the stationary contact member 58. In order to increase the output voltage of the transformer 10, the hand crank 28 is rotated in a clockwise direction to thereby actuate the movable contact member 22 to such a position that it engages the stationary contact 46. The output voltage of the transformer 10 is further increased by rotating the hand crank 28 further in the clockwise direction to thereby actuate the movable contact member 24 so that it too makes electrical contact with the stationary contact member 46. This sequence of positioning of the movable contact members 22 and 24 is continued by rotating the crank 28 in a clockwise direction until both the movable contact members 22 and 24 are in electrical contact with the stationary contact member 34 of the tap-changer 17. Up to this position, the turns of the tapped winding 14 aid the turns of the fixed winding 12. Then the hand crank 28 is rotated further in the clockwise direction until the movable contact member 22 makes electrical contact with the stationary contact member 50. The hand crank 28 is then further rotated in a clockwise direction to actuate the movable contact member 24 so that it will make electrical contact with the stationary contact member 50, and as soon as the movable contact member 24 breaks contact with the stationary contact member 34, the movable contact member 60 of the reversible switch 54 is actuated so as to make electrical contact with the stationary contact member 56.

With both the movable contact members 22 and 24 in electrical contact with the stationary contact member 50 and the movable contact member 60 of the reversing switch 54 in electrical contact with the stationary contact member 56, the tap-changer is in the neutral position in which the input and output voltages are substantially equal. By rotating the hand crank further in the clockwise direction, the output voltage of the transformer 10 is further increased since the turns of the tapped winding 14 are now bucking the turns of the fixed winding 12. The output voltage of the transformer 10 continues to increase as long as the hand crank 28 is further rotated in a clockwise direction and the stop disk 82 is thereby further rotated in a counterclockwise direction until finally both the movable contact members 22 and 24 of the tap-changer 17 engage the stationary contact member 34. Once this position is reached, the trip bar 78 actuates the trip latch 76 to thereby disengage the end 74 from the notch 72 in the trip bar 70 and thereby permit the trip bar 70 to move to the right under the force of the spring 80 until it engages the cam member 110. On further rotation of the stop disk 82 in the counterclockwise direction, the trip bar 70 ef-

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fects a rotation of the cam member 110 about its pivot point 112 until the leg 140 of the cam member 110 rests against the protruding stop member 130, thus preventing any further rotation of the stop disk 82 in the counterclockwise direction. When this position of the stop disk 82 is reached, as shown in Fig. 4, the movable contact members 22 and 24 are positioned as shown in Fig. 5. Therefore, when the movable contact member 50 of the reversing switch 54 is in electrical contact with the stationary contact member 56, it is impossible to actuate the movable contact member 22 of the tap-changer 17 until it engages the stationary contact member 50 to thereby electrically connect the preventive autotransformer across the tapped portion of the tapped winding 14, which would cause injury to the preventive autotransformer.

When the cam member 110 is rotated about its pivot point 112, the spring-loaded pin member 120 is permitted to extend beyond the plate member 116, and when in this spring unloaded position, it rests against the edge of the plate member 116 under the influence of the spring member 124, and thus the cam member 110 is prevented from returning to its original position. On rotating the hand crank 28 in a counterclockwise direction to return the tap-changer to its normal operating range, the stop bar 70 slides along the surface of the cam member 110 until it is reset. This resetting occurs when the stop bar 70 has moved far enough to the left to permit the end 74 of the trip latch 76 to again enter the notch 72 of the stop bar 70 under the force of the spring 100.

Once the hand crank 28 has been turned further in a counterclockwise direction to thereby rotate the stop disk 82 a predetermined distance in the opposite direction, the pin member 120 disposed in the cam member 110 is reset by means of a reset mechanism 142 shown in Fig. 3. In order to return the output voltage of the transformer 10 to its minimum value, the hand crank 28 is rotated further in a counterclockwise direction until both the movable contact members 22 and 24 are in electrical contact with the stationary contact member 48 of the tap-changer 17, and the movable contact member 60 of the reversing switch 54 is in electrical contact with the stationary contact member 58. Further actuation of the movable contact member 24 so that it would engage the stationary contact member 50 of the tap changer 17 is prevented by the stop mechanism 18. If the movable contact member 24 were permitted to make electrical contact with the stationary contact member 50, the preventive autotransformer 62 would be electrically connected across the tapped portion of the tapped winding 14, thus causing injury thereto. Such action is prevented since before the movable contact member 24 reaches the stationary contact member 50 of the tap changer 70, the stop bar 70 is tripped to thereby engage the cam member 111 and thus rotate it about its pivot point 114 into engagement with the protruding stop member 132. Such an action permits the spring-loaded pin member 122 of the cam member 111 to extend beyond the plate member 116 and thereby engage the edge of the plate member. The spring member 124 then biases the pin member 122 against the edge of the plate member 116, holding the cam member 111 in such a rotated position that the trip bar 70 slides along the surface of the cam member 111 when the hand crank 28 is rotated in a clockwise direction. By sliding along

the surface of the cam member 111 in this manner, the stop bar 70 is reset and assumes the position illustrated in Fig. 1. On further rotation of the hand crank 28 in a clockwise direction, the pin member 122 is reset by the reset mechanism 142 to thereby permit the spring member 124 to rotate the cam member 111 about its pivot point 114 until it assumes the position illustrated in Fig. 2.

From the above discussion, it is realized that the tap-changer 17 cannot be actuated beyond the maximum and minimum limits of its operating range since the stop mechanism 18 prevents such further rotation. In addition, the stop mechanism 18 automatically resets itself. Thus, no manual resetting of the apparatus is necessary, which heretofore gave rise to injuries to the apparatus as hereinbefore mentioned.

Since certain changes may be made in the above apparatus and circuits, and different embodiments of the invention may be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. In a transformer whose output voltage is varied by means of a tap-changer associated therewith, the combination comprising, a stop mechanism including a stop bar, a stop disk disposed to cooperate with the stop bar, two cam members pivoted about two predetermined points on the stop disk, means for simultaneously rotating the stop disk and for positioning the tap-changer, means for tripping the stop bar once the tap-changer has reached a predetermined position to thereby effect engagement of the stop bar with one of the cam members and thus prevent further positioning of the tap-changer and rotation of the stop disk in a given direction, the engaging of said one of the cam members by the stop bar effecting a rotation of said one of the cam members about its pivot point to thereby assume a new position, and means for preventing said one of the cam members from returning to its original position until the stop disk rotates a predetermined distance in the opposite direction, whereby the stop bar slides along the surface of said one of the cam members as the stop disk rotates in said opposite direction to thereby effect a resetting of the stop bar.

2. In a transformer whose output voltage is varied by means of a tap-changer associated therewith, the combination comprising, a stop mechanism including a stop bar, a stop disk disposed to cooperate with the stop bar, two cam members pivoted about two predetermined points on the stop disk, a spring member connected to each of the cam members for biasing the cam members in a direction towards one another, means for simultaneously rotating the stop disk and for positioning the tap-changer, means for tripping the stop bar once the tap-changer has reached a predetermined position to thereby effect engagement of the stop bar with one of the cam members and thus prevent further positioning of the tap-changer and rotation of the stop disk in a given direction, the engaging of said one of the cam members by the stop bar effecting a rotation of said one of the cam members about its pivot point to thereby extend the spring member, and means for preventing said one of the cam members from returning to its original position by the action of the spring member until the stop

disk rotates a predetermined distance in the opposite direction, whereby the stop bar slides along the surface of said one of the cam members as the stop disk rotates in said opposite direction to thereby effect a resetting of the stop bar.

3. In a transformer whose output voltage is varied by means of a tap-changer associated therewith, the combination comprising, a stop mechanism including a stop bar, a stop disk disposed to cooperate with the stop bar, means for simultaneously rotating the stop disk and positioning the tap-changer, two cam members pivoted about two predetermined points on the stop disk, each cam member having disposed therein a spring-loaded pin member, a plate member disposed to cooperate with the pin members and hold them in the spring-loaded position during the normal positioning of the tap-changer, a spring connected to each of the cam members for biasing the cam members in such a direction as to enable the plate member to hold the pin members in the spring-loaded position during the normal positioning of the tap-changer, means for tripping the stop bar once the tap-changer has reached a predetermined position, to thereby effect an engagement of the stop bar with one of the cam members, rotating it about its pivot point, extending the spring member and permitting its spring-loaded pin member to extend beyond the plate member and thereby preventing further rotation of the stop disk and positioning of the tap-changer in a given direction, and means for resetting the spring-loaded pin member of said rotated cam member once the stop disk has been rotated a predetermined distance in the opposite direction, the stop bar during a portion of this latter rotation sliding along the surface of said rotated cam member to thereby return it to its original position.

4. In a transformer whose output voltage is varied by means of a tap-changer associated therewith, the combination comprising, a stop mechanism including a stop bar, a stop disk having two protruding stop members disposed to cooperate with the stop bar, two cam members for the stop disk, one of the cam members being pivoted about a point associated with one of the protruding stop members, and the other cam member being pivoted about a point associated with the other protruding stop member, means for simultaneously rotating the stop disk and for positioning the tap-changer, means for tripping the stop bar once the tap-changer has reached a predetermined position to thereby effect engagement of the stop bar with one of the cam members, thus rotating said one of the cam members about its pivot point until it engages its associated protruding stop member, thereby preventing further rotation of the stop disk in a given direction and positioning of the tap-changer in a given direction, and means for preventing said one of the cam members from returning to its original position until the stop disk rotates a predetermined distance in the opposite direction, whereby the stop bar slides along the surface of said one of the cam members as the stop disk rotates in said opposite direction to thereby effect a resetting of the stop bar.

5. In a transformer whose output voltage is varied by means of a tap-changer associated therewith, the combination comprising, a stop mechanism including a spring loaded stop bar, a stop disk having two protruding stop members disposed to cooperate with the stop bar, two L-shaped cam members for the stop disk, one of

the L-shaped cam members being pivoted about a point associated with one of the two protruding stop members, the other L-shaped cam member being pivoted about a point associated with the other protruding stop member, means for simultaneously rotating the stop disk and for positioning the tap-changer, means for tripping the stop bar once the tap-changer has reached a predetermined position to thereby effect engagement of the stop bar with one of the legs of one of the L-shaped cam members, thus rotating said one of the L-shaped cam members about its pivot point until said one of the legs engages its associated protruding stop member, thereby preventing further rotation of the stop disk in a given direction and positioning of the tap-changer in a given direction, and means for preventing said one of the L-shaped cam members from returning to its original position until the stop disk rotates a predetermined distance in the opposite direction, whereby the stop bar slides along the surface of the other leg of said one of the L-shaped cam members as the stop disk rotates in said opposite direction to thereby effect a resetting of the stop bar.

6. In a transformer whose output voltage is varied by means of a tap-changer associated therewith, the combination comprising, a stop mechanism including a spring-loaded stop bar, a stop disk having two protruding stop members disposed to cooperate with the stop bar, means for simultaneously rotating the stop disk and positioning the tap-changer, two cam members pivoted about two predetermined points on the stop disk, each cam member having disposed therein a spring-loaded pin member, a plate member disposed to cooperate with the pin members and hold them in the spring-loaded position during the normal positioning of the tap-changer, a spring connected to each of the cam members for biasing the cam members in such a direction as to enable the plate member to hold the pin members in the spring-loaded position during the normal positioning of the tap-changer, means for tripping the stop bar once the tap-changer has reached a predetermined position, to thereby effect an engagement of the stop bar with one of the legs of one of the L-shaped cam members, thus rotating said one of the L-shaped cam members about its pivot point until it engages its associated protruding stop member thus preventing further rotation of the stop disk in a given direction and thereby extending the spring member and permitting the spring-loaded pin member of said one of the cam members to extend beyond the plate member to thus hold said

one of the cam members in its rotated position, and means for resetting the spring-loaded pin member of said one of the cam members once the stop disk has been rotated a predetermined distance in the opposite direction, the stop bar during a portion of this latter rotation sliding along the surface of said one of the cam members to thereby return it to its spring-loaded position.

7. In a transformer whose output voltage is varied by means of a tap-changer associated therewith, the combination comprising, a stop mechanism including a spring-loaded stop bar, a stop disk having two protruding stop members disposed to cooperate with the stop bar, means for simultaneously rotating the stop disk and positioning the tap-changer, two L-shaped cam members for the stop disk, one of the L-shaped cam members being pivoted about a point associated with one of the two protruding stop members, the other L-shaped cam member being pivoted about a point associated with the other protruding stop member, each cam member having disposed therein a spring-loaded pin member, a plate member disposed to cooperate with the pin members and hold them in the spring-loaded position during the normal positioning of the tap-changer, a spring connected to each of the L-shaped cam members for biasing the L-shaped cam members in such a direction as to enable the plate member to hold the pin members in the spring-loaded position during the normal positioning of the tap-changer, means for tripping the stop bar once the tap-changer has reached a predetermined position, to thereby effect an engagement of the stop bar with one of the legs of said one of the L-shaped cam members, thus rotating said one of the L-shaped cam members until said one of the legs engages its associated protruding stop member, thus preventing further rotation of the stop disk in a given direction and thereby extending the spring member and permitting the spring-loaded pin member of said one of the L-shaped cam members to extend beyond the plate member to thus hold said one of the L-shaped cam members in its rotated position, and means for resetting the spring-loaded pin member of said one of the L-shaped cam members once the stop disk has been rotated a predetermined distance in the opposite direction, the stop bar during a portion of this latter rotation sliding along the surface of the other leg of said one of the L-shaped cam members to thereby return it to its spring-loaded position.

No references cited.