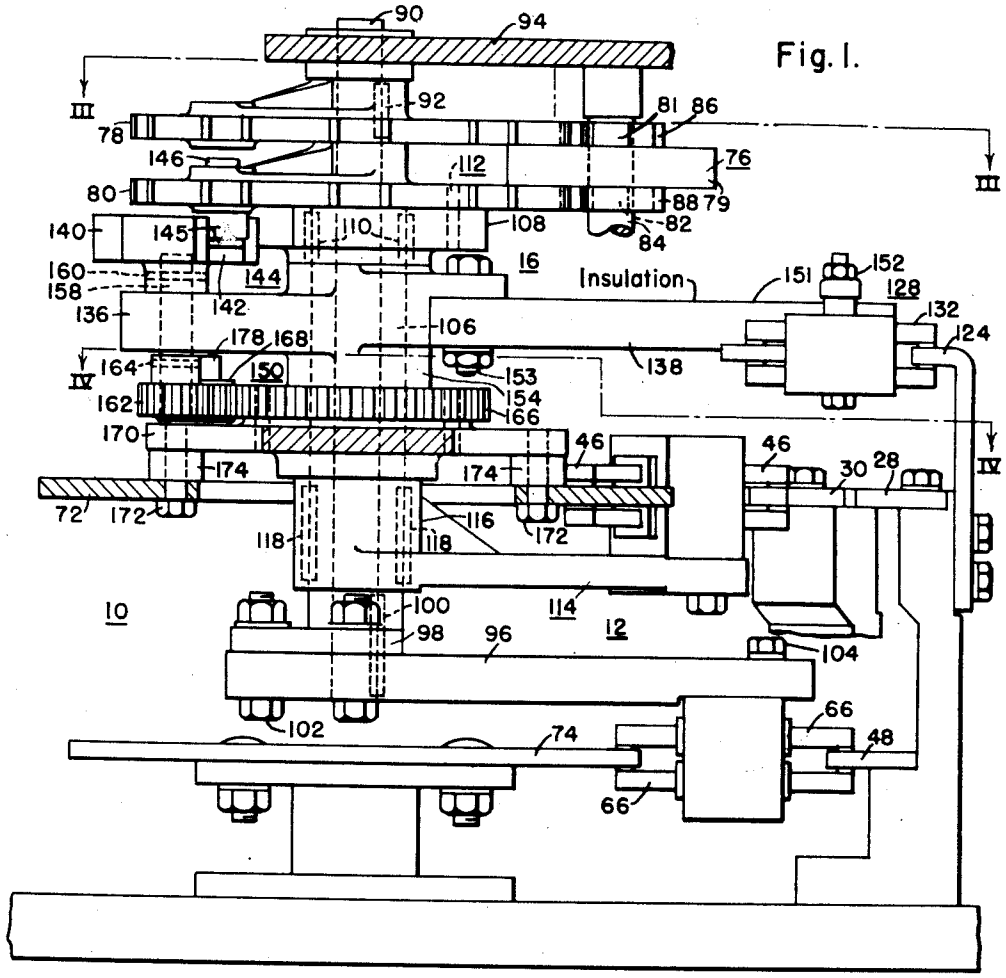
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TAP-CHANGERS

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Fig. 1.



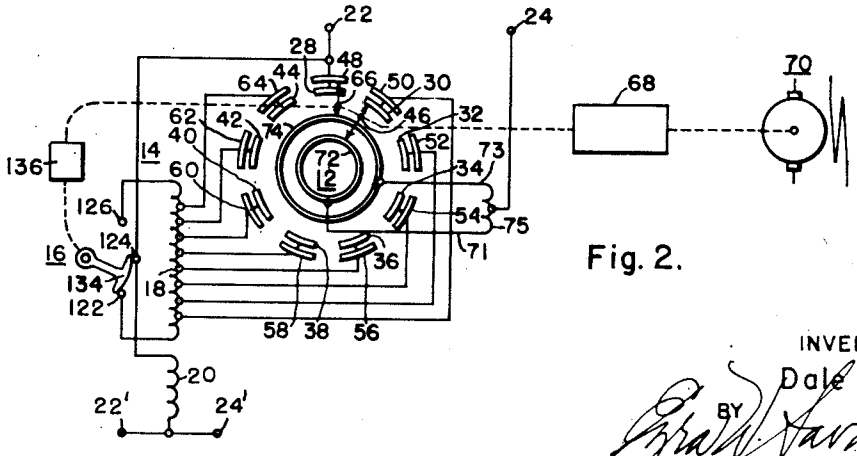


Fig. 2.

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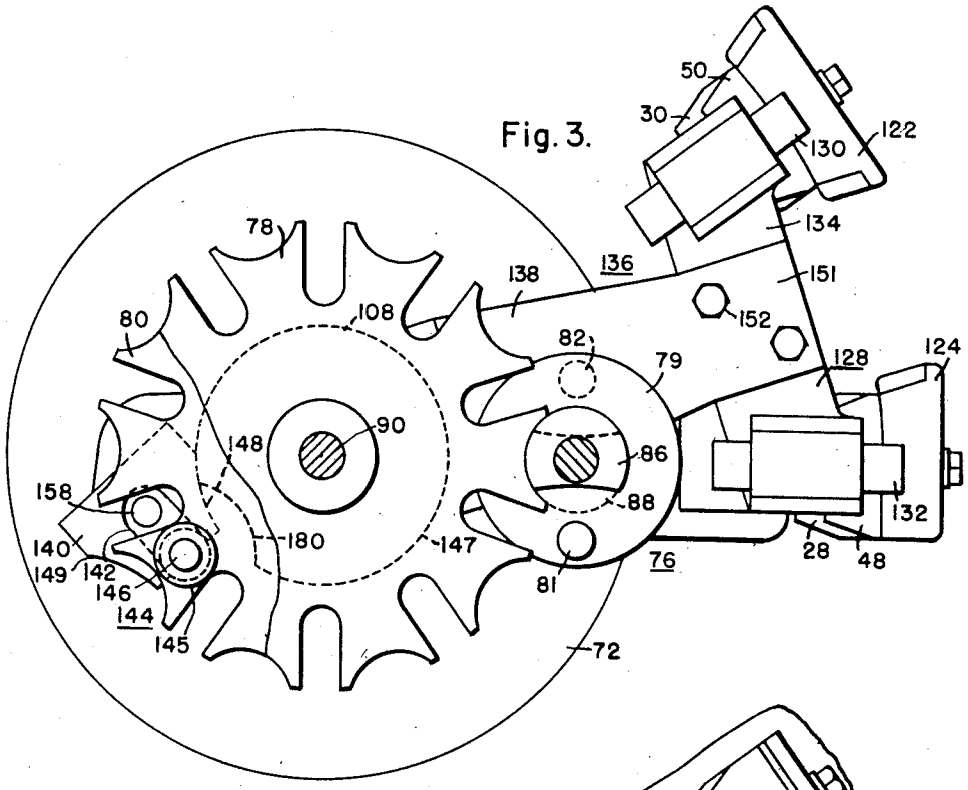
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TAP-CHANGERS

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Fig. 3.



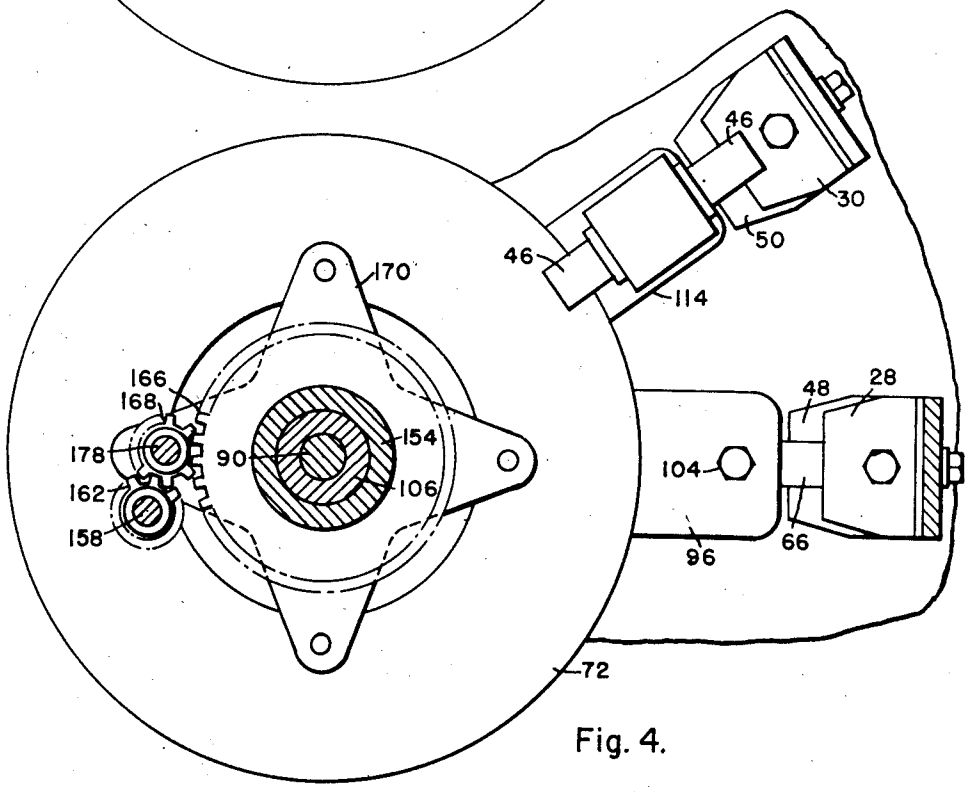


Fig. 4.

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2,785,242

TAP-CHANGERS

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3 Claims. (Cl. 200—18)

This invention relates to transformer tap-changers and, more particularly, to the switch actuating mechanism for the tap-changer.

A tap-changer for use with an autotransformer, having a fixed and a tapped winding, includes a multiple position selector switch for selecting the desired tap position and a reversing switch for connecting the fixed and tapped winding in either buck or boost relationship. The selector switch and the reversing switch each have a switch actuating mechanism, the mechanisms being driven from a common drive. Heretofore, the pivot center for the reversing switch actuating mechanism was offset from the center of the selector switch actuating shaft. However, such a prior art arrangement has several disadvantages. For instance, if proper electrical clearances are to be maintained in this prior art device, the combined size of the selector and reversing switch becomes excessive.

This difficulty as to size is brought about by two things. First, the space between the selector switch actuating shaft and the pivot center of the reversing switch actuating mechanism cannot be used for electrical clearances. Second, the high amount of slip for the reversing switch, that is the distance the movable contact member slides along each of the associated stationary contact members before breaking, inherent in this type of prior art reversing switch, makes it necessary to use wide stationary contact members. This necessitates the placing of one of the stationary contact members behind the remaining stationary contact members in order to maintain the proper electrical clearances.

A broad object of this invention is to provide a new and improved switch actuating mechanism for a transformer tap-changer.

Another object of this invention is to provide a compact transformer tap-changer having large electrical clearances therein.

A more specific object of this invention is to provide a compact selector and reversing switch driven from a common drive and having a maximum of creep distance between the movable contact assembly of the reversing switch and its associated metallic actuating mechanism, and a maximum of jump distance between adjacent stationary contact members of the reversing switch.

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

Figure 1 is a side elevation view, partly in section, of the transformer tap-changer embodying the teachings of this invention;

Fig. 2 is a schematic diagram of the transformer tap-changer shown in Fig. 1 illustrating its electrical relationship to the transformer;

Fig. 3 is a view in section taken along the line III—III of Fig. 1; and

Fig. 4 is a view in section taken along the line IV—IV of Fig. 1.

Referring to the drawings, in which like components shown in Figs. 1 through 4 have been given the same reference characters, a tap-changer 10 embodying the teachings of this invention comprises, in general, a multiple position selector switch 12 for changing the tap position of an autotransformer 14 and a reversing switch 16 for connecting the tapped winding 18 and the fixed winding 20 of the autotransformer 14 in either buck or boost relationship with respect to one another. Energy for the autotransformer 14 is received from supply terminals 22 and 22' and the autotransformer 14 effects a supply of energy to load terminals 24 and 24'.

In general, the multiple position selector switch 12 comprises a plurality of circumferentially spaced stationary contact members 28, 30, 32, 34, 36, 38, 40, 42 and 44 which are disposed to be selectively engaged by a movable contact member 46; a plurality of circumferentially spaced stationary contact members 48, 50, 52, 54, 56, 58, 60, 62 and 64 which are disposed to be selectively engaged by a movable contact member 66; and a selector switch actuating mechanism 68 for effecting an actuation of the movable contact members 46 and 66. As illustrated in Fig. 2, the stationary contact members 28, 30, 32, 34, 36, 38, 40, 42 and 44 are electrically connected to the stationary contact members 48, 50, 52, 54, 56, 58, 60, 62 and 64, respectively, and the stationary contact members 50, 52, 54, 56, 58, 60, 62 and 64 are electrically connected to the tapped winding 18 of the autotransformer 14.

As the movable contact member 46 is actuated through its various positions by the switch actuating mechanism 68, which is driven by a motor 70, one of its ends remains in electrical contact with a circular shaped electrical conducting member 72. On the other hand, as the movable contact member 66 is actuated through its various positions by the switch actuating mechanism 68 one of its ends remains in electrical contact with a circular-shaped electrical conducting member 74. A preventive autotransformer 75 is electrically connected to the circular-shaped members 72 and 74, through conductors 71 and 73, respectively, in order to prevent an excessive flow of current through these conductors 71 and 73 when they are electrically connected by means of the selector switch 12 across a portion of the tapped winding 18.

The mechanical structure of the selector switch actuating mechanism 68 will now be described. Referring to Figs. 1, 3 and 4, a pin wheel 76 is disposed to alternately effect an actuation of Geneva gears 78 and 80. As illustrated, the pin wheel 76 comprises a wheel 79 on the upper side of which there is a pin member 81 which engages the slots of the Geneva gear 78 to thus effect a rotary movement of the Geneva gear 78, and on the lower side of which there is a pin member 82 which engages the slots of the Geneva gear 80 to thus effect a rotary movement of the Geneva gear 80. Rotary movement of the wheel 79 is effected by a shaft 84 which is suitably secured to the wheel 79 and driven by the motor 70.

In order to prevent rotation of the Geneva gear 78 until the pin member 81 engages a slot of the Geneva gear 78, a locking member 86 is provided on the upper side of the wheel 79, the locking member 86 being integral with the wheel 79. On the other hand, in order to prevent rotation of the Geneva gear 80 until the pin member 82 engages a slot of the Geneva gear 80 a locking member 88 is provided on the lower side of the wheel 79, the locking member 88 also being integral with the wheel 79.

The Geneva gear 78 is operable to effect a rotary movement of a selector switch actuating shaft 90 which in turn is operable to effect an actuation of the movable contact member 66. In particular, the Geneva gear 78 is keyed to the selector switch actuating shaft 90 by means of a key 92, the shaft 90 being held in vertical position by a frame support member 94.

In order to effect a rotary movement of the movable contact member 66 on rotation of the selector switch actuating shaft 90, a selector switch actuating arm 96 is suitably connected to the shaft 90 and to the movable contact member 66. In particular, the shaft 90 is keyed to a bracket member 98 by means of a key 100, the bracket member 98 being secured to the arm 96 by means of a plurality of bolts and nuts 102. The other end of the switch actuating arm 96 is secured to the movable contact member 66 by means of a bolt 104.

The Geneva gear 80 is operable to effect a rotary movement of a selector switch actuating sleeve shaft 106 which in turn is operable to effect an actuation of the movable contact member 46 of the selector switch 12. Rotary movement of the sleeve shaft 106 is effected by securing to the Geneva gear 80 for rotary movement therewith a locking member 108, concentric with the shafts 90 and 106, which in turn is keyed to the sleeve shaft 106 by means of keys 110. The function of the locking member 108, which in this instance is secured to the Geneva gear 80 by pins 112, will be described hereinafter.

For the purpose of effecting a rotary movement of the movable contact member 46 on rotation of the sleeve shaft 106, a selector switch actuating arm 114, having a hub 116, is connected between the sleeve shaft 106 and the movable contact member 46 of the selector switch 12. Keys 118 are provided for keying the hub 116 to the sleeve shaft 106 and a bolt 120 is provided for securing the movable contact member 46 to the selector switch actuating arm 114.

Referring to Figs. 2 and 3, the reversing switch 16 comprises a plurality of spaced stationary contact members 122, 124 and 126 which are disposed to be engaged by a movable contact assembly 128. In Fig. 3 only the stationary contact members 122 and 124 are shown in the drawing. As shown in Fig. 3, the movable contact assembly 128 includes movable contact members 130 and 132 which are held in spaced relationship by an electrical conducting bridging member 134. A reversing switch actuating mechanism 136, also responsive to the rotation of the motor 70, is provided for effecting an actuation of the movable contact members 130 and 132 relative to the spaced stationary contact members 122, 124 and 126 of the reversing switch 16.

The mechanical structure of the reversing switch actuating mechanism 136 is shown in Figs. 1, 3 and 4. As shown, the reversing switch actuating mechanism 136 comprises a reversing switch actuating arm 138 which is disposed to pivot about the selector switch actuating shafts 90 and 106; a sector 140 of a Geneva gear having a slot 142 therein and being carried at one end of the switch actuating arm 138, the sector 140 being free to rotate with respect to the switch actuating arm 138 and being disposed to coact with an actuating member 144, including a roller 145 and a shoulder bolt 146, carried by the Geneva gear 80 for rotary movement therewith; the locking member 108 whose locking surface 147 cooperates with either the locking surface 148 or the locking surface 149 of the sector 140 to thus prevent rotation of the sector 140 until the actuating member 144 engages the slot 142 in the sector 140; and a gear train 150 responsive to the rotary movement of the sector 140 and operable to effect a pivotal movement of the reversing switch actuating arm 138.

The reversing switch actuating arm 138 includes an insulating arm 151 constructed of insulating material, one end of which is secured to the bridging member 134 by means of a plurality of bolts and nuts 152 and the other end of which is secured by a bolt and nut 153 to a pivotable gear support member 154 which is free to pivot about the sleeve shaft 106. In order to render the gear train 150 responsive to the rotary movement of the sector 140, a rotatable shaft 158 is fixed to the sector 140 by means of a pin 160, the rotatable shaft 158 being disposed in a passageway in the pivotable member 154 at one end of the switch actuating arm 138.

As shown in Figs. 1 and 4, the gear train 150 comprises a driving spur gear 162 which is fixed to the rotatable shaft 158 by a pin 164; a fixed annular spur gear 166 which is concentric with the switch actuating shafts 90 and 106; and a freely rotatable intermediate spur gear 168 carried by the pivotable member 154 and disposed to mesh with the driving spur gear 162 and the fixed annular spur gear 166, so that on rotation of the rotatable shaft 158 a pivotal movement of the reversing switch actuating arm 138 is effected as will be explained more fully hereinafter in the description of the operation of the apparatus. The fixed annular spur gear 166 is suitably secured to a frame support member 170, the circular-shaped member 72 being secured to the frame support member 170 by means of stud bolts 172 and spacer members 174, the frame support member 170 being held in fixed position relative to space. On the other hand, the intermediate spur gear 168 is carried by the pivotable member 164 by means of a stud shaft 178.

The operation of the tap-changer 10 shown in Figs. 1, 3 and 4 can be more clearly understood by referring to Fig. 2. For instance, the output voltage of the autotransformer 14, as it appears across the load terminals 24 and 24', is at a maximum when the movable contact members 46 and 66 of the selector switch 12 are in electrical contact with the stationary contact members 44 and 64, respectively, and the bridging member 134 of the reversing switch 16 is electrically connected to the stationary contact members 122 and 124. In order to decrease the output voltage of the autotransformer 14, a rotation of the motor 70 is effected so as to turn the pin wheel 76 in a counterclockwise direction to thereby actuate the movable contact member 66 to such a position that it engages the stationary contact member 62. The output voltage of the autotransformer 14 is further decreased by rotating the pin wheel 76 further in the counterclockwise direction to thereby actuate the movable contact member 46 so that it makes electrical contact with the stationary contact member 42. This sequence of positioning of the movable contact members 66 and 46 is continued by rotating the pin wheel 76 in a counterclockwise direction until the movable contact members 66 and 46 are in electrical contact with the stationary contact members 50 and 30, respectively, of the selector switch 12. Up to this position, the turns of the tapped winding 18 add to the turns of the fixed winding 20. Then the pin wheel 76 is rotated further in a counterclockwise direction until the movable contact member 66 makes electrical contact with the stationary contact member 48. This is then the position of the movable contact members 66 and 46 as shown in Figs. 1, 2 and 4.

The specific operation of the mechanism shown in Figs. 1, 3 and 4 will now be described. On further rotation of the pin wheel 76 in a counterclockwise direction the pin 82 engages a slot in the Geneva gear 80 and thus causes a rotary movement of the Geneva gear 80 in the clockwise direction. This in turn causes the roller 145 of the actuating member 144 to enter the slot 142 in the sector 140 and engage the surface defining the slot 142 to thus effect a rotary movement of the sector 140, with respect to the switch actuating arm 138, in a counterclockwise direction. Up until this time, the locking surface 147 of the member 108 has cooperated with the locking surface 148 of the sector 140 to prevent rotation of the sector 140. However, when the position shown in Fig. 3 is reached, the cut-away portion 180 of the locking member 108 permits rotation of the sector 140.

A rotary movement of the sector 140 in a counterclockwise direction effects a rotary movement of the shaft 158 in the same direction, to thus rotate the driving gear 158 in a counterclockwise direction. Such an action effects a rotary movement of the intermediate gear 168 in a clockwise direction. Since the annular gear 166 is

fixed and since the driving gear **162** and the intermediate gear **168** are carried by the reversing switch actuating arm **138**, a rotary movement of the intermediate gear **168** in a clockwise direction effects a pivotal movement of the switch actuating arm **138** in a clockwise direction. As the pin wheel **76** is rotated further in the counterclockwise direction, the sector **140** is rotated further, with respect to the switch actuating arm **138**, in a counterclockwise direction and the switch actuating arm **138** is pivoted further in a clockwise direction until the bridging member **134** of the reversing switch **16** bridges the stationary contact members **124** and **126** of the reversing switch **16** and the movable contact members **130** and **132** are in electrical contact with the stationary contact members **124** and **126**, respectively. When the movable contact members **130** and **132** of the reversing switch **16** are so positioned the sector **140** has been so rotated, with respect to the switch actuating arm **138**, that the roller **145** of the actuating member **144** disengages itself from the slot **142** in the sector **140**. The locking surface **149** of the sector **140** then cooperates with the locking surface **147** of the locking member **108** to prevent rotation of the sector **140**.

At the same time the pin wheel **76** is effecting a pivotal movement of the reversing switch actuating arm **138** in a clockwise direction it is also effecting a rotation of the sleeve shaft **106** in a clockwise direction through the action of the Geneva gear **80** and the locking member **108**. A rotation of the sleeve shaft **106** in a clockwise direction effects a rotary movement of the selector switch actuating arm **14** in a clockwise direction, to thus bring the movable contact member **46** into electrical contact with the stationary contact member **28** of the selector switch **12**.

With the movable contact members **66** and **46** in electrical contact with the stationary contact members **48** and **28**, respectively, the selector switch **12** is in the neutral position and a further rotary movement of the pin wheel **76** in the counterclockwise direction brings the pin **81** into engagement with a slot in the Geneva gear **78** to thus effect a rotary movement of the Geneva gear **78** in the clockwise direction. A rotary movement of the Geneva gear **78** in a clockwise direction effects a rotary movement of the selector switch actuating arm **96** in a clockwise direction, to thus bring the movable contact member **66** into electrical contact with the stationary contact member **64** of the selector switch **12**, to thereby further decrease the output voltage of the autotransformer **14** since the turns of the tapped winding **18** are now bucking the turns of the fixed winding **20**.

The output voltage of the autotransformer **14** continues to decrease as the pin wheel **76** is rotated in a counterclockwise direction until finally the movable contact members **46** and **66** are actuated into engagement with the stationary contact members **30** and **50**, respectively. With the movable contact members **46** and **66** of the selector switch **12** so positioned and with the movable contact members **130** and **132** of the reversing switch **16** in engagement with the stationary contact members **124** and **126**, respectively, the output voltage of the autotransformer **14** is at a minimum.

The output voltage of the autotransformer **14** is then increased by rotating the pin wheel **76** in a clockwise direction to thus effect a sequence of positioning of the movable contact members **46** and **66** until they are brought into engagement with the stationary contact members **28** and **48**, respectively. A further rotation of the pin wheel **76** in a clockwise direction brings the pin **82** into engagement with a slot of the Geneva gear **80** to thus effect a rotary movement of the Geneva gear **80** in a counterclockwise direction. Such an action causes the roller **145** of the actuating member **144** to engage the surface defining the slot **142** in the sector **140**, to thus effect a rotary movement of the sector **140**, with respect to the switch actuating arm **138**, in a clockwise direction. This, in turn, effects a rotary movement of the shaft **158** and the driving gear **162** in a clockwise direction. A rotary movement of the driving gear **162** in a clockwise direction effects a rotary movement of the intermediate gear **168** in a counterclockwise direction, to thereby effect a pivotal movement of the reversing switch actuating arm **138** in a counterclockwise direction, to thus bring the bridging member **134** of the reversing switch **16** to the position shown in the drawings.

At the same time the reversing switch **16** is being actuated to the position shown in the drawings, the rotary movement of the pin wheel **76** in the clockwise direction effects an actuation of the movable contact member **46** into engagement with the stationary contact member **30**. In particular, when the pin **82** of the pin wheel **76** engages the slot of the Geneva gear **80** and effects a rotary movement of the Geneva gear **80** in a counterclockwise direction, the sleeve shaft **106** and the selector switch actuating arm **114** rotate in a counterclockwise direction to thus bring the movable contact member **46** into engagement with the stationary contact member **30**. The output voltage of the autotransformer **14** can then be further increased by rotating the pin wheel **76** further in the clockwise direction until the movable contact members **46** and **66** are again in electrical contact with the stationary contact members **44** and **64**, respectively.

The apparatus embodying the teachings of this invention has several advantages. For instance, the selector switch **12** and the reversing switch **16** are compact and yet have proper electrical clearances. In particular, the creep distance between the bridging member **134** of the reversing switch **16** and the pivotable member **154** is large and the jump distance between adjacent stationary contact members **122** and **124** of the reversing switch **16** and between adjacent stationary contact members **124** and **126** is large. In addition, the slip of the movable contact members **130** and **132** on the stationary contact members **122**, **124** and **126** of the reversing switch **16** can be controlled and be made small and even zero. Therefore, the stationary contact members **122**, **124** and **126** of the reversing switch **16** can be made short and placed side by side as shown in the drawings. Further, since the reversing switch movable contact members **130** and **132** rotate in the same direction as the selector switch movable contacts **46** and **66**, the reversing switch stationary contacts **122**, **124** and **126** can be mounted on the proper selector switch contact posts and thus eliminate all bus work to the reversing switch stationary contact members **122**, **124** and **126**.

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

I claim as my invention:

1. In a transformer tap-changer having a multiple position selector switch and a reversing switch having a pair of spaced stationary contact members and a movable contact member, the combination comprising, a switch actuating shaft operable to effect an actuation of the multiple position selector switch, a Geneva gear operable to effect a rotary movement of the switch actuating shaft, the Geneva gear having an actuating member thereon for rotary movement therewith, means for driving the Geneva gear, a switch actuating arm disposed to pivot about the switch actuating shaft, the movable contact member of the reversing switch being carried at one end of the switch actuating arm for pivotal movement therewith, a sector of a Geneva gear carried at the other end of the switch actuating arm for pivotal movement therewith, said sector being free to rotate with respect to the switch actuating arm and disposed to coact with said actuating member, so that on rotary movement of the said actuating member a rotary movement of the said sector is effected, and a gear train responsive to the rotary movement of the said

sector and operable to effect a pivotal movement of the switch actuating arm, to thus actuate the movable contact member into and out of engagement with the spaced pair of stationary contact members.

2. In a transformer tap-changer having a multiple position selector switch and a reversing switch having a pair of spaced stationary contact members and a movable contact member, the combination comprising, a switch actuating shaft operable to effect an actuation of the multiple position selector switch, a Geneva gear operable to effect a rotary movement of the switch actuating shaft, the Geneva gear having an actuating member thereon for rotary movement therewith, means for driving the Geneva gear, a switch actuating arm disposed to pivot about the switch actuating shaft, the movable contact member of the reversing switch being carried at one end of the switch actuating arm for pivotal movement therewith, a rotatable shaft disposed on the other end of the switch actuating arm, a sector of a Geneva gear fixed to one end of said rotatable shaft, said sector being disposed to be actuated by said actuating member to thus effect a rotary movement of the said rotatable shaft, a driving gear fixed to the other end of the said rotatable shaft, a fixed annular gear concentric with the switch actuating shaft, and a freely rotatable intermediate gear carried by the switch actuating arm and disposed to mesh with the driving gear and the fixed annular gear, so that on rotation of the said rotatable shaft a pivotal movement of the switch actuating arm is effected, to thus actuate the movable contact member relative to the spaced stationary contact members.

3. In a transformer tap-changer having a multiple position selector switch and a reversing switch having a pair of spaced stationary contact members and a movable contact member, the combination comprising, a switch actuating shaft operable to effect an actuation of the multiple position selector switch, a Geneva gear operable to effect a rotary movement of the switch actuating shaft, the Geneva gear having a roller carried thereby for rotary movement therewith, means for driving the Geneva gear, a switch actuating arm disposed to pivot about the switch actuating shaft, the movable contact member of the reversing switch being carried at one end of the switch actuating arm for pivotal movement therewith, a rotatable shaft disposed on the other end of the switch actuating arm, a sector of a Geneva gear having a slot therein and being fixed to one end of said rotatable shaft, the surface defining the slot in said sector being disposed to be engaged by said roller to thus effect a rotary movement of the said rotatable shaft, a locking member concentric with the switch actuating shaft for preventing movement of the said sector until the said roller engages the surface defining the slot in the said sector, a driving gear fixed to the other end of the said rotatable shaft, a fixed annular gear concentric with the switch actuating shaft, and a freely rotatable intermediate gear carried by the switch actuating arm and disposed to mesh with the driving gear and the fixed annular gear, so that on rotation of the said rotatable shaft a pivotal movement of the switch actuating arm is effected, to thus actuate the movable contact member relative to the spaced stationary contact members.

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