Aug. 12, 1958 O. P. McCARTY ET AL 2,847,541

DOUBLE BREAK LIQUID BLAST CONTACTOR

Filed Oct. 24, 1955 4 Sheets-Sheet 1

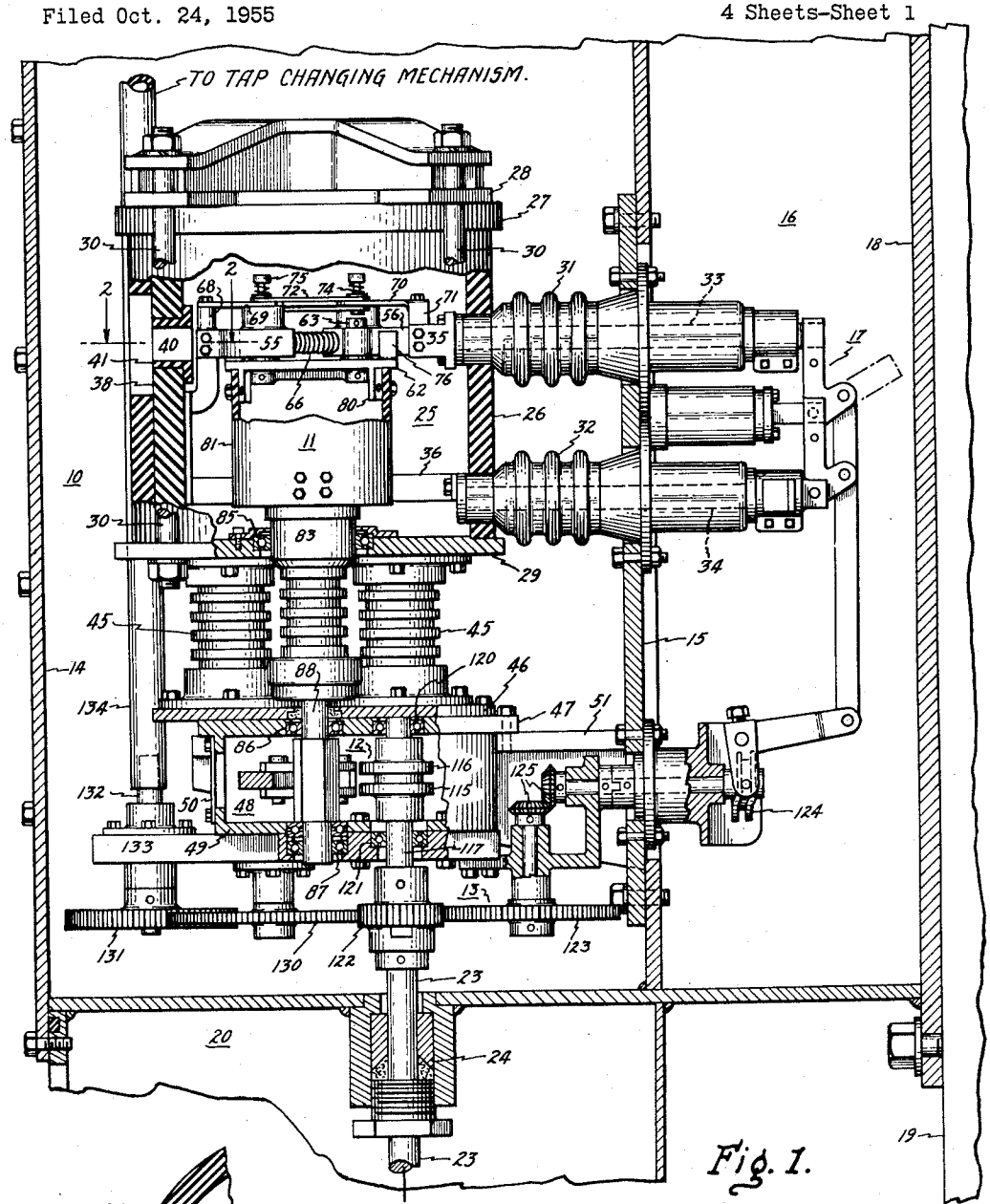


Fig. 1.

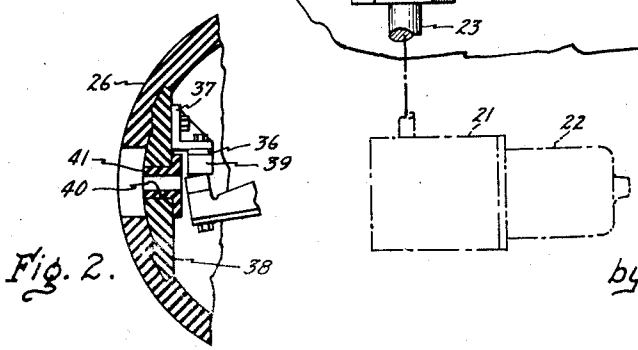


Fig. 2.

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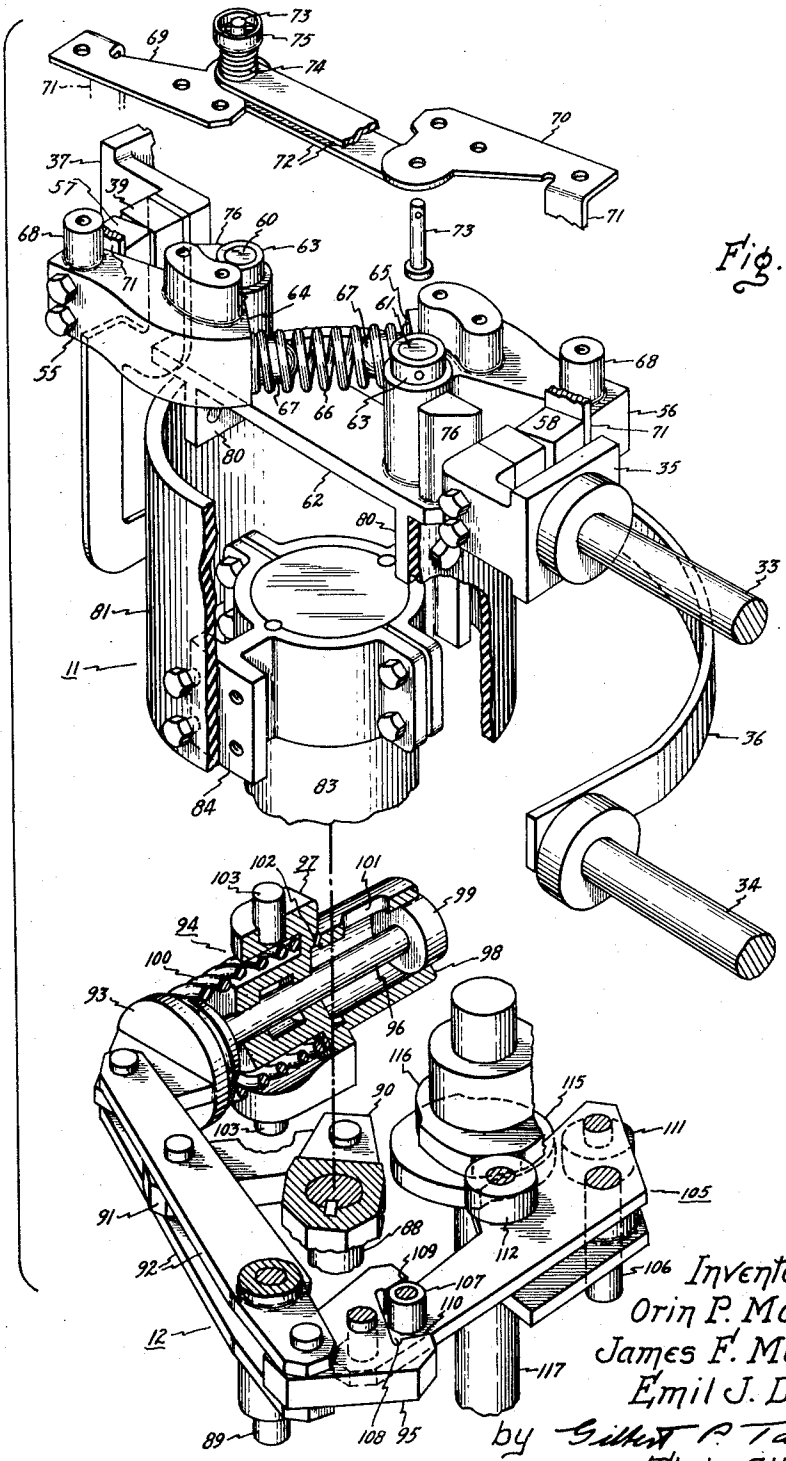


Fig. 3.

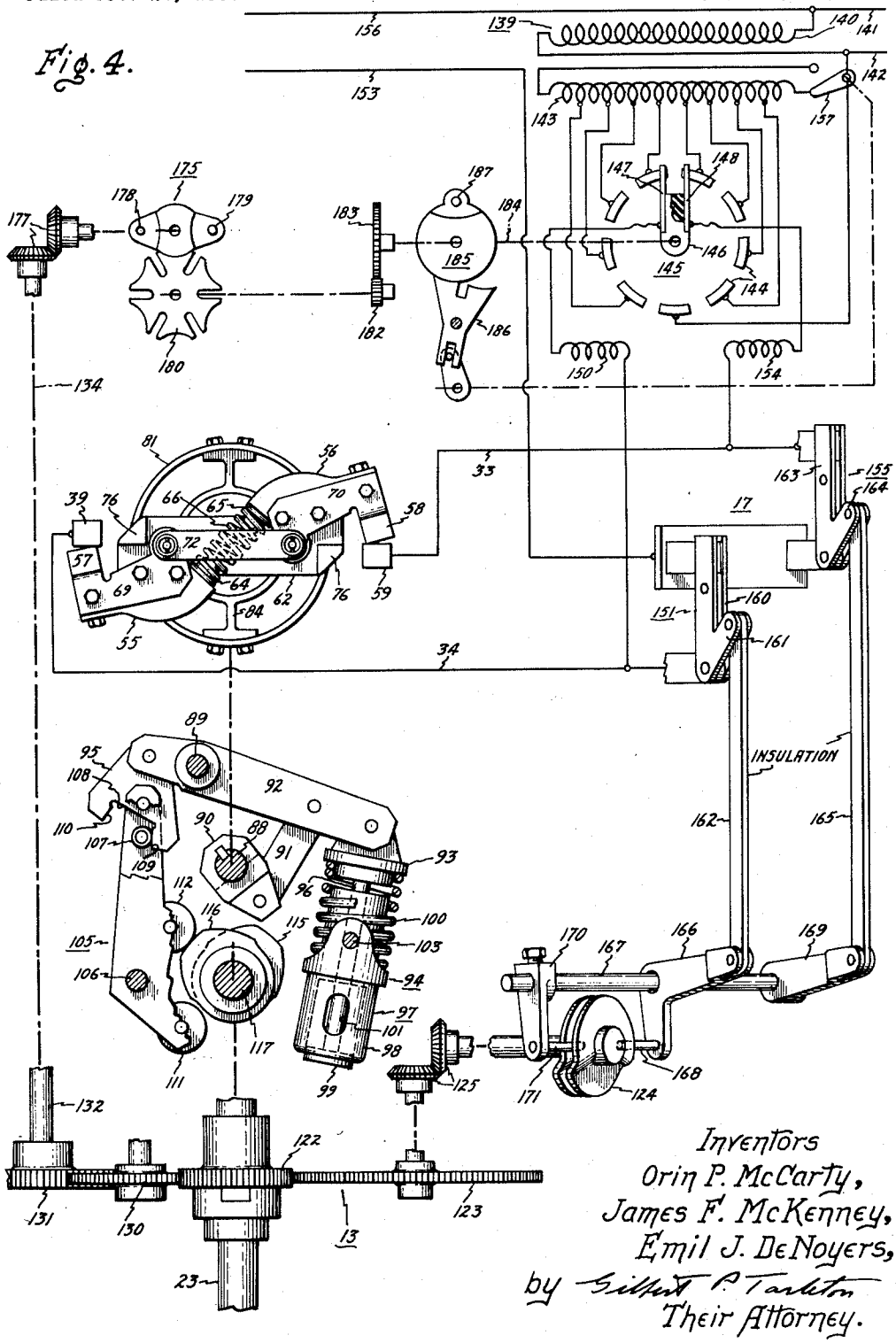
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Fig. 4.



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DOUBLE BREAK LIQUID BLAST CONTACTOR

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Fig. 5.

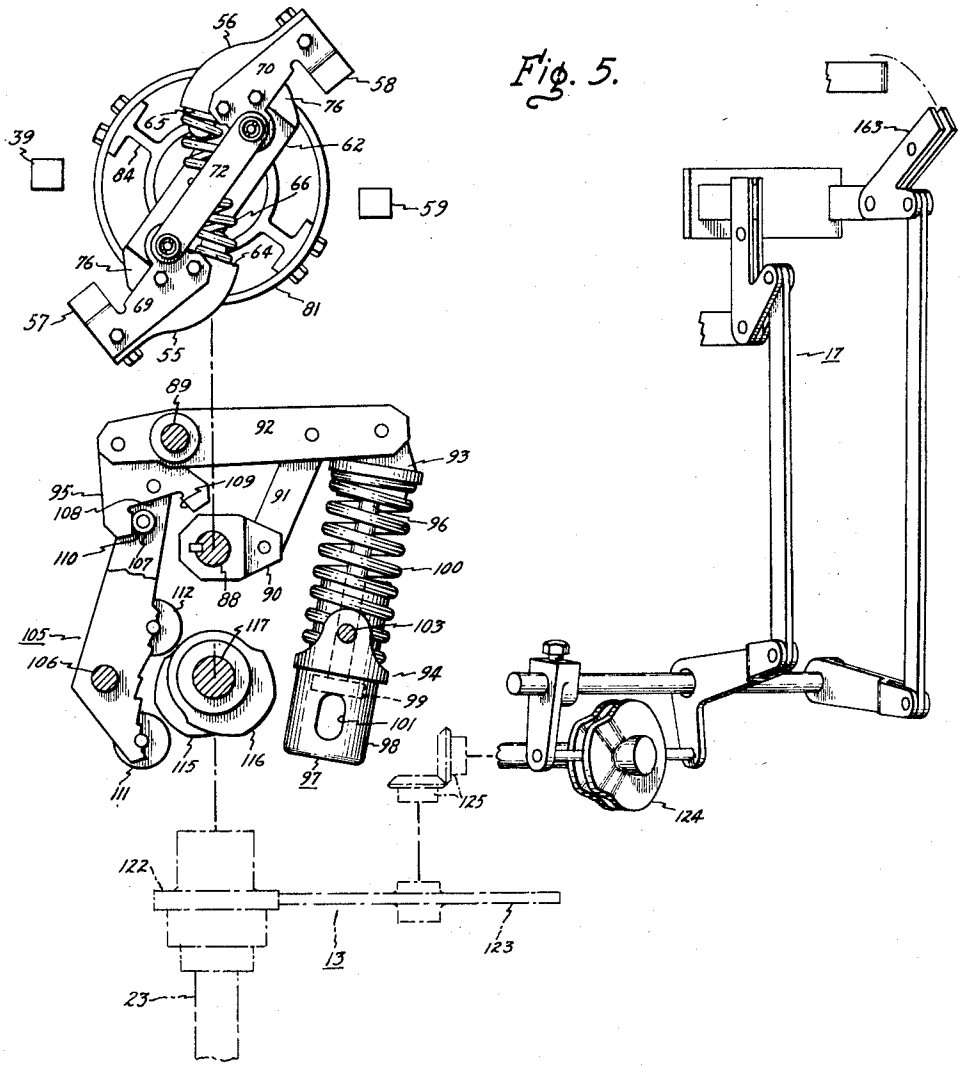
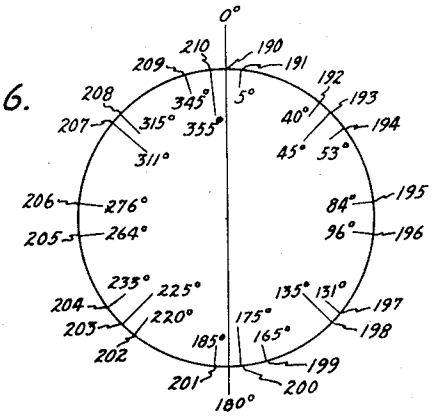


Fig. 6.



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United States Patent Office

2,847,541

Patented Aug. 12, 1958

2,847,541

DOUBLE BREAK LIQUID BLAST CONTACTOR

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Application October 24, 1955, Serial No. 542,158

19 Claims. (Cl. 200—150)

This invention relates to means for interrupting electrical currents, and more in particular to an improved liquid blast contactor characterized by long contact tip life even when employed to interrupt electrical currents of great magnitude.

In the past, electrical contactors have been developed to interrupt alternating current in electrical equipment, such as load tap changing transformers, rated as high as about 125,000 kilovolt amperes for long periods of time without maintenance. The difficulties encountered, however, have in general prevented extending the use of such contactors to equipment with higher ratings, even though the tendency at present is to increase the capacity of electrical equipment. In load tap changing transformer systems for example, the contactors must be capable of making and breaking full load current many times in carbonized oil without contact tip or insulation maintenance. It is also required that the contactors have suitable overload capacity to complete a tap change during a short circuit on the transformer. The mechanical construction of the contactor must be capable of withstanding several million operations without maintenance, so as to perform satisfactorily for the approximate 30 years or more of estimated life of the transformer.

In a liquid blast type of contactor, the arc between a pair of contacts is extinguished by means of a stream of dielectric liquid such as oil being forced across the contacts to lengthen the arc until it is finally extinguished. In this type of contactor, the liquid stream is usually generated by means of pressure being built up in liquid filled chamber or chambers containing the contacts and due to an electrical arc therein, the liquid thereby being forced out of the chamber through suitable apertures and past the contacts.

In one type of such contactor, movable contacts are given a linear motion within the dielectric liquid filled chamber to separate them from stationary contacts, thereby resulting in a change in the internal volume of the chamber. This arrangement results in the tendency for liquid to be sucked into the chamber through the apertures by means of a piston action at the time when the pressure is being built up within the chamber for the purpose of expelling liquid from the chamber through the apertures, and thereby the desired pressure build-up is partly neutralized.

It is therefore an object of this invention to provide an improved contactor for interrupting electrical current.

Another object of this invention is to provide a rugged dielectric liquid blast contactor capable of satisfactory operation in interrupting the full load current of electrical equipment rated as high as about 450,000 kilovolt amperes.

Still another object of this invention is to provide an improved liquid blast contactor for use on electrical equipment rated as high as about 450,000 kilovolt amperes, such as on load tap changing transformers, without requiring maintenance during the estimated life of the equipment, and capable of handling the overload currents of such equipment such as may result from short circuit conditions.

Briefly stated, in accordance with the preferred embodiment of this invention, we provide an electrical contactor comprised of a pair of rotatable contacts mounted for rotation about a common axis by means of an insulating shaft. A pair of stationary electrical contacts are disposed in the path of the rotatable contacts, the rotatable contacts being preferably adapted for rotational movement in a plane perpendicular to the axis of the insulating shaft. A pair of pivot pins are provided on the insulating shaft, and the rotatable contacts are mounted on these pins for rotation about axes parallel to the axis of the insulating shaft. Resilient means are provided between the rotatable contacts to bias the rotatable contacts in the same direction about their respective pivot pins in order to provide wiping action between the contacts, and also to provide the desired contact pressure between the contacts. Means are also provided to rotate the insulating shaft through a predetermined angle to effect the rapid separation of the contacts, and the less rapid contacting of the contacts after the separation thereof.

The contactor is preferably disposed in a substantially enclosed dielectric liquid filled chamber having an aperture extending therethrough adjacent one of the stationary contacts, in order that pressures generated within the chamber by arcing at the contacts results in an expulsion of the liquid from the chamber through the aperture and past one of the arcing contacts, thereby resulting in lengthening of the arc. This type of contactor has been found to be suitable for interrupting currents of electrical equipment rated as high as about 450,000 kilovolt amperes with a single pair of contacts. The arrangement also provides rapidly very large contact gaps or separations with relatively small angular motions of the insulating shaft, and without a change in the internal volume of the cylinder.

This invention also provides a tripping mechanism operable upon either clockwise or counterclockwise rotation of a motor drive shaft to provide an accelerated angular movement of the insulating shaft through a predetermined angle of rotation during the separation of the rotary end fixed contacts. The tripping mechanism is comprised of a wind-up cam rotated by the motor drive to depress a helical spring by means of suitable levers. A toggle arrangement is employed to hold the spring depressed until the toggle is tripped by means of a tripping cam also rotated by the drive shaft. Upon tripping of the toggle, the spring expands rapidly, and this rapid linear motion is transmitted by means of suitable mechanical links to provide a rapid rotary motion through a predetermined angle for the insulating shaft.

This 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.

In the drawing:

Fig. 1 is a partially sectional view of the liquid blast contactor and toggle mechanism of this invention in combination with a typical transfer switch assembly of a load tap changing transformer,

Fig. 2 is a partially sectional view taken along the lines 2—2 of Fig. 1 and illustrating the contact tips of the contactor of Fig. 1,

Fig. 3 is an exploded perspective view of the contactor and tripping mechanisms of the contactor of Fig. 1 with the contacts closed, and the tripping mechanism in position ready to be tripped to open the contacts,

Fig. 4 is a diagrammatic representation of the contacts and tripping mechanism in position ready to trip, and including a circuit diagram of a typical load tap changing transformer system connected to the contactor,

Fig. 5 is a diagrammatic representation of the contacts and cam and toggle mechanism with the mechanism tripped and the contacts open, and

Fig. 6 is a sequence diagram of the operations of the system of Fig. 4.

Referring now to the drawings and more in particular to Fig. 1, therein is illustrated a contactor arrangement comprised of a chamber **10** filled with a dielectric liquid such as oil and enclosing a contactor assembly denoted generally by the numeral **11**, a tripping mechanism denoted generally by the numeral **12**, and a gear assembly denoted generally by the numeral **13**. The chamber **10** has a removable front cover **14** and a rear wall **15**. Immediately behind the rear wall **15** of the chamber **10** is a second chamber **16** filled with a dielectric liquid such as oil and containing a transfer switch assembly **17** and an operating mechanism to be explained in more detail later. The second chamber **16** has a rear wall **18** which may be bolted onto the wall **19** of a load tap changing transformer, or the entire above-described assembly may be enclosed within the tank of the transformer. Immediately below the chamber **10** is another chamber **20** containing a conventional motor drive, consisting of a gear reduction **21** and a motor **22** and a drive shaft **23** extends upwardly from the gear reduction **21** through a packing gland assembly **24** and into the chamber **10**.

The contactor assembly **11** is enclosed in a chamber **25** filled with a dielectric liquid such as oil and having walls comprised of a hollow tube or cylinder **26** of an insulating material, a circular chamber cover **27** also made of an insulation material, and top and bottom press plates **28** and **29** respectively. The press plates are metallic, and are preferably reinforced. (In the drawing only the top press plate **28** is illustrated as being reinforced.) A plurality of tie rods **30** extend between the press plates and are bolted thereto by conventional means. The above-described members enclosing the chamber **25** must have sufficient mechanical strength to withstand the pressures generated within the chamber **25**.

A pair of high voltage bushings **31** and **32** extending between the hollow tube **26** and the transfer switch assembly **17** and through the rear wall **15** have central conductors **33** and **34** respectively. The conductor **33** is connected directly to one contact tip support **35** rigidly mounted within the chamber **25** on the wall of the tube **26**, and the other conductor **34** is connected to a conductor **36** extending circumferentially around the inner wall of the chamber **25** and thence upwardly to a second contact tip support **37** (see Fig. 2) rigidly mounted on the diametrically opposite wall of the chamber **25** as the support **35**. As may be more clearly seen in Fig. 2, the contact tip support **37** is mounted upon an insulating plate **38** which is firmly held in grooves machined in the side of hollow tube **26**. The contact tip support **37** is provided with a stationary contact tip **30**, and an aperture **40** is provided extending through the hollow tube **26** and insulating plate **38** adjacent the contact tip **39** to provide a passage communicating with the chambers **10** and **25**. The aperture **40** in the insulating plate **38** may be lined with a fibrous insulating material **41** that is characterized by gasification upon contact with an electric arc, in order that the aperture remains free from the carbonized deposits which might otherwise occur due to the discharge of hot fluids therethrough.

Referring again to Fig. 1, the chamber **25** is mounted on a plurality of insulating support members **45** which extend between a metallic plate **46** and the bottom press plate **29**. The plate **46** is mounted on the top plate **47** of a compartment **48** enclosing the tripping assembly **12**. The compartment **48** has a bottom plate **49** and a removable front cover **50** and is suitably sealed to prevent carbonized oil from the contactor chamber from damaging the finely machined parts therein. The plate **47** is mounted upon a plurality of support brackets **51**, of which only one is illustrated in Fig. 1, which are in turn supported by the rear wall **15** of chamber **10**.

Referring now to Figs. 1 and 3, the contactor assembly is comprised of a pair of pivoted contact arms **55** and **56** respectively, which are preferably made of aluminum in order to reduce the inertia of the movable assembly. The contact arms **55** and **56** have contact tips **57** and **58** respectively which contact the stationary contact tip **39** on tip support **37** and the stationary contact tip **59** on tip support **35** respectively. The contact arms **55** and **56** are pivotally mounted on a pair of pins **60** and **61** respectively which extend parallel to the longitudinal axis of the chamber **25** and are rigidly affixed to a rotor plate **62**. Collars **63** pinned to the pins **60** and **61** prevent vertical movement of the contact arms. Contact arms **55** and **56** are provided with faces **64** and **65** respectively facing the axis of the chamber **25**, and a helically wound compression spring **66** is provided extending between these faces. Bosses **67** on the faces **64** and **65** serve to retain the spring **66** in place. The spring **66** biases the contact arms **55** and **56** in the same direction about their respective pivots in order to provide the desired contact tip pressure, and also to provide a wiping action at the contact tips as will be described in greater detail in the following paragraphs. A plurality of bosses **68** are provided extending from the upper surface of the contact arms, and copper connector plates **69** and **70** are fastened to the contacts arms **55** and **56** respectively by means of bolts screwed into threaded holes in the bosses **68**. Each of the connector plates has a lug **71** which extends downwardly and is sandwiched between the respective contact tip and contact arm. A pair of copper shunt members **72** are provided pivotally mounted between the copper plates **69** and **70** respectively in order to provide positive electrical connection between the copper plates. The pivotal connection between the copper plates and shunts is comprised of pins **73** passing through holes in the copper plates and copper shunts, and springs **74** held in compression between the upper shunt member **72** and collars **75** held on the upper ends of the pin **73**. The copper plates **69** and **70** and the copper shunts **72** provide a positive electrical connection between the movable contact tips **57** and **58**. A pair of upwardly extending stop members **76** are firmly affixed to the rotor plate **62** to limit the angular displacement of the contact arms about their respective axis when the contacts are open, and the stop members are so positioned that the initial contact made between the contact tips upon closure of the contacts is accomplished with the respective stationary and movable contact tips being in substantially complete contact with each other.

The rotor plate **62** is provided with a pair of downwardly extending lugs **80** and these lugs are rigidly affixed to a hollow cylindrical rotor made of an insulating material and adapted for rotation about a vertical axis. The rotor plate **62** thus extends in a horizontal plane across the top of the rotor **81**. A rotatable insulating shaft **83** is provided extending downwardly from the rotor **81** and a short distance into the lower portion of the rotor **81**, having the same axis as the rotor **81**. A rotor support means **84** is provided extending between the upper portion of the shaft **83** and the lower portion of the inner wall of the rotor **81**. The rotor support means **84** is bolted to the rotor **81** and suitably affixed to the shaft **83** so that upon rotation of the shaft, the contactor assembly will also rotate.

As may be more clearly seen in Fig. 1, the insulating shaft **83** extends downwardly through a bearing **85** in the bottom press plate **29** of the chamber **25**, and thence downwardly through packing in the plate **46** and a bearing **86** in the plate **47** and also downwardly through the chamber **48** to a bearing assembly **87** in the bottom plate of the chamber **48**. The portion of the shaft **83** extending between the press plate **29** and the plate **46** may be grooved in order to provide additional electrical creepage. The portion **88** of the shaft **83** passing through the plates **46**, **47** and **49** and the chamber **43** may have a reduced diameter, and for additional strength and ease

of fabrication the lower portion 88 of the shaft 33 may be of a metallic material.

The tripping assembly 12, which may be more clearly seen in Fig. 3, is comprised of a main finger link 90 having one end keyed to the shaft 88. The other end of the main finger link 90 is pivotally attached to one end of a short finger link 91. The other end of the finger link 91 is pivotally attached between a pair of parallel lever arms 92. One end of each of the lever arms 92 is pivotally attached to the head 93 of a dashpot assembly 94, the other ends of the lever arms 92 are pivotally attached to a toggle link and stop plate 95. The lever arms 92 are pivotally mounted upon a stationary axis 89 located intermediate of the pivotal connection with the toggle link and stop plate 95 and the pivotal connection with the finger link 91.

The dashpot assembly 94 is comprised of the head 93, which is pivotally attached to the levers 92 on one side thereof, and a stud 96 which is rigidly affixed to and extends from the other side of the head 93. The stud extends through an aperture in a body member 97, and thence into the cylinder 98. A piston 99, slidably positioned within the cylinder 98, is rigidly mounted to the end of the stud 96. A helical spring 100 is positioned surrounding the stud 96 between the head 93 and the body member 97, the spring being in compression so that it tends to force the head 93 away from the body 97. A slot 101 is provided in the side of the cylinder, in the central portion of the movement of the piston 99, and a vent 102 of predetermined size is positioned in the wall of the cylinder 98 toward the body 97 and beyond the furthest movement of the piston 99 toward the body 97. The vent 102 and the slot 101 in the wall of the cylinder provide free movement for the piston 99 for all positions thereof except when the spring 100 is substantially fully extended, or in other words the retarding action of the dash pot 94 occurs only when the head 93 is in the region of its further position from the body 97. The dash pot assembly 94 is provided with a pair of studs 103 extending in opposite directions from the body and on an axis perpendicular to the longitudinal axis of the dashpot assembly, and the dashpot is pivotally mounted by the studs 103 for rotation about a stationary axis.

The toggle link and stop plate 95 is also pivotally attached to one end of a cam lever assembly 105, and the cam lever assembly is mounted for rotation about a fixed axis on a pivot shaft 106. The cam lever assembly 105 is provided with a projection 107 which extends into an aperture 108 in the toggle link and stop plate 95. The toggle link and stop plate have two stop faces 109 and 110 in the aperture 108 and adapted to separately engage the projection 107. The cam lever assembly 105 also has mounted thereon a trip cam roller 111 and a wind-up cam roller 112 mounted to cooperate with a trip cam 115 and a wind-up cam 116 respectively mounted on a cam shaft 117.

Referring once again to Fig. 1, the cam shaft 117 is mounted for rotation in bearings 120 and 121 in the plate 47 and 49 respectively, and the cam shaft extends downwardly through the bottom plate 49 of the chamber 48. The cam shaft 117 and the drive shaft 23 are pinned in opposite hubs of a pinion gear 122. A second gear 123 is mounted for rotation with the gear 122, and angular motion of the gear 123 is transmitted to a transfer switch cam 124 in the transfer switch chamber 16 by way of bevel gears 125. The transfer switch cam 124 is connected by means of suitable levers, as will be described in more detail in the following paragraphs, to operate the transfer switch assembly 17.

Another gear 130 is also mounted for rotation with gear 122, and the gear 130 is mounted to rotate still another gear 131. The gear 131 is pinned to a shaft 132 which extends upwardly through a bearing in support member 133, and the shaft 132 is connected to a tap changing mechanism shaft 134 which extends upwardly beyond the contactor mechanism to a tap changing mechanism (not shown in Fig. 1) located above the chamber 10.

Referring now to Fig. 4, therein is illustrated a circuit diagram of a typical tap changing transformer system in combination with a diagrammatic representation of the contactor and tripping assemblies of this invention. A load tap changing transformer 139 is therein illustrated having a shunt winding 140, connected across a pair of power lines 141 and 142, and a tapped series winding 143. Each of the taps of the series winding 143 is connected to a separate segment or contact shelf 144 of a tap switch 145, which in the illustration of Fig. 4 has nine such segments. The tap switch 145 is provided with an insulated rotor 146 having two circumferentially separated contact fingers 147 and 148. The fingers 147 and 148 and the segments 144 are arranged such that in one tap position (as shown in Fig. 4) the fingers will contact adjacent segments, and in the next adjacent tap position in either direction of rotation of the rotor 146, the fingers will both contact the same segment. For the sake of nomenclature, a full tap change is to be considered a tap change wherein both fingers move from a position in which they are both contacting one segment to a position where both of the fingers contact the next adjacent segment, or wherein the fingers move from a position in which they contact adjacent segments to the next adjacent position in which they contact adjacent segments, and a half tap change is to be considered that change occurring when both of the fingers change from a position where they occupy the same segment to a position where they contact adjacent segments, or vice versa. The contact finger 147 is connected by way of reactor 150 and transfer switch 151 to power line 153, and the finger 148 is connected by way of reactor 154 and transfer switch 155 to power line 153. Power line 156 is connected directly to power line 141. The power line 142 is connected to one end of the series winding 143, depending upon the position of reversing switch 157. The contactor circuit comprised of conductor 33, contact tip 59, contact tip 58, copper plate 70, copper shunt 72, copper plate 69, contact tip 57, contact tip 39, and conductor 34, is connected in series with the transfer switches 151 and 155. Stated in another manner, the contactor circuit, and transfer switches are connected in series to form a loop circuit, with the junction of the transfer switches being connected to the power line 153, the junction between transfer switch 151 and the contactor circuit being connected to reactor 50 and finger 147, and the junction between transfer switch 155 and the contactor circuit being connected to finger 148 by way of reactor 154.

The transfer switch 151 is comprised of a conducting blade 160 for bridging the two stationary contacts and is pivotally connected to one of the stationary contacts. The blade 160 is provided with an extension 161 to which one end of an insulating link 162 is pivotally attached. The stationary contacts, blade, and extension, are arranged such that substantially linear motion of the lever 162 results in angular motion of the blade 160 about its pivot to open and close the switch 151. Similarly the transfer switch 155 is provided with a blade 163 having an extension 164 pivoted to one end of an insulating link 165. The other end of the link 162 is pivotally connected to one end of a lever arm 166 adapted for free pivotal movement about a shaft 167, and the other end of the lever arm 166 is provided with a pin 168 extending into the cam track of transfer switch cam 124. The other end of insulating link 165 is connected to one end of the link 169, and the other end of the link 169 is keyed to the shaft 167 for rotation thereabout. An arm 170 also connected for rotation with shaft 167 has a pin 171 riding in the cam track of transfer switch cam 124. The

operating mechanism for the transfer switches is so arranged, and the cam **124** is fabricated such that during a complete revolution or rotation of the cam **124** about its axis each of the transfer switches **151** and **155** will have opened and closed once. For example, in a preferred sequence of operation commencing with the position of the switches as illustrated in Fig. 4, during the first 5° of clockwise rotation of the cam **124**, both of the transfer switches will remain closed. During the next 35° of rotation of cam **124**, the transfer switch **155** will be opening, and during the next 100° of rotation the transfer switch **155** will remain completely open. For the next 35° of rotation the transfer switch **155** will be closing and during the next 10° of rotation of the cam both of the transfer switches will be closed. For the following 35° of rotation of the cam **124** the transfer switch **155** will be opening, during the next 100° of rotation of the cam the transfer switch **151** will remain fully open, during the next 35° of rotation of the cam the transfer switch **151** will be closing, and during the remaining 5° of complete revolution of cam **124** both of the transfer switches will remain closed. The gears **122** and **123** have such a ratio that a single revolution of the cam shaft **117** of the cam and toggle assembly corresponds to one half of a revolution of the cam **124**.

Still referring to Fig. 4, the shaft **134** is connected to rotate a Geneva gear driver **175** by way of bevel gears **177**. The Geneva gear driver **175** has driver pins **178** and **179** respectively positioned to effect the rotation of Geneva gear **180**. The Geneva gear **180** is connected to a pinion gear **182**. The pinion gear **182** is coupled to another gear **183** which is connected by shaft means **184** to provide angular movement for the rotor **146** of tap switch **145**. In the arrangement as illustrated in Fig. 4, the Geneva gear **180** has six segments, the pins of the Geneva driver **175** are disposed 180° apart, and the gears **182** and **183** have a ratio of 1:3. Each 180° of rotation of the shaft **134** results in the turning of the Geneva gear through one segment or 60°, and therefore results in the turning of the pinion gear **182** through 60° and the gear **183** through 20°. An angular displacement of 20° on the gear **183** results in a half tap change being made on the tap changing switch **145**, and therefore a full turn of the shaft **134** results in a full tap change on the tap changing switch **145**. The shaft **184** is also connected to a Geneva driver **185**, and the Geneva driver **185** is positioned to cooperate with a Geneva segment **186**. The Geneva segment **186** is coupled by suitable mechanical links to the reversing switch **157**, and the pin **187** of the Geneva driver **185** is so positioned that the reversing switch is actuated to reverse the series winding **143** as the tap switch **145** passes through a neutral position (i. e., when none of the series windings is present between the power lines **142** and **153**).

In Fig. 4 the tripping mechanism **12** is illustrated in cocked position and ready to be tripped. Rotation of the wind-up cam **116**, in either direction, has previously caused the cam lever assembly **105** to be rotated in a counterclockwise direction about its pivot **106**, the force on the cam lever assembly being exerted by means of the wind-up cam roller **112**. The clockwise movement of the cam lever assembly has caused the toggle link **95** to rotate in a generally clockwise direction until the stop face **109** rests against the projection **107** on the cam lever assembly. At this time the pivotal axis between the cam lever assembly **105** and the toggle link **95** is located to the left of a hypothetical line extending from the center of the axis of the pivot between the toggle link **95** and the lever **92**, and the axis **106** of the cam lever assembly and the accelerating spring **100** is compressed. The force of the spring **100** tending to provide counterclockwise rotation of the levers **92** about the axis **93** results in the stop face **109** being firmly held against the projection **107** to prevent any rotational movement of the lever **92**. The wind-up and trip cams **116** and **115** respectively, and their respective cam rollers **112** and **111** are positioned such that substantially 180° of rotation of the cam shaft **117** in either direction separates the position at which the wind-up cam roller **112** rides on the highest peak of the wind-up cam **116** and the position at which the trip cam roller **111** rides on the highest peak of the trip cam **115**. This arrangement permits identical action of the trip mechanism regardless of the direction of rotation of the cam shaft **117**. Although the peaks of the two cams are angularly separated with respect to their respective cam rollers by 180°, the functions of the cams are preferably completed before the rollers contact the highest point of the respective cams in order that the operation of the contactors may be properly synchronized with the other switching functions in the load tap changing transformer system (as will be disclosed in more detail in the following paragraphs). Upon rotation of the cam shaft **117** from the position illustrated in Fig. 4, after a predetermined angle of rotation, the trip cam roller **111** will begin to ride on the projection of trip cam **115**, thereby resulting in the cam lever assembly **105** being forced in a clockwise direction about its axis **106** against the force exerted on the projection **107** by the stop face **109**. When the cam lever assembly **105** has been forced thusly a sufficient distance for the pivotal axis between the toggle link **95** and the cam lever assembly **105** to pass to the right of the hypothetical line between the axis **106** of the cam lever assembly and the pivotal axis between the toggle link **95** and the lever **92**, the compressive force of the accelerating spring **100** is released, thereby resulting in rapid counterclockwise rotational movement of the lever **92** until the stop face **110** of the toggle link **95** rests against the projection **107** of the cam lever assembly **105**. The resultant position of the various levers of the tripping mechanism at this time is illustrated in Fig. 5. The rapid counterclockwise rotational movement of the lever **92** has resulted in similar rapid counterclockwise rotation of the shaft **88** through a predetermined angle by means of the main finger link **90** and the finger link **91**. Due to the action of the piston and cylinder arrangement of the dashpot assembly **94**, the terminal portions of the angular movement of the shaft **88** is somewhat retarded in order to prevent excessive stresses being placed upon the members of the tripping mechanism and contactor assembly. The amount of retarding is controlled by the size of the aperture **102** (Fig. 3) in the cylinder wall of the dashpot assembly **94**.

Upon further rotation of the cam shaft **117**, the wind-up cam roller **112** will again ride on the projection of the wind-up cam **116** thereby resulting in the cam lever assembly **105** being forced in a counterclockwise direction about its pivot **106** against the force of the stop plate **110** bearing against the projection **107**. This movement results in the clockwise rotation of the lever **92** about its axis **93**, and therefore in the compressing of the spring **100** and the clockwise rotation of the shaft **88** by means of the main finger **90**. The compressing of spring **100** continues until the wind-up cam has forced the cam lever assembly **105** sufficiently in a counterclockwise direction about its axis **106** that the axis of the pivot between the cam lever assembly and the toggle link is to the left of the hypothetical line between the pivotal axis **106** of the cam lever assembly and the pivotal axis between the toggle link **95** and the lever **92**. At this time, by means of toggle action of the toggle **95** and the cam lever assembly **105**, the spring **100** will expand slightly to force the lever **92** in a counterclockwise direction until the stop face **109** bears against the projection **107** on the cam lever assembly. At this time the members of the tripping mechanism **12** are once again in the position illustrated in Fig. 4. A full revolution of the cam shaft **117** is required in order to complete a full cycle of winding up and tripping of the tripping mechanism. The tripping mechanism provides

a rapid rotation of the shaft **88** through a predetermined angle separated from a relatively slow rotation of the shaft **88** in the reverse direction through the same predetermined angle.

In the fully closed position of the contactor mechanism **11**, as illustrated in Fig. 4, only the radially inward edges of the movable contact tips **57** and **58** contact their respective stationary contact tips **39** and **59**. The movable contact tips are held in position against the stationary contact tips by means of the force exerted on the contact arms **55** and **56** by the spring **66** tending to force the contact arms **55** and **56** in a clockwise direction about their respective pivotal axis. Upon counterclockwise rotation of the insulating rotor tube **81**, caused by the rapid rotation of shaft **88**, the rotor plate **62** also rotates in a counterclockwise direction until the projections **76** thereon engage the sides of the contact arms **55** and **56**. During this time the movement of the pivot pins of the contact arms, which are affixed to the rotor plate **62**, have permitted clockwise rotation of the contact arms about their respective axis due to expansion of the spring **66**. This movement of the contact arms results in a wiping action at the contact tips, and continues until the projections **76** contact the sides of the contact arms **55** and **56**, at which time the contact faces of the respective stationary and movable contact tips are preferably substantially parallel and in full contact with each other. Further counterclockwise rotational movement of the insulating rotor **81** results in the movable contact tips **57** and **58** being held stationary with respect to the movable contact assembly due to the action of the projection **76**, and the entire movable contactor assembly being rotated to cause a separation of the movable contact tips from the stationary contact tips. This rotational movement continues until a desired separation between the contact tips has been attained as determined by the magnitude of the predetermined angle of rotation of the shaft **88**. At this time the relative position of the members of the contactor assembly will be illustrated in Fig. 5. It is noted that in this position the contact arms **55** and **56** are being forced in a clockwise direction in about their respective axis against the projection **76** by means of the spring **66**.

In the closing of the contactor, the rotor **81** rotates relatively slowly in a clockwise direction, and a contactor assembly rotates with its members remaining stationary with respect thereto until the contact tips just meet the stationary contact tips. The rotor **81** continues to rotate for a slight angular displacement beyond the position where the contacts just meet, however, and this additional movement results in a counterclockwise movement of the contact arms **55** and **56** about their respective pivotal axis against the forces exerted thereon by the spring **66**. This movement of the contact arms results in a wiping action at the contact tips, and the radial outermost edges of the tips are separated when the rotor comes to rest in the position illustrated in Fig. 4. When the container is closed, positive electrical connection between the stationary contacts **39** and **59** is assured by means of copper plates **69** and **70** which are connected directly to the movable contact tips **57** and **58** respectively, and connected together by means of the copper shunt **72**. As has been stated previously, the contact arms **55** and **56** are preferably made of aluminum to reduce the inertia of the moving assembly.

The operation of the contactor mechanism and tripping mechanism of this invention may be more easily understood by reference to the sequence diagram of Fig. 6. This diagram represents the occurrence of events in the sequence of operation of the apparatus in terms of the angular displacement of either the gear **123** or the gear **131** from the position illustrated in Fig. 4. Since a full rotation of the gear **131** corresponds to a full tap change on the tap changing switch, and a full rotation of the gear **123** corresponds to a full sequence of operation of the transfer switch mechanism, the cam shaft **117** will have rotated through 720° for each revolution of the gears **123** or **131** since two complete cycles of the contacting mechanism are required for each full tap change. In other words the ratio of teeth of the gears **131** to **122**, and **123** to **122**, is 2:1.

Referring now to Fig. 6, at the displacement **190** of zero degrees the various components will have the position as indicated in Fig. 4. At the displacement **191** of 5°, the transformer switch **155** will start to open, and at the displacement **192** of 40° the transfer switch **155** will be completely open. The opening of transfer switch **155**, however does not result in the interruption of any current, since the current formerly flowing through switch **155** now flows through transfer switch **151** and the contactor assembly. At the displacement **193** of 45°, or in other words after the cam shaft **117** has rotated through 90°, the trip cam roller **11** had risen for a sufficient distance on the propection of the trip cam **115** to result in release of the spring **100** to rotate the shaft **88** through a predetermined angle and thereby open the contactors. This contact separation breaks the current flowing through finger **148**. At the displacement **194** of 53° the pin **179** of Geneva driver **175** enters the slot of Geneva gear **180**, and the continued motion of the Geneva gear driver **175** results in the breaking of the contact between the finger **148** and the contact segments **144** upon which it is riding at the displacement **195** of 84°. At the displacement **196** of 96° the finger **148** has contacted an adjacent contact segment **144** and at the displacement **197** of 131° the pin **179** leaves the slot of the Geneva gear **180**. At the displacement **198** of 135°, the wind-up cam roller **112** contacts the wind-up cam **116** sufficiently to start the closing of the contactor, and at the displacement **199** of 165°, the contactor assembly is completely closed and current may once again flow through the finger **148**. Ten degrees later at the displacement **200** of 175°, the transfer switch **155** closes once again, and a half tap change has been completed.

In the second half cycle of operation to complete a full tap change, the transfer switch **151** opens at the displacement **201** of 185°, and the opening of the transfer **151** is completed at the displacement **202** of 220°. Then 5° later at the displacement **203** of 225°, the tripping mechanism **12** opens the contacting assembly **11** to interrupt the current flowing to the finger **147**. At the displacement **204** of 233°, the pin **178** of Geneva gear driver **175** enters a slot of the Geneva gear **180**, and continued motion of the Geneva driver results in the separation of the contact finger **147** from one of the contact segments **144** at the displacement **205** of 264°. Twelve degrees later at the displacement **206** of 276°, the contact finger **147** contacts the next adjacent segment **144**, and at the displacement **207** of 311° the pin **178** leaves the slot of the Geneva gear **180**. Then at the displacement **208** of 315° the wind-up cam roller **112** rides sufficiently high on the wind-up cam **116** to commence the closing of the contactors, and at the displacement **209** of 345°, the contactors are completely closed. Finally at the displacement **210** of 255° of rotation of the gear **123** or **131**, the transfer switch **151** closes and in 5° further displacement the components are once again positioned as illustrated in Fig. 4. From the above discussion it may be seen that during normal operation of the transformer **139**, the load current is carried by the transfer switches **151** and **155**, and that for the purpose of interrupting this current for making a tap change, the current is diverted through the contactor assembly by the opening of one of the transfer switches.

The specific angular displacements as above-described are merely illustrative, and it shall be understood that other angular displacements or sequences of operation may be employed without departing from the spirit or scope of this invention.

It will be understood, of course, that, while the form

of the invention herein shown and described constitutes the preferred embodiment of the invention, it is not intended herein to illustrate all of the possible equivalent forms or ramifications thereof. It will also be understood that the words used are words of description rather than of limitation, and that various changes, such as changes in shape, relative size, and arrangement of parts, may be made without departing from the spirit or scope of the invention herein disclosed, and it is aimed in the appended claims to cover all such changes that fall within the true spirit and scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. An electrical contactor comprised of a pair of rotatable contacts mounted for rotation about a common axis and being electrically connected together, a pair of stationary contacts disposed in the path of rotation of said rotatable contacts, a pair of pivot means, said rotatable contacts being pivotally mounted for rotation on said pivot means, resilient means biasing said rotatable contacts in the same direction about their respective pivot means, stop means limiting the angular displacement of said rotatable contacts about their respective pivot means, and means for rotating said rotatable contacts through a predetermined angle about said common axis in one direction to effect the contacting and in the other direction to effect the separating of said rotatable and stationary contacts.

2. An electrical contactor comprised of a pair of rotatable contacts mounted for rotation about a common axis and being electrically connected together, a pair of stationary contacts disposed in the path of rotation of said rotatable contacts, a pair of pivot means, said rotatable contacts being pivotally mounted for rotation on said pivot means, resilient means biasing said rotatable contacts in the same direction about their respective pivot means, stop means limiting the angular displacement of said rotatable contacts about their respective pivot means, and means for rotating said rotatable contacts in one direction about said common axis rapidly through a predetermined angle to effect the separation of said rotatable and stationary contacts and relatively slowly in the other direction through said predetermined angle to effect the contacting of said rotatable contacts with said stationary contacts.

3. An electrical contactor comprised of a first and second rotatable contacts mounted for rotation about a common axis into and out of contacting relationship with first and second stationary contacts respectively, a first and second pivot means separated from said common axis, said first and second rotatable contacts being mounted on said first and second pivot means for rotation about pivotal axes parallel to said common axis, resilient means between said rotatable contacts biasing said rotatable contacts in the same direction about their respective pivotal axes, stop means limiting the angular displacement of said rotatable contacts about their respective pivot means, a rotatable drive shaft, and tripping means operable upon rotation of said drive shaft in either direction to rotate said rotatable contacts about said common axis rapidly through a predetermined angle to effect the separation of said respective contacts and relatively slowly in the opposite direction through said predetermined angle to effect the contacting of said respective contacts.

4. An electrical contactor comprised of first and second rotatable contacts mounted for rotation about a common axis into and out of contacting relationship with first and second stationary contacts respectively, a first and second pivot means separated from said common axis, said first and second rotatable contacts being mounted on said first and second pivot means for rotation about pivotal axes parallel to said common axis, resilient means between said rotatable contacts biasing said rotatable contacts in the same direction about their respective pivotal axes, stop means limiting the angular displacement of said rotatable contacts about their respective pivot means, a rotatable drive shaft, and tripping means operable upon rotation of said drive shaft in either direction to rotate said rotatable contacts about said common axis rapidly through a predetermined angle to effect the separation of said respective contacts and relatively slowly in the opposite direction through said predetermined angle to effect the contacting of said respective contacts, said stop means and resilient means being disposed to provide wiping action between said respective contacts for a predetermined angle of rotation of said rotatable contacts about said common axis.

5. An electrical contactor comprised of first and second rotatable contacts mounted for rotation about a common axis into and out of contacting relationship with first and second stationary contacts respectively, a first and second pivot means separated from said common axis, said first and second rotatable contacts being mounted on said first and second pivot means for rotation about pivotal axes parallel to said common axis, resilient means between said rotatable contacts biasing said rotatable contacts in the same direction about their respective pivotal axes, stop means limiting the angular displacement of said rotatable contacts about their respective pivot means, a rotatable drive shaft, and tripping means operable upon rotation of said drive shaft in either direction to rotate said rotatable contacts about said common axis rapidly through a predetermined angle to effect the separation of said respective contacts and relatively slowly in the opposite direction through said predetermined angle to effect the contacting of said respective contacts, said stop means and resilient means disposed to provide a first contact position at one limit of angular displacement of said rotatable contacts about said common axis in which rotatable contacts are free of said stop means and are held in a line contact against their respective stationary contacts by pressure of said resilient means, a second intermediate contact position in which said resilient means holds said rotatable contacts against said stop means and in substantially full contact with said respective stationary contact, and a third position at the other limit of said angular displacement about said common axis in which said rotatable contacts are free of said respective stationary contacts and prevented from rotational movement about their respective pivotal axes by said stop means.

6. An electrical contactor comprising substantially enclosed dielectric liquid filled chamber means, a pair of stationary contact means disposed on opposite walls of said chamber means, a pair of rotatable contact means electrically connected together and within said chamber means, shaft means for rotating said rotatable contact means together in one direction to effect the separation and in the other direction to effect the contacting of said rotatable and stationary contact means, a pair of pivot means mounted on said shaft means, each of said rotatable contact means being pivotally mounted on one of said pivot means, resilient means disposed between said rotatable contact means to provide a wiping action between said rotatable and stationary contact means, and aperture means extending through the wall of said chamber means adjacent one of said stationary contact means.

7. An electrical contactor comprising substantially enclosed dielectric liquid filled chamber means, a pair of stationary contact means disposed on opposite walls of said chamber means and being electrically insulated from each other, a pair of rotatable contact means electrically connected together and within said chamber means, insulating shaft means for rotating said rotatable contact means about a common axis in one direction to effect the separation and in the other direction to effect the contacting of said rotatable and stationary contact means, a pair of pivot means mounted on said shaft means and extending parallel to the axis of said shaft means, each

of said rotatable contact means being pivotally mounted on one of said pivot means, resilient means disposed between said rotatable contact means and being positioned to provide a force on each of said rotatable contact means tending to cause rotation about their respective pivot means, said resilient means providing wiping action between said rotatable and stationary contact means, and aperture means extending through the wall of said chamber means adjacent one of said stationary contact means.

8. An electrical contactor comprising a substantially enclosed dielectric liquid filled chamber, first and second stationary electrical contacts disposed on opposite walls of said chamber and being electrically insulated from each other, first and second rotatable electrical contacts electrically connected together and within said chamber, said first and second rotatable contacts being positioned to contact said first and second stationary contacts respectively, insulating shaft means for rotating said rotatable contacts about a common axis in one direction to effect the separation and in the other direction to effect the contacting of said respective rotatable and stationary contacts, first and second pivot pins on said shaft means and extending parallel to said shaft means, said first and second rotatable contacts being pivotally mounted on said first and second pivot pins respectively, resilient means positioned between said rotatable contacts providing a rotational force on each of said rotatable contacts in the same direction about their respective pivot pins in order to provide wiping action between said rotatable contacts and their respective stationary contacts, and aperture means extending through the wall of said chamber adjacent one of said stationary contacts.

9. An electrical contactor comprising a substantially enclosed dielectric liquid filled chamber, first and second stationary electrical contacts disposed on opposite walls of said chamber and being electrically insulated from each other, first and second rotatable electrical contacts electrically connected together and within said chamber, said first and second rotatable contacts being positioned to contact said first and second stationary contacts respectively, insulating shaft means for rotating said rotatable contacts about a common axis in one direction to effect the separation and in the other direction to effect the contacting of said respective rotatable and stationary contacts, first and second pivot pins on said shaft means and extending parallel to said shaft means, said first and second rotatable contacts being pivotally mounted on said first and second pivot pins respectively, resilient means positioned between said rotatable contacts providing a rotational force on each of said rotatable contacts in the same direction about their respective pivot pins in order to provide wiping action and contact pressure between said rotatable contacts and their respective stationary contacts, stop means on said shaft means for limiting the angular displacement of said rotatable contacts about their respective pivot pins, and aperture means extending through the wall of said chamber means adjacent one of said stationary contact means.

10. An electrical contactor comprising a substantially enclosed dielectric liquid filled chamber, first and second stationary contacts disposed on opposite walls of said chamber and being electrically insulated from each other, first and second rotatable electrical contacts within said chamber, means electrically connecting said rotatable contacts together, insulating shaft means extending into said chamber for rotating said rotatable contacts about a common axis in one direction to effect the separation and in the other direction to effect the contacting of said first and second rotatable contacts with said first and second stationary contacts respectively, first and second pivot pins on said insulating shaft means, said first and second rotatable contacts being pivotally mounted on said first and second pivot pins for rotation about pivotal axes parallel to said common axis, common spring means biasing said rotatable contacts in the same direction about their respective pivotal axes to provide wiping action and contact pressure between said rotatable contacts and their respective stationary contacts, stop means on said shaft means for limiting the angular displacement of said rotatable contacts about their respective pivotal axes, and aperture means extending through the wall of said chamber adjacent one of said stationary contacts.

11. An electrical contactor comprising a substantially enclosed dielectric liquid filled chamber, first and second stationary contacts disposed on opposite walls of said chamber and being electrically insulated from each other, first and second rotatable electrical contacts within said chamber, means electrically connecting said rotatable contacts together, insulating shaft means extending into said chamber for rotating said rotatable contacts about a common axis, first and second pivot pins on said shaft means, said first and second rotatable contacts being pivotally mounted on said first and second pivot pins respectively for rotation about pivotal axes parallel to and equidistant from said common axis, means for rotating said shaft means through a predetermined angle in one direction to effect the separation and in the other direction to effect the contacting of said first and second rotatable contacts with said first and second stationary contacts respectively, common spring means biasing said rotatable contacts in the same direction about their respective pivotal axes, to provide contact pressure between said respective contacts, stop means on said shaft means for limiting the angular displacement of said rotatable contacts about their respective pivotal axes, stop means and common spring means being cooperatively positioned to provide wiping action between said respective contacts for a predetermined angle of rotation of said shaft means, and aperture means extending through the wall of said chamber adjacent one of said stationary contacts.

12. An electrical contactor comprising a first substantially enclosed dielectric liquid filled chamber disposed in a second dielectric liquid filler chamber, first and second stationary contacts disposed on diametrically opposite inner walls of said first chamber and being electrically insulated from each other, first and second rotatable electrical contacts within said first chamber, means electrically connecting said rotatable contacts together, insulating shaft means extending into said chamber for rotating said rotatable contacts about a common axis, first and second pivot pins on said shaft means, said first and second rotatable contacts being pivotally mounted on said first and second pivot pins respectively for rotation about pivotal axes parallel to and spaced equidistant from said common axis on diametrically opposite sides thereof, means for rapidly rotating said shaft means through a predetermined angle in one direction to effect the separation of said first and second rotatable contacts from contacting relationship with said first and second stationary contacts respectively and in the other direction for relatively slowly effecting the contacting of said respective rotatable and stationary contacts, common spring means biasing said rotatable contacts in the same direction about their respective pivotal axes to provide contact pressure between said respective contacts, stop means on said shaft means for limiting the angular displacement of said rotatable contacts about their respective pivotal axes, said stop means and common spring means being cooperatively positioned to provide wiping action between said respective contacts for a predetermined angle of rotation of said shaft means, and aperture means extending through the wall of said first chamber adjacent one of said stationary contacts.

13. An electrical contactor comprising a first substantially enclosed dielectric liquid filled chamber disposed in a second dielectric filled chamber, first and second stationary contacts disposed on diametrically opposite inner walls of said first chamber and being electrically insulated from each other, and both lying in the same

plane, first and second rotatable contacts within said first chamber and disposed for rotational movement in said plane into and out of electrical contact with said first and second stationary contacts respectively, means electrically connecting said rotatable contacts together, insulating shaft means extending into said first chamber for rotating said rotatable contacts in said plane about a common axis, first and second pivot pins on said shaft means, said first and second rotatable contacts being pivotally mounted on said first and second pivot pins respectively for rotation in said plane about pivotal axes parallel to and spaced equidistant from said common axis on diametrically opposite sides thereof, means for rapidly rotating said shaft means through a predetermined angle in one direction to effect the separation of said first and second rotatable contacts from contacting relationship with said first and second stationary contacts respectively and in the other direction for relatively slowly effecting the contacting of said rotatable and stationary contacts, a helical spring disposed in compression in said plane between said rotatable contacts and biasing said contacts in the same direction about their respective pivotal axes to provide contact pressure between said respective contacts, stop means on said shaft means for limiting the angular displacement of said rotatable contacts about their respective pivotal axes, said stop means and spring being cooperatively positioned to provide wiping action between said respective contacts for a predetermined angle of rotation of said shaft means, and aperture means extending through the wall of said first chamber adjacent one of said stationary contacts.

14. A liquid blast electrical contactor comprising a first substantially enclosed dielectric liquid filled chamber disposed in a second dielectric liquid filled chamber, said first chamber being substantially a circular cylinder having side walls comprised of a tube of an insulating material, first and second stationary contacts disposed diametrically opposite to each other on the inner walls of said cylinder and both lying in the same plane perpendicular to the axis of said cylinder, first and second rotatable contacts within said cylinder and disposed for rotational movement in said plane, means electrically connecting said rotatable contacts together, insulating shaft means extending into said cylinder for rotating said rotatable contacts about said axis, first and second pivot pins on said shaft means, said first and second rotatable contacts being pivotally mounted on said first and second pivot pins respectively for rotation in said plane about pivotal axes parallel to and spaced equidistant from said axis on diametrically opposite sides thereof, means for rapidly rotating said shaft means through a predetermined angle in one direction to effect the separation of said first and second rotatable contacts from contacting relationship with said first and second stationary contacts respectively and in the other direction for relatively slowly effecting the contacting of said respective rotatable and stationary contacts, a helical spring disposed in compression between said rotatable contacts biasing said rotatable contacts in the same direction about their respective pivotal axes to provide contact pressure between said respective contacts, stop means on said shaft means for limiting the angular displacement of said rotatable contacts about their respective pivotal axes, said stop means and spring being cooperatively positioned to provide wiping action between said respective contacts for a predetermined angle of rotation of said shaft means, and aperture means extending through the wall of said cylinder adjacent one of said stationary contacts.

15. An electrical contactor comprised of a first and second rotatable contacts mounted for rotation about a common axis into and out of contacting relationship with first and second stationary contacts respectively, a first and second pivot means separated from said common axis, said first and second rotatable contacts being mounted on said first and second pivot means for rotation about pivotal axes parallel to said common axis, resilient means between said rotatable contacts biasing said rotatable contacts in the same direction about their respective pivotal axes, stop means limiting the angular displacement of said rotatable contacts about their respective pivot means, a rotatable drive shaft, and tripping means operable upon rotation of said drive shaft in either direction to rotate said rotatable contacts about said common axis rapidly through a predetermined angle to effect the separation of said respective contacts and relatively slowly through said predetermined angle to effect the contacting of said respective contacts, said tripping means being comprised of first cam means on said drive shaft, pivoted toggle lever means operable upon rotation of said first cam means to compress spring means, first stop plate means on said lever means to hold said spring means compressed, second cam means on said drive shaft, said lever means being operable upon rotation of said second cam means to release said spring means, insulating shaft means connected to rotate said rotatable contacts, and link means connecting said lever means to said insulating shaft means for rotating said insulating shaft means.

16. An electrical contactor comprised of a first and second rotatable contacts mounted for rotation about a common axis into and out of contacting relationship with first and second stationary contacts respectively, a first and second pivot means separated from said common axis, said first and second rotatable contacts being mounted on said first and second pivot means for rotation about pivotal axes parallel to said common axis, resilient means between said rotatable contacts biasing said rotatable contacts in the same direction about their respective pivotal axes, stop means limiting the angular displacement of said rotatable contacts about their respective pivot means, a rotatable drive shaft, and tripping means operable upon rotation of said drive shaft in either direction to rotate said rotatable contacts about said common axis rapidly through a predetermined angle to effect the separation of said respective contacts and relatively slowly through said predetermined angle to effect the contacting of said respective contacts, said tripping means comprising first and second cam means mounted for rotation on said drive shaft, first lever means, toggle link means, second lever means, said lever means and link being connected together and being operable upon rotation of said first cam means to compress a spring means, stop plate means for holding said spring means compressed, insulating shaft means connected to rotate said rotatable contacts about said common axis, link means connecting said lever means for rotating said shaft means, said lever means being operable upon rotation of said second cam means to release said spring means to effect the rapid rotation of said insulating shaft means through a predetermined angle.

17. A tripping mechanism for an electrical contactor characterized by a rapid rotation of an insulating shaft through a predetermined angle followed by a relatively slow return of said insulating shaft through the same predetermined angle upon rotation of a drive shaft in either direction and comprising windup cam means and tripping cam means on said drive shaft, first lever means, said cam means being positioned to force said first lever in opposite directions at different angular displacements of said drive shaft, a second lever means, toggle link means connecting said first lever means to said second lever means, spring means, said link, lever, and spring means being connected to effect the compression of said spring means upon incidence of said first lever means with said windup cam means, means inhibiting the release of said spring means, and finger link means connecting said lever means to said insulating shaft, said link, lever, and spring means being operable upon incidence of said first lever means with said tripping cam means to release said spring means.

18. A tripping mechanism for an electrical contactor characterized by a rapid rotation of an insulating shaft through a predetermined angle followed by a relatively slow return of said insulating shaft through the same predetermined angle upon rotation of a drive shaft in either direction and comprising windup cam means and tripping cam means on said drive shaft, first lever means, said cam means being positioned to force said first lever in opposite directions at different angular displacements of said drive shaft, toggle link means connected to said first lever means and forming a toggle with said first lever means, second lever means having one end connected to said toggle link means and the other end connected to a spring means, said link, lever, and spring means being connected to effect the compression of said spring upon the incidence of said first lever means with said windup cam means, means on said toggle link means inhibiting the release of said spring means, said lever and link means being connected to release said spring means upon incidence of said first lever means with said tripping cam means due to the passing of said toggle through a dead center position, and finger link means connecting said lever means to said insulating shaft means.

19. An electrical contactor comprised of a pair of rotatable contacts mounted for rotation about a common axis and being electrically connected together, a pair of stationary contacts disposed in the path of rotation of said rotatable contacts, a pair of pivot means, said rotatable contacts being pivotally mounted for rotation on said pivot means, a face on each of said rotatable contacts toward said common axis, a helical spring extending in compression between said faces and biasing each of said contacts in the same direction about their respective pivot means, stop means limiting the angular displacement of said rotatable contacts about their respective pivot means, and means for rotating said rotatable contacts in one direction about said common axis rapidly through a predetermined angle to effect the separation of said rotatable and stationary contacts and relatively slowly in the other direction through said predetermined angle to effect the contacting of said rotatable contacts with said stationary contacts.

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