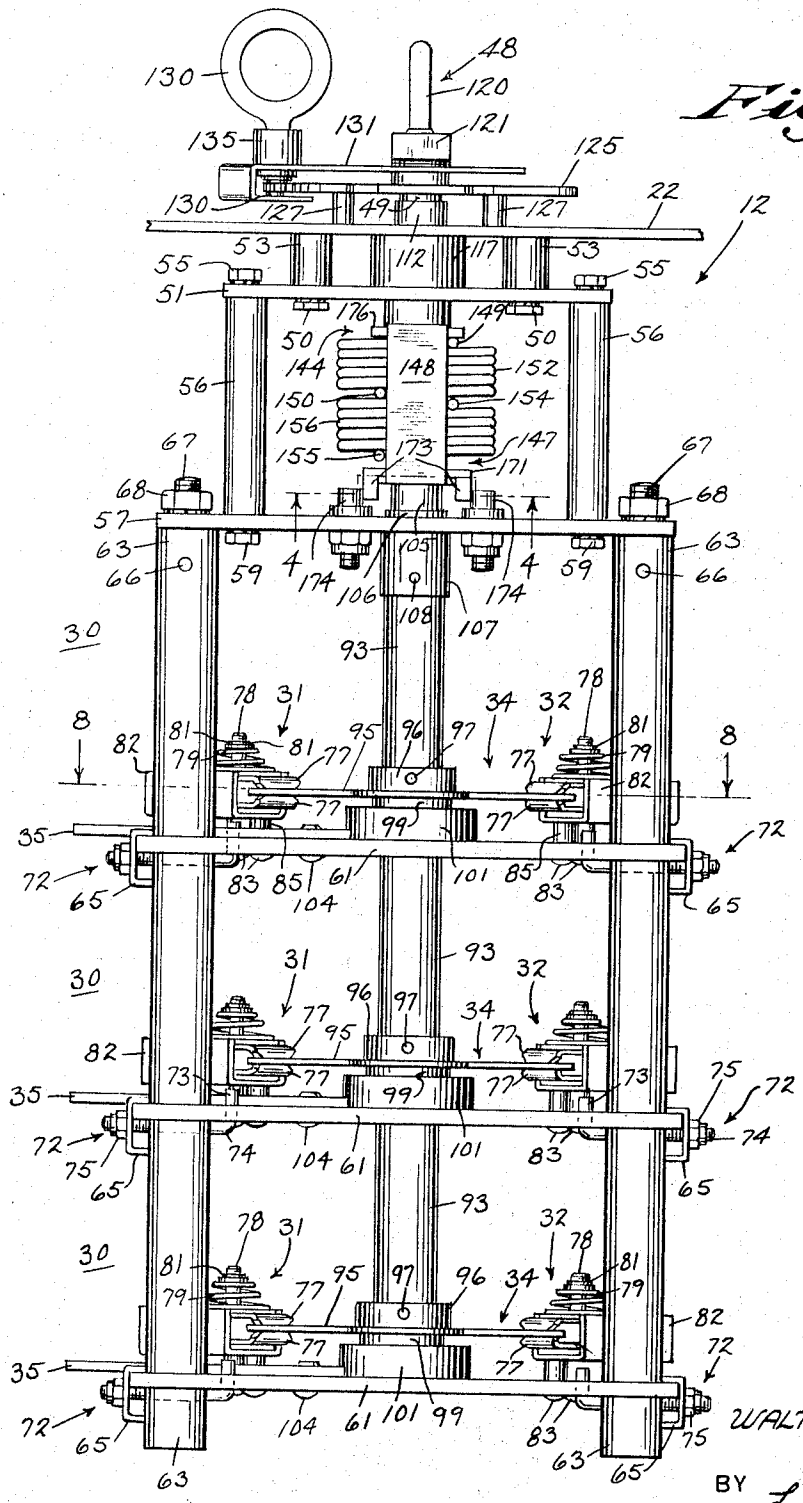
April 25, 1967 W. KOWALSKI 3,316,367

REVERSIBLE SECTIONALIZING SWITCH

Filed Aug. 26, 1965 6 Sheets-Sheet 1

Fig. 1



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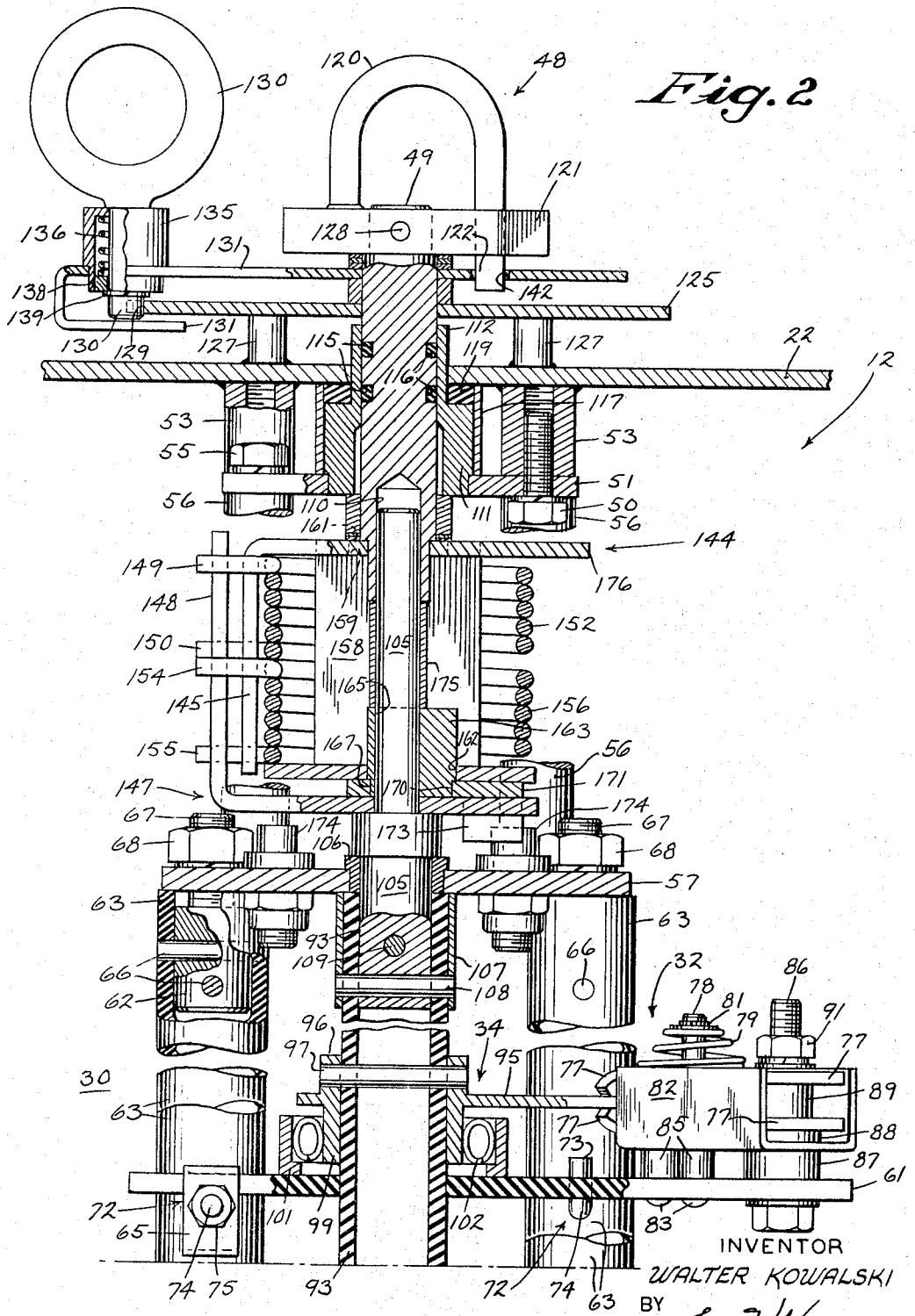
April 25, 1967 W. KOWALSKI 3,316,367

REVERSIBLE SECTIONALIZING SWITCH

Filed Aug. 26, 1965 6 Sheets-Sheet 2

Fig. 2



April 25, 1967 W. KOWALSKI 3,316,367

REVERSIBLE SECTIONALIZING SWITCH

Filed Aug. 26, 1965 6 Sheets-Sheet 3

Fig. 3

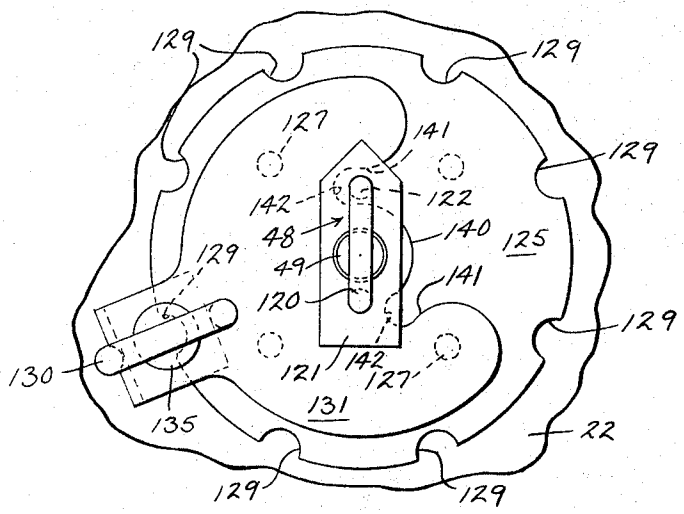
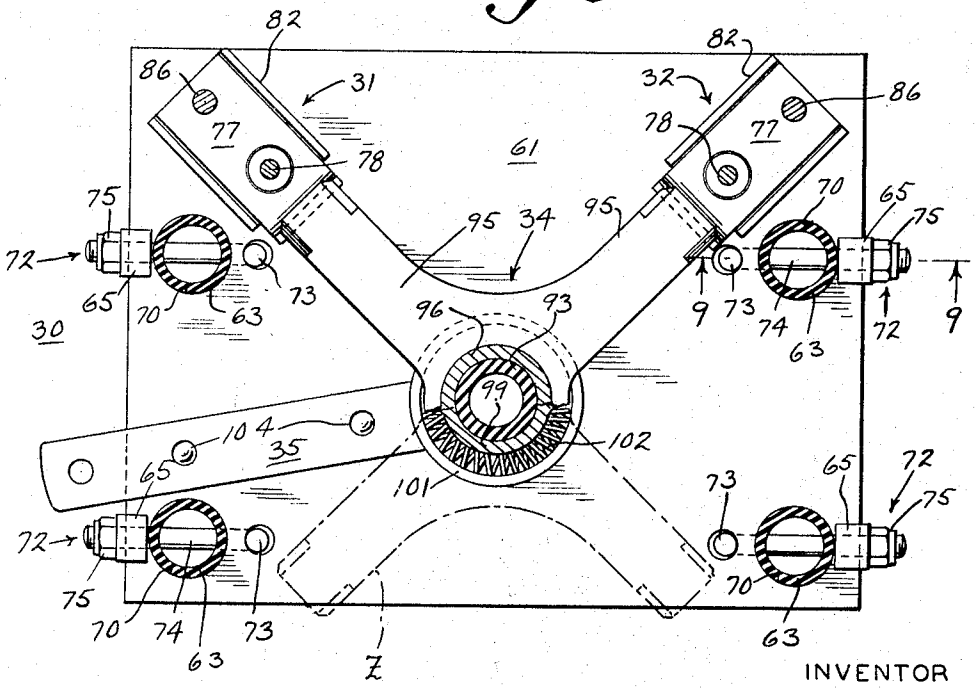


Fig. 8



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REVERSIBLE SECTIONALIZING SWITCH

Filed Aug. 26, 1965 6 Sheets-Sheet 4

Fig. 4

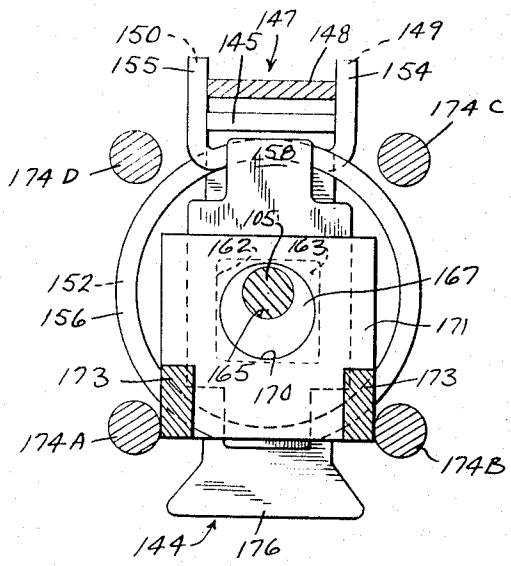


Fig. 5

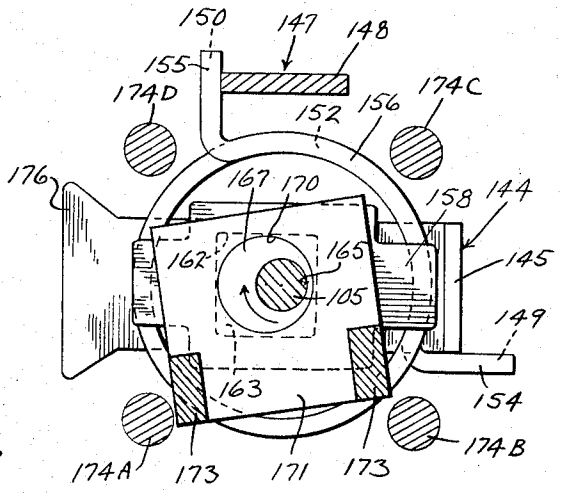


Fig. 6

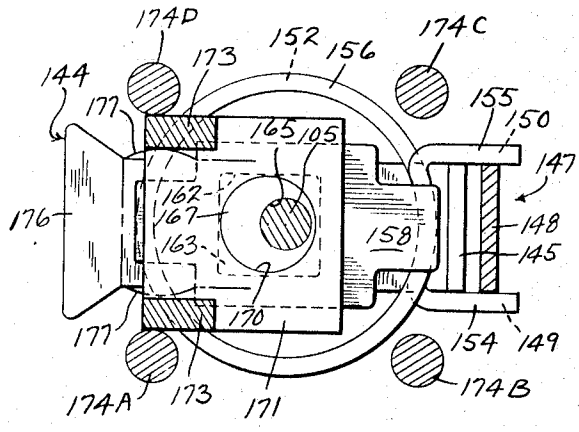
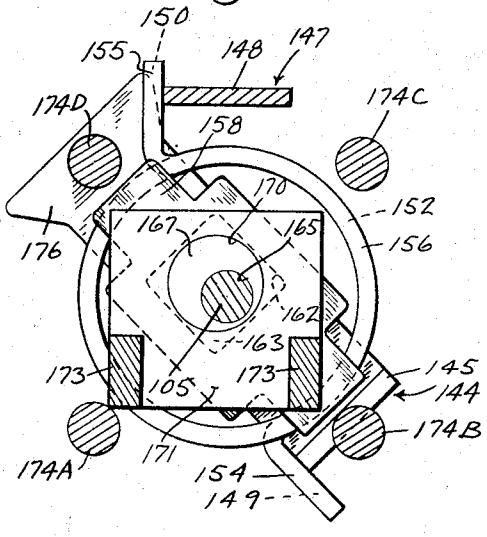


Fig. 7



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April 25, 1967 W. KOWALSKI 3,316,367

REVERSIBLE SECTIONALIZING SWITCH

Filed Aug. 26, 1965 6 Sheets-Sheet 5

Fig. 9

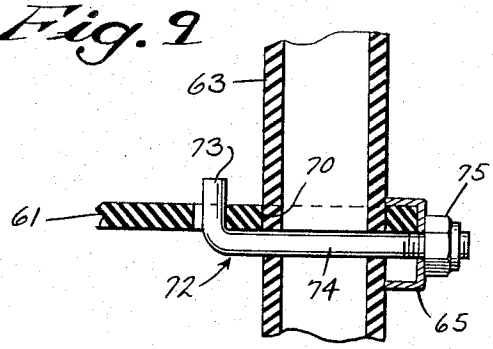
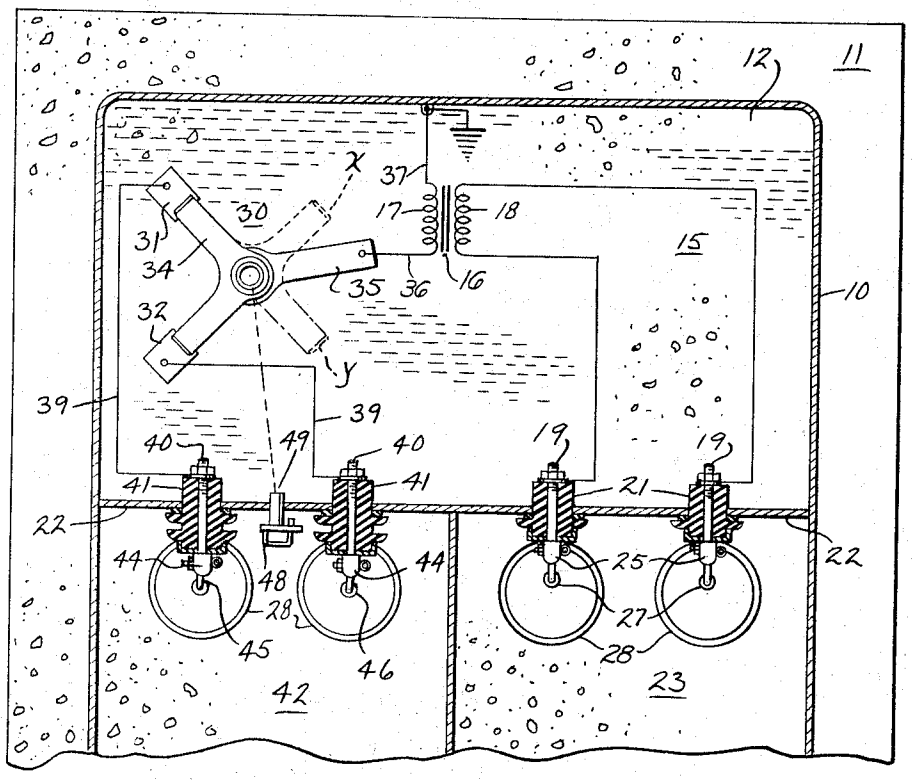


Fig. 11



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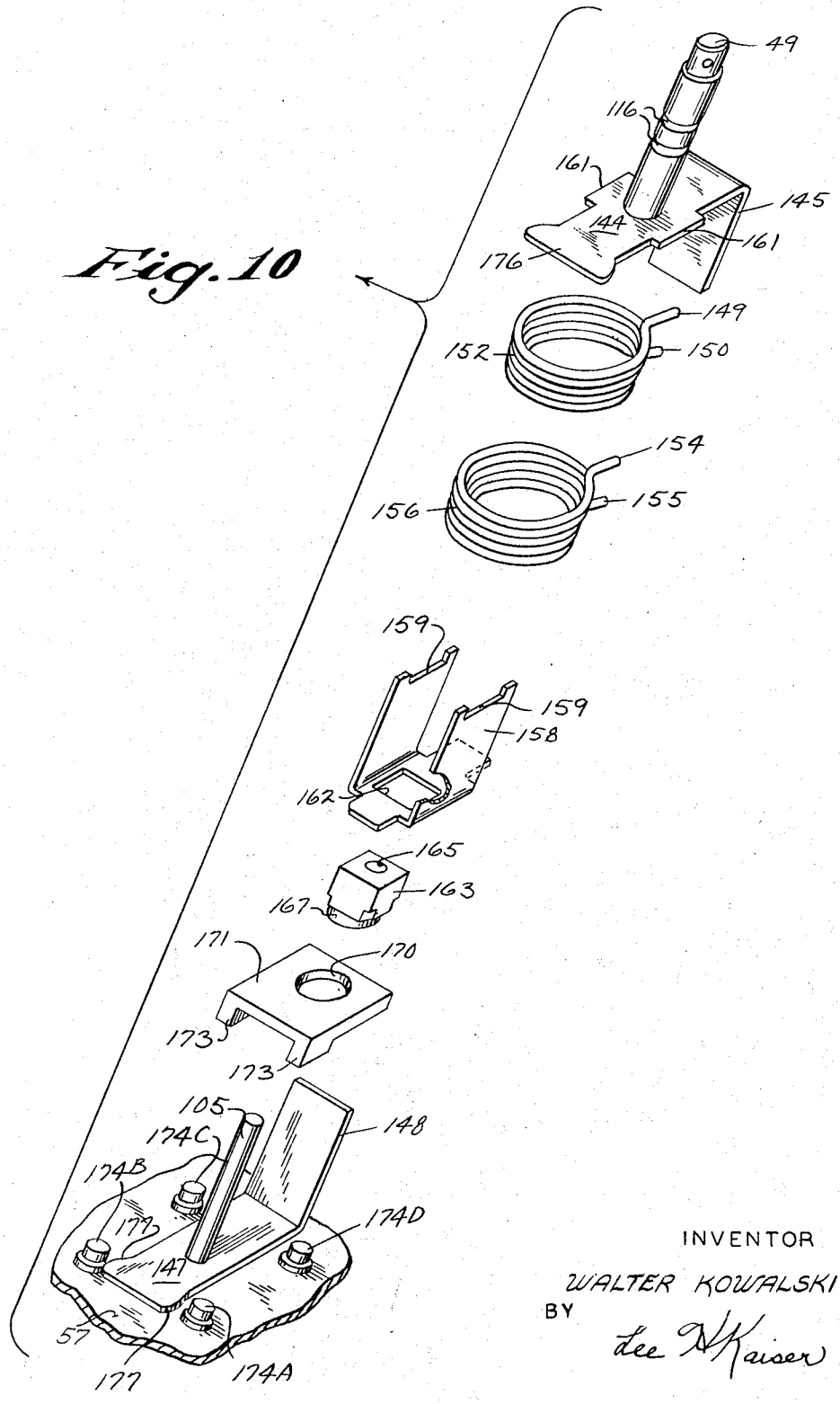
April 25, 1967 W. KOWALSKI 3,316,367

REVERSIBLE SECTIONALIZING SWITCH

Filed Aug. 26, 1965 6 Sheets-Sheet 6

Fig. 10



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United States Patent Office

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REVERSIBLE SECTIONALIZING SWITCH

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Filed Aug. 26, 1965, Ser. No. 482,730
24 Claims. (Cl. 200—48)

This invention relates to electric circuit makers and breakers and in particular to high voltage sectionalizing switches for power distribution systems.

Although underground power distribution systems improve the beauty of residential areas and minimize the problem of lightning, ice, wind, and tree-limb damage, the high cost and complexity of such an underground system in comparison to overhead has discouraged more widespread adoption of underground systems for residential services. Known underground distribution systems utilize distribution transformers supported on ground level concrete pads and enclosed in metallic housings which must be large enough to enclose an expulsion fuse and air disconnect switches to permit changeover to an alternate power source in the event of a fault at one location on a loop power distribution system. Air disconnect switches used for sectionalizing in such ground level transformer housings are incapable of interrupting load current, and the circuit can only be interrupted by operation of the expulsion fuse which is accompanied by the evolution of large amounts of gas and ionized particles. Such ground level transformer housings must be sufficiently strong to withstand the pressure arising from the gas and ionized particles generated upon operation of the expulsion device. Further, such air disconnect sectionalizing switches are not suitable for installation in an underground vault, and, consequently, they have retarded adoption of completely buried underground residential power systems.

It is an object of the invention to provide a reversible sectionalizing switch capable of operation under the oil of an electrical transformer, thereby greatly reducing the size of the transformer installation in comparison to known apparatus using separate air disconnects for sectionalizing and also permitting installation of the transformer in an underground vault. It is a further object of the invention to provide such a sectionalizing switch which is capable of interrupting magnetizing and load current to the transformer, thereby eliminating the necessity of an expulsion device which inherently operates with a loud noise and evolves large quantities of gas and ionized particles. Another object of the invention is to provide a reversible four-position sectionalizing switch for use in a transformer of an underground power distribution system which alternatively permits both power sources in a loop system to be open and the transformer de-energized to allow service and repair; either source to be open and the transformer energized from the other source; or the two power sources to be interconnected and the transformer energized. A still further object of the invention is to provide such a reversible sectionalizing switch having load-break ability which provides positive indication of contact position and is modular in construction in that one, two, or three poles can be provided as desired by addition of simple components and wherein high dielectric strength is provided between the poles and between the stationary contacts of multi-phase embodiments.

These and other objects and advantages of the invention will be more readily apparent from the following detailed description when taken in conjunction with the accompanying drawing wherein:

FIG. 1 is a front elevation view of a three pole, four-position embodiment of the invention wherein the operating shaft is vertically disposed;

FIG. 2 is an enlarged vertical sectional view showing the actuating means for the switch of FIG. 1;

FIG. 3 is a plan view of the switch of FIG. 1 taken externally of the transformer compartment in which it is enclosed and showing the means engageable by a hotstick for operating the sectionalizing switch;

FIGS. 4 to 7 are views taken along line 4—4 of FIG. 1 showing different positions assumed by the members which comprise the switch actuating means during switch operation;

FIG. 8 is a view taken along line 8—8 of FIG. 1;

FIG. 9 is a view taken along line 9—9 of FIG. 8;

FIG. 10 is an exploded view of the elements which comprise the actuating and latching means of the embodiment of FIG. 1; and

FIG. 11 is a partly schematic horizontal sectional view through a ground level transformer housing incorporating a sectionalizing switch in accordance with the invention.

Referring to FIG. 11 of the drawing, an electrical power distribution transformer for an underground residential distribution system is illustrated as including a grounded metallic housing **10** supported on a concrete pad **11** at ground level and having a transformer compartment **12** containing a suitable dielectric liquid such as transformer oil **15** in which is immersed a transformer core and coil assembly schematically illustrated as including a magnetic core **16** inductively linked by a primary transformer winding **17** and a transformer secondary winding **18**. The ends of secondary winding **18** may be connected to conductve studs **19** of secondary insulating bushings **21** which extend through a wall **22** into the secondary compartment **23** of the transformer and terminate in suitable connectors **25**. Underground secondary cables **27** leading to adjacent electrical loads may be secured to connectors **25** and extend through conduits **28** in concrete pad **11**.

A sectionalizing switch **30** embodying the invention is schematically illustrated as immersed in the transformer oil **15** and including two stationary contacts **31** and **32**, a generally V-shaped movable contact **34** adapted to engage the stationary contacts **31** and **32**, and a terminal **35** electrically connected to movable contact **34**. One end of transformer primary winding **17** is connected to terminal **35** by conductor **36** and the other end is connected to metallic tank **10** and ground by conductor **37**. The switch stationary contacts **31** and **32** are connected by conductors **39** to conductive studs **40** on primary insulating bushings **41** which extend through wall **22** into the primary compartment **42** of the ground level transformer and terminate in suitable primary connectors **44**. An incoming primary underground cable **45** of a loop system may extend through a conduit **28** into primary compartment **42** and be secured to one primary connector **44**, and an outgoing primary cable **46** of the loop system may extend through a conduit **28** in concrete pad **11** into primary compartment **42** and be connected to the connector **44** on the other primary insulating bushing **41**.

As illustrated in FIG. 11, movable contact **34** connects terminal **35** to both stationary contacts **31** and **32**, thus permitting the two power sources over the primary underground cables **45** and **46** to be interconnected and the transformer primary winding **17** energized. Switch **30** may be actuated by a hotstick engaged with a switch operating eye **48** mounted on a switch operating shaft **49** extending through wall **22** (and schematically shown in FIG. 11 as operatively connected to movable contact **34**) from the position shown in full lines in FIG. 11 clockwise to the position X shown in dotted lines wherein one arm of V-shaped movable contact **34** engages stationary contact **31** but the other arm thereof is disengaged from stationary contact **32**, thereby connecting transformer primary winding **17** to primary cable **45** and opening the power source over primary cable **46**. Alternative-

ly sectionalizing switch 30 may be actuated counterclockwise from the position shown in full lines in FIG. 11 to the position Y shown in dot-dash lines wherein one arm of V-shaped movable contact 34 engages stationary contact 32 but the other arm thereof is disengaged from stationary contact 31, thereby connecting transformer primary winding 17 to primary cable 46 and opening the power source over primary cable 45. Switch 30 may also be actuated to a fourth position (shown in dot-dash lines in FIG. 8) wherein movable contact 34 is disengaged from both stationary contacts 31 and 32, thereby permitting the power sources over both primary cables 45 and 46 to be open and the transformer de-energized to allow service and repair.

FIG. 11 schematically illustrates one phase of the ground level transformer, but sectionalizing switch 30 may be a three pole switch adapted to open and close three phases of a power system, and the embodiment illustrated in FIGS 1–10 is a three phase, four-position switch which may be mounted on wall 22 by four screws 50 (see FIG. 2) extending through clearance apertures in a switch mounting plate 51 and engaging internally threaded studs 53 welded to wall 22 within the oil-filled transformer compartment 12. Switch mounting plate 51 is connected by cap screws 55 to one end of each of four posts 56 having internally threaded holes in each end thereof, and at their opposite end the posts 56 are secured to an index plate 57 by cap screws 59.

The stationary contacts 31 and 32 for each of the three phases are mounted on different contact plates 61 of suitable insulating material, and the three contact plates 61 are spaced apart and supported from index plate 57 by tubular insulating spacers 63. Shoulder studs 62 are disposed within the one end of the tubultr spacers 63 adjacent index plate 57 and are secured thereto by through pins 66, and each shoulder stud 62 has a reduced diameter threaded portion 67 which extends through a clearance aperture in index plate 57 and is secured thereto by a nut 68. Each insulating contact plate 61 has four apertures 70 (see FIGS. 8 and 9) therein through which the tubular spacers 63 extend, and contact plates 61 are secured to tubular spacers 63 by L-shaped studs 72. The short leg 73 of L-shaped stud 72 protrudes through a clearance aperture in contact plate 61 (see FIG. 9), and the longer leg 74 extends diametrically through apertures in opposed portions of tubular spacers 63 and through a clearance aperture in a U-shaped metallic clip 65 which fits over the end of contact plate 61. When a nut 75 is threaded onto leg 74 of L-shaped stud 72, the legs of the U-shaped clip 65 abut against tubular spacer 63, and L-shaped stud 72 prevents movement of contact plate 61 in one direction axial of tubular spacer 63 and the overlapping leg of U-shaped clip 65 prevents movement of contact plate 61 in the opposite axial direction.

The disclosed construction permits easy and rapid assembly of one, two, or three contact plates 61 on the tubular spacers 63 as desired, thereby allowing the same basic elements to be used on single pole, double pole, or three pole embodiments of the sectionalizing switch. The tubular spacers 63 are preferably of high dielectric strength insulating material and provide high breakdown strength between the stationary contacts of the three phases mounted on contact plates 61 and also between the movable contacts 34 of the three phases.

Each switch stationary contact 31 and 32 may comprise a pair of stationary contact members 77 of high conductivity material such as copper having opposed, bent-over ends between which movable contact 34 is engaged. A headed pin 78 extends through clearance apertures in the stationary contact members 77 and through a spiral spring 79 which resiliently urges the contact members 77 toward each other and against movable contact 34, and a snap ring 81 engages the end of pin 78 to maintain spring 79 compressed. The stationary contact members 77 are disposed within a U-shaped contact support bracket 82 which at one end is secured to contact plate 61 by a pair of rivets 83 that protrude through spacers 85 disposed between bracket 82 and contact plate 61. The other end of support bracket 82 is secured to contact plate 61 by a cap screw 86 which extends through aligned clearance apertures in bracket 82 and in the stationary contact members 77 and through axial openings in spacers 87, 88, and 89 disposed respectively between bracket 82 and contact plate 61, between bracket 82 and one stationary contact member 77, and between the stationary contact members 77. Cap screw 86 engages a nut 91.

The movable contacts 34 of the three phases are secured to, and actuated by, a driven shaft portion 93 which may be of tubular insulating material having high dielectric strength and protruding through aligned clearance apertures in the three contact plates 61. Each movable contact 34 includes a generally V-shaped movable contact member 95 of high conductivity material such as copper having a tubular flange 96 on one side thereof concentric to the movable contact axis and through which a pin 97 extends diametrically to affix member 95 to driven shaft portion 93. Movable contact member 95 also has a coaxial sleeve bearing portion 99 on the side thereof opposite flange 96. Bearing portion 99 extends into a cup-shaped contact portion 101 of terminal 35 resting on contact plate 61, and a continuous, current transfer, coil spring 102 of high conductivity material such as beryllium copper is compressed between the internal periphery of cup-shaped contact portion 101 and bearing portion 99 on movable contact member 95 to permit current transfer from movable contact member 95 to terminal 35 which is integral with cup-shaped portion 101 and affixed to contact plate 61 by rivets 104 and connected by conductor 36 to a single phase primary winding 17 of the transformer.

The insulating spacers 63 and the insulating driven shaft portion 93 provide high breakdown strength between the stationary contacts of the three phases and between the movable contacts of the three phases. Tubular insulating driven shaft portion 93 receives one end of a metallic driven shaft portion 105 which extends through a bearing 106 in index plate 57. A metallic collar 107 surrounds the end of tubular insulating shaft portions 93 into which metallic driven shaft portion 105 protrudes, and pins 108 and 109 extending diametrically through collar 107, insulating tubular shaft portion 93, and metallic driven shaft portion 105 rigidly affix these members together.

Driven shaft portion 105 protrudes into and is journalled within an axial compartment 110 in one end of driving shaft 49. The opposite end of driving shaft 49 extends through wall 22 and terminates in operating eye 48. Driving shaft 49 protrudes through a hub 111 affixed by suitable means such as welding to mounting plate 51 and having an axially extending tubular portion 112 which protrudes through a clearance aperture in wall 22. Continuous resilient gaskets 115 compressed by tubular portion 112 within circumferential grooves 116 in driving shaft 49 provide a hermetic seal for oil-filled compartment 12 of tank 10 at driving shaft 49. Hub 111 is spaced from wall 22, and a sleeve 117 of greater axial length than hub 111 surrounds hub 111 between mounting plate 51 and wall 22. A continuous gasket 119 of resilient material surrounding tubular portion 112 is compressed between hub 111 and the internal periphery of sleeve 117 when cap screws 50 are tightened to provide a hermetic seal between tubular portion 112 and wall 22.

Operating eye 48 is formed by a U-shaped rod 120 which is welded at one end to a pointer 121 and at the other end 122 extends through an aperture in pointer 121. Pointer 121 is affixed to the end of driving shaft 49 by a pin 128. Pointer 121 cooperates with an index plate 125 to indicate the position of sectionalizing switch 30. Index plate 125 is preferably welded to a plurality of studs 127 which are in turn welded to the wall 22 exterior

of the oil-filled compartment **12**. Index plate **125** has a plurality of circumferentially spaced apart arcuate notches **129** (see FIG. 3) which are adapted to receive the end of an indexing eyebolt **130** engageable by a hotstick and resiliently urged into one of the notches **129**. Eyebolt **130** is carried adjacent the radially outward end of an index arm **131** disposed between index plate **125** and pointer **121** and having an aperture therein through which driving shaft **49** protrudes so as to rotatably mount index arm **131** relative to drive shaft **49**. Index arm **131** has a cup-shaped portion **135** disposed away from its axis of rotation through which eyebolt **130** protrudes, and a spring **136** compressed within cup-shaped portion **135** urges eyebolt **130** into one of the indexing notches **129**. One end of spring **136** engages the transverse wall of cup-shaped portion **135**, and the other end engages a spacer **138** slidable within cup-shaped portion **135** and abutting against a retaining ring **139** engaged within a circumferential groove in eyebolt **130** to normally urge eyebolt **130** into one of the notches **129**. A shoulder on eyebolt **130** abutting against the transverse wall of cup-shaped portion **135** limits axial travel of eyebolt **130**. Index arm **131** is generally of heart shape (see FIG. 3) and has a generally W-shape peripheral edge **140** along which depending end **122** of U-shaped member **120** of switch operating eye **48** travels.

The generally W-shape periphery **140** of index arm **131** defines two depressions **141** having generally radially extending stop surfaces **142** which interfere with member **120** and limit travel of operating eye **48** to approximately 150 degrees of angular movement. When depending end **122** of U-shaped member **120** is in one of the two depressions **141** as shown in FIG. 3, operating eye **48**, and thus switch **30**, cannot be actuated in the counterclockwise direction and is limited to sufficient movement in the clockwise direction to actuate the switch to the next switch position and to break apart the movable and stationary contacts if they become welded together due to excessive current flow. If it is desired to actuate switch operating eye **48** in the counterclockwise direction as shown in FIG. 3, it is first necessary for the lineman to engage eyebolt **130** with a hotstick and pull eyebolt **130** from the notch **129** in index plate **125** in which it is engaged and then rotate index arm **131** in the counterclockwise direction until eyebolt **130** can fall into the second notch **129** in the counterclockwise direction from that shown in FIG. 3. In this new position of index arm **131** (not shown in the drawing) operating eye **48** cannot be actuated in the clockwise direction but can be rotated through a sufficient angle in the counterclockwise direction to actuate the movable contacts **34** to the next switch position. The index plate **125** and index arm **131** thus assure positive positioning of the switch movable contacts **34** by allowing rotation of the switch operating eye **48** in one direction only and only as far as the succeeding switch position, and they also give positive indication of switch position.

The switch actuating and latching means will now be described. Driving shaft **49** carries a driving dog **144** having a depending arm **145** extending parallel to the shaft axis as seen in FIGS. 2 and 10, and driven shaft **105** similarly carries a driven dog **147** having an upstanding arm **148** also extending parallel to the shaft axis. The parallel arms **145** and **148** are disposed between the radially extending ends **149** and **150** of a first torsion coil spring **152** surrounding driven shaft **105** and they are also disposed between the radially extending ends **154** and **155** of a second torsion coil spring **156** surrounding driven shaft **105**. A U-shaped index bracket **158** disposed within coil springs **152** and **156** has notches **159** in the ends of the legs thereof adapted to receive radially extending ears **161** on driving dog **144** so that index bracket **158** rotates with driving shaft **49**. Index bracket **158** has a non-circular aperture **162** in the cross-piece thereof which receives a complementary non-circular cam block **163** having a circular aperture **165** through which driven shaft **105** protrudes and a circular cam surface portion **167** eccentric relative to the axis of aperture **165** and driven shaft **105**. Index bracket **158** operatively connects cam **163** to driving shaft **49**. Eccentric cam portion **167** is received within a circular aperture **170** in a pawl **171** and reciprocates pawl **171** in a radial direction as driving shaft **49**, and thus index bracket **158** and cam block **163**, rotate. Pawl **171** has a pair of depending ears **173** which fit over driven dog **147** to prevent relative rotation therebetween and are normally retained between an adjacent pair of four stop pins **174A**, **174B**, **174C** and **174D** mounted approximately ninety degrees apart about the axis of driven shaft **105** on contact plate **57** to normally prevent movement of driven shaft **105** and switch movable contacts **34**. A tubular spacer **175** (see FIG. 2) surrounding driven shaft **105** and disposed between cam block **163** and the end of driving shaft **49** holds the eccentric portion **167** of cam block **163** within the circular aperture **170** in pawl **171** and also retains the non-circular cam block **163** within the non-circular aperture **162** in index bracket **158**.

The normal position of pawl **171** relative to stop pins **174** is best seen in FIG. 4 of the drawing, and it will be appreciated that driving shaft **49** and driving dog **144** carrying depending arm **145** can be rotated in either direction to load torsion springs **152** and **156**. Assume that driving shaft **49** and driving dog **144** carried thereby are rotated approximately ninety degrees in the clockwise direction as shown in FIG. 5, thereby causing arm **145** on driving dog **144** to actuate spring ends **149** and **154** in the clockwise direction while spring ends **150** and **155** abut against arm **148** of driven dog **147** and are prevented from movement by pawl **171** being retained between a pair of stop pins **174A** and **174B**, thereby loading torsion springs **152** and **156**. It will be noted that after approximately ninety degrees of clockwise rotation of driving shaft **49**, cam portion **167** has radially withdrawn pawl **171** to the position shown in FIG. 5 wherein it still engages stop pin **174A**. After approximately forty-five additional degrees of rotation of driving shaft **49**, cam portion **167** retracts pawl **171** radially to a position wherein it is free of stop pin **174A**, and loaded torsion springs **152** and **156** snap arm **148** on driven dog **147**, and thus driven shaft **105** carrying movable contacts **34**, to the succeeding position. In moving to the suceeding switch position, pawl **171** rotates relative to cam portion **167** which forces pawl **171** radially outward between stop pins **174A** and **174D** as shown in FIG. 6 to retain the movable contacts **34** in the succeeding position until the switch **30** is again operated. Pawl **171** is guided in its radially outward path between stop pins **174A** and **174D** by outwardly flared guiding surfaces **177** on driven dog **147** (shown in FIG. 10 and in dotted lines in FIG. 6) which engage the internal surfaces of depending ears **173** of pawl **171**.

If the movable contact members **95** become welded to the stationary contact members **77** under overload or short circuit current conditions and loaded springs **152** and **156** do not have sufficient force to break the welded contacts apart, driving shaft **49** may be rotated further until the radially extending striker portion **176** on driving dog **144** positively engages arm **148** on driven dog **147**, whereby further rotation of driving shaft **49**, with direct engagement between driving and driven shafts **49** and **105**, will break the movable contacts **34** apart from the stationary contacts **31** or **32**.

The rapid snap action of the movable contacts **34** by the loaded torsion springs **152** and **156** permits interruption of magnetizing and load current to the transformer primary winding **17** with minimum arcing and minimum erosion of the movable contact members **95** and stationary contact members **77**.

The generally radially extending stop surfaces **142** on index arm **131** subtend an angle of approximately 150 degrees relative to the axis of driving shaft **49**, and this

angle is slightly greater than the approximately 135 degrees rotation of driving shaft **49** required to rotate cam block **163** sufficiently to retract pawl ears **173** from between adjacent stop pins such as **174A** and **174B**. This approximately one hundred and fifty degrees of rotation of operating eye **48** permitted by the stop surfaces **142** is sufficient to permit striker portion **176** on driving dog **144** to engage arm **148** on driven dog **147** and positively separate the movable and stationary contacts.

While only a single embodiment of the invention has been illustrated and described, many modifications and variations thereof will be readily apparent to those skilled in the art, and consequently it is intended in the appended claims to cover all such modifications and variations which fall within the true spirit and scope of the invention.

I claim:

1. In a reversible, multi-position, sectionalizing switch, in combination, support means, a plurality of stop pins mounted in circumferentially spaced apart relation in a circle on said support means, coaxial driving and driven shafts rotatable about an axis through the center of said circle, helical torsion spring means surrounding said axis and having radially extending ends, driving and driven members having portions extending parallel to said axis and spaced from said axis and positioned between said radially extending ends of said torsion spring means and being affixed to driving and driven shafts respectively, a radially reciprocable pawl operatively connected to said driven member and normally occupying a position between a pair of adjacent stop pins and preventing rotation of said driven shaft, an eccentric operatively connected to said driving shaft for rotation therewith and engaging said pawl and being adapted when rotated to radially retract said pawl from said normal position between said pair of adjacent stop pins, rotation of said driving shaft simultaneously loading said torsion spring means and retracting said pawl, while said driven shaft is held against rotation by said pawl engaged between said adjacent stop pins until said driving shaft has rotated said eccentric sufficiently to withdraw said pawl from between said adjacent stop pins and permit said torsion spring means to snap said driven shaft to a succeeding position.

2. In the combination defined by claim **1** wherein said driving and driven members are L-shaped dogs having portions extending parallel to said axis.

3. In the combination defined by claim **2** wherein said pawl has ears extending parallel to said axis and spaced on opposite sides of said driven dog to operatively connect them together and wherein said ears engage said stop pins to prevent rotation of said driven member and said driven shaft.

4. In the combination defined by claim **3** wherein said driven dog has guiding surfaces which engage said ears and direct said pawl as it is actuated radially outward by said eccentric to a position between a succeeding adjacent pair of said stop pins.

5. In the combination defined by claim **2** wherein said driving dog has a radially extending portion adapted to engage said portion of said driven dog parallel to said axis after rotation of said driving shaft through a predetermined angle greater than that required to withdraw said pawl from between said adjacent stop pins if said driven shaft is undesirably held against movement under the force of said torsion spring means.

6. In the combination defined by claim **3** wherein said pawl has a circular opening therein and said eccentric is a cam journalled about said driven shaft and encircled by said torsion spring means and has a circular cam surface portion eccentric to said axis disposed within said circular opening in said pawl.

7. In the combination defined by claim **6** wherein said driving and driven shafts are rotatably journalled together.

8. In the combination defined by claim **7** wherein said cam has a non-circular portion and including a member engaging said driving dog and encircled by said torsion spring means and having a non-circular aperture receiving said non-circular portion of said cam and operatively connecting said cam to said driving shaft.

9. The combination defined by claim **1** and including a plurality of stationary contacts circumferentially spaced apart in a circle having said axis as a center and including a V-shaped movable contact of high conductivity material operatively connected to said driven shaft and adapted when rotated by said driven shaft to engage said stationary contacts individually and also to bridge between adjacent stationary contacts.

10. In the combination defined by claim **9** wherein said switch has a pair of stationary contacts and the arms of said V-shaped movable contact subtend approximately the same angle at said axis as said pair of stationary contacts.

11. In the combination defined by claim **10** wherein said movable contact has a circumferential flange and including a stationary terminal of high conductivity material having a cup-shaped portion circumjacent said flange and also including a continuous helical spring of high conductivity material disposed between said flange and said cup-shaped portion and carrying current therebetween as said movable contact and said flange are rotated relative to said cup-shaped portion of said stationary terminal.

12. In the combination defined by claim **9** wherein said switch includes first and second sets of said circumferentially spaced apart stationary contacts and said first and second sets are spaced apart axially of said driven shaft and said switch also includes a pair of said V-shaped movable contacts adapted to respectively engage said stationary contacts of said first and second sets and wherein said driven shaft has a portion of insulating material of high dielectric strength and said V-shaped movable contacts are connected to said insulating material portion.

13. In the combination defined by claim **12** wherein each of said first and second sets has two stationary contacts and said V-shaped movable contacts have circumferential flanges and including first and second stationary terminals of high conductivity material having cup-shaped portions circumjacent said circumferential flanges of said movable contacts and including first and second continuous helical springs of high conductivity material disposed between said circumferential flanges and said cup-shaped portions and carrying current therebetween.

14. In the combination defined by claim **13** and including first and second insulating support plates spaced apart axially of said driven shaft and having registering apertures therein receiving said insulating material portion of said driven shaft and respectively carrying said first and second sets of stationary contacts and said first and second stationary terminals and including means for mounting said first and second insulating plates on said support means.

15. In the combination defined by claim **14** wherein said first and second insulating support plates have registering openings therein and said mounting means includes tubular insulating spacers of high dielectric strength extending through said registering openings in said insulating support plates and having apertures extending diametrically therethrough and spaced apart axially of said tubular spacers, said mounting means also including studs protruding through said apertures and supporting said insulating plates on said tubular spacers, and means for affixing said tubular spacers to said support means.

16. In the combination defined by claim **12** and including first and second insulating support plates spaced apart axially of said driven shaft and having registering apertures therein through which said driven shaft freely protrudes, said first and second support plates and said support means having registering openings therein, tubular insulating spacers extending through said registering openings in said support plates, means including

threaded studs disposed within the axial bore in said tubular spacers and protruding through said openings in said support means for mounting said tubular spacers on said support means, L-shaped studs extending through said tubular spacers at points spaced apart axially thereof for mounting said support plates on said spacers, and wherein said first and second support plates respectively carry said first and second sets of stationary contacts.

17. The combination defined by claim **9** and including a metallic housing, an insulating dielectric fluid within said housing, means engaging said support means and a wall of said housing for supporting said switch within said housing and immersed in said dielectric fluid, said wall having an opening therein freely receiving driving shaft, and an operating eye affixed to said driving shaft exterior of said housing and being engageable by a hotstick.

18. The combination defined by claim **17** wherein said pawl has a circular opening therein and said eccentric is a cam journalled about said driven shaft and encircled by said torsion spring means and has a circular cam surface portion eccentric to said axis disposed within said circular opening in said pawl.

19. The combination defined by claim **18** wherein said driving and driven members are L-shaped dogs having portions extending parallel to said axis and said cam has a non-circular portion and including a member engaging said driving dog and encircled by said torsion spring means and having a non-circular aperture receiving said non-circular portion of said cam and operatively connecting said cam to said driving shaft.

20. The combination defined by claim **19** wherein said driving and driven shafts are rotatably journalled together and said driving dog has a radially extending portion adapted to engage said portion of said driven dog parallel to said axis after rotation of said driving shaft through a predetermined angle greater than that required to withdraw said pawl from between said adjacent stop pins if said movable contact becomes welded to one of said stationary contacts as a result of excessive current flow therebetween.

21. The combination defined by claim **20** and including means releasably connected to said wall exterior of said tank and mounted for rotation about said driving shaft for preventing rotation of said operating eye in one direction and for limiting rotation of said operating eye in the opposite direction to an angle slightly larger than said predetermined angle, and wherein said means for preventing rotation can be released and reset to a different position wherein it prevents rotation of said operating eye in said opposite direction and limits rotation thereof in said one direction to said angle slightly larger than said predetermined angle.

22. The combination defined by claim **17** wherein said operating eye has a depending leg portion and including an index plate affixed to said wall exterior of said housing, an index arm rotatably mounted on said driving shaft and having stop portions in the path of said and interfering with said depending leg portion of said operating eye and adapted to prevent rotation of said operating eye, and means for releasably securing said index arm to said index plate.

23. The combination defined by claim **22** wherein said stop portions of said index arm are generally radially extending surfaces disposed in the path of said depending leg portion of said operating eye when said operating eye is rotated and said index plate has a plurality of circumferentially spaced apart notches therein and including an eye carried by said index arm and engageable by a hotstick and having a latching portion adapted to fit within said notches in said index plate, and resilient means for urging said latching portion into one of said notches in said index plate.

24. The combination defined by claim **23** wherein said driving and driven members are L-shaped dogs having portions extending parallel to said axis and said driving dog has a radially extending portion adapted to engage said portion of said driven dog parallel to said axis after rotation of said driving shaft through a predetermined angle greater than that required to withdraw said pawl from between said adjacent stop pins if said movable contacts undesirably becomes welded to one of said stationary contacts and wherein the angle between said generally radially extending surfaces on said index arm is slightly greater than said predetermined angle.

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