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Trayer

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[45] **Feb. 26, 1974**

[54] **SUBMERSIBLE SWITCH AND DOUBLE TOGGLE, POWER TRANSMISSION MEMBER OPERATING MECHANISM THEREFORE**

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Related U.S. Application Data

[63] Continuation of Ser. No. 214,330, Dec. 30, 1971, abandoned.

[52] **U.S. Cl.**..... **200/153 G,** 200/153 V, 335/191

[51] **Int. Cl.**..... **H01h 3/46,** H01h 3/48

[58] **Field of Search**.....200/153 G, 153 H, 153 V, 200/153 SC, 144 B, 148 F; 335/68, 71, 72, 76, 191

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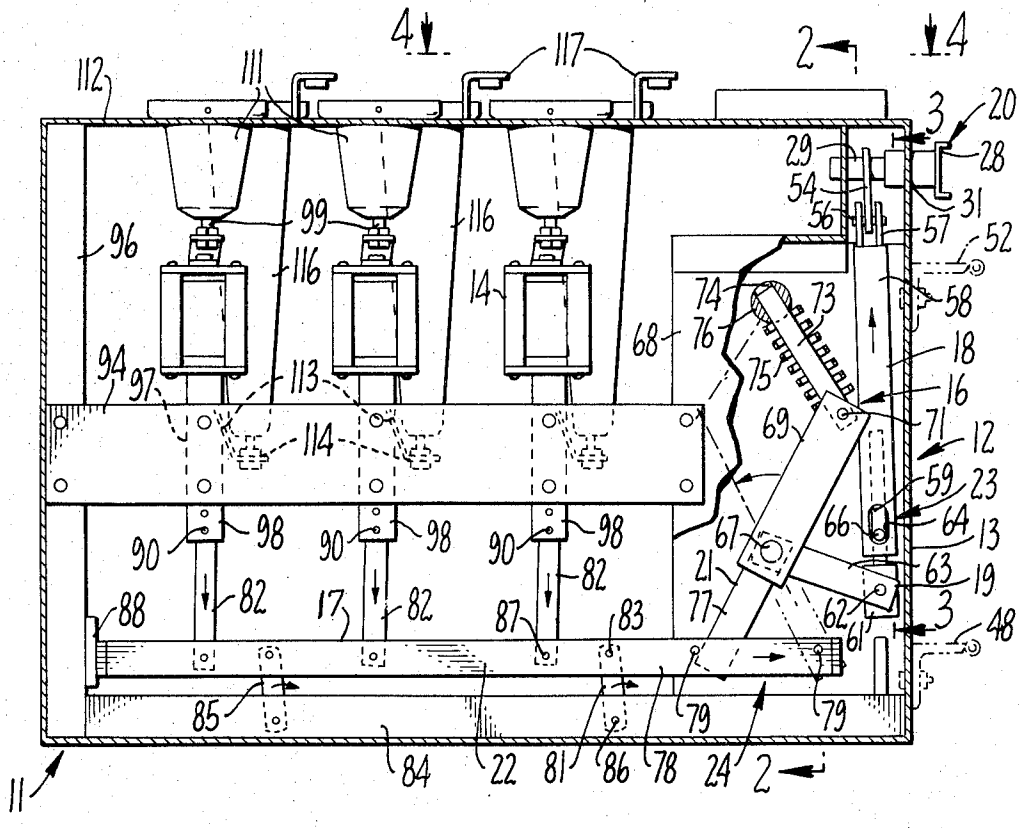
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Primary Examiner—Robert K. Schaefer
Assistant Examiner—Robert A. Vanderhye
Attorney, Agent, or Firm—Schapp and Hatch

[57] **ABSTRACT**

A medium-voltage submersible switch having a pair of over-center toggle mechanisms in series in the power train operating the switch elements, the first of the toggle mechanisms being operable from outside the tank housing the switch. Lost Motion connections are placed between the first toggle mechanism and the operator, and between the first and second toggle mechanisms. Three parallel switches are shown, actuated by a single driving bar, which is equipped with a stop to limit its motion just beyond the over-center point of the second toggle mechanism in one direction, and a latch mechanism is shown for remote triggering of the switch after the mechanism has been cocked. A motor operator is shown pivotally attachable to the outside of the enclosure and engageable with the operating member of the first toggle. The motor operator may be disengaged from the operating member for manual switch operation by being pivoted about the pivoted attachment. An alternate form is shown having a single switch element and a fuse in series with the switch element, for testing circuits suspected of high fault currents.

14 Claims, 9 Drawing Figures



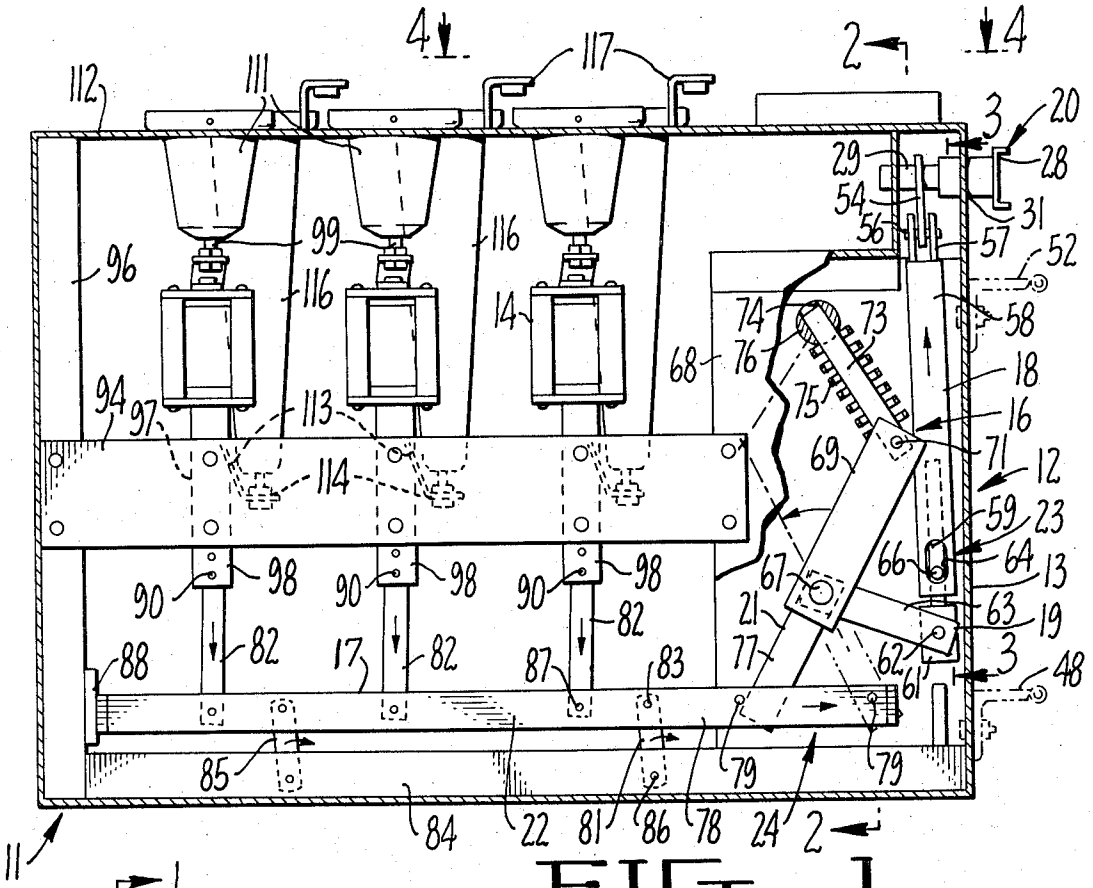


FIG. 1.

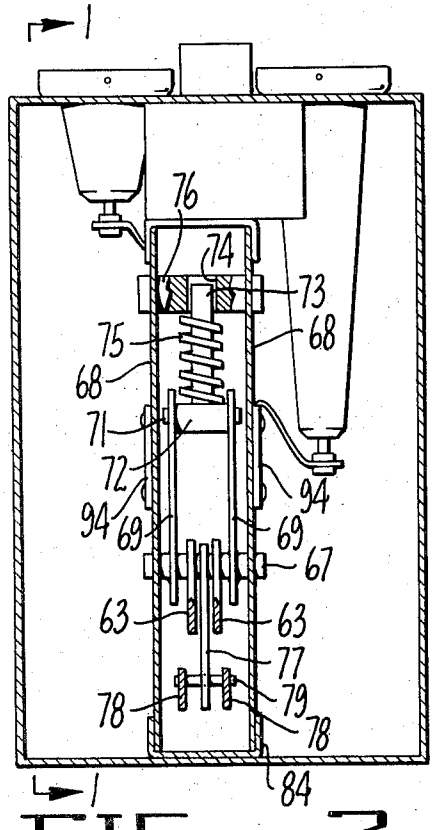


FIG. 2.

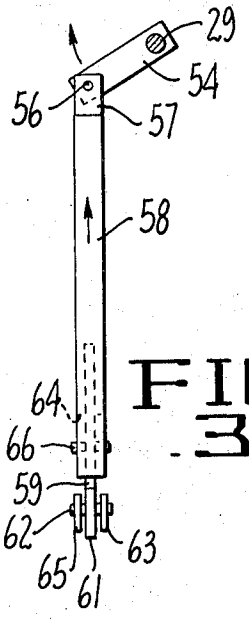


FIG. 3.

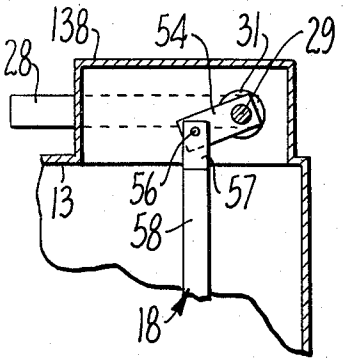


FIG. 9.

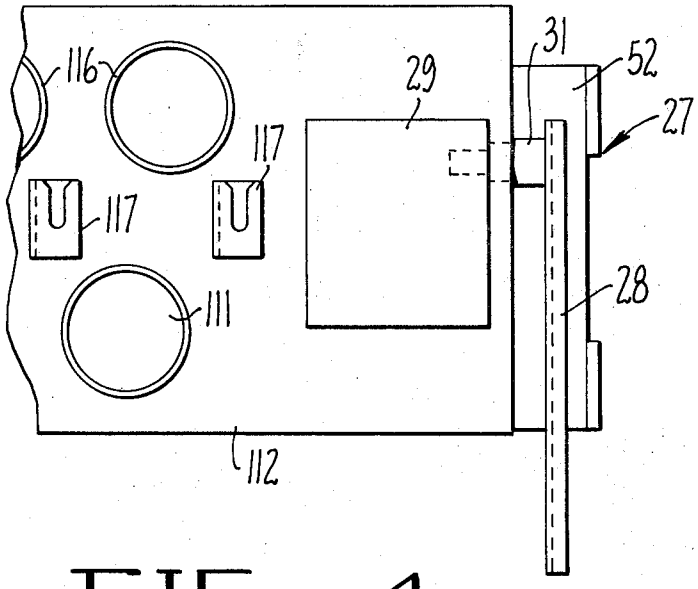


FIG. 4.

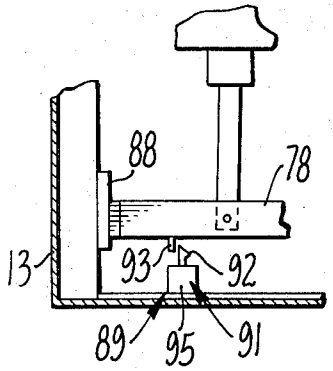


FIG. 5.

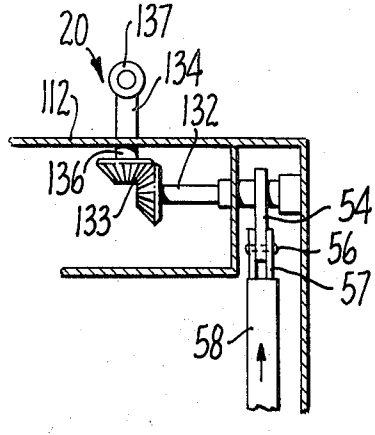


FIG. 8.

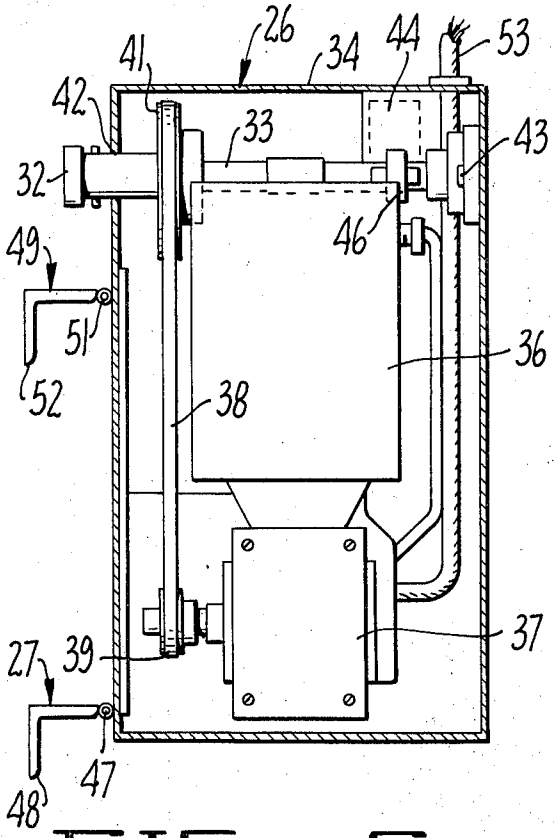


FIG. 6.

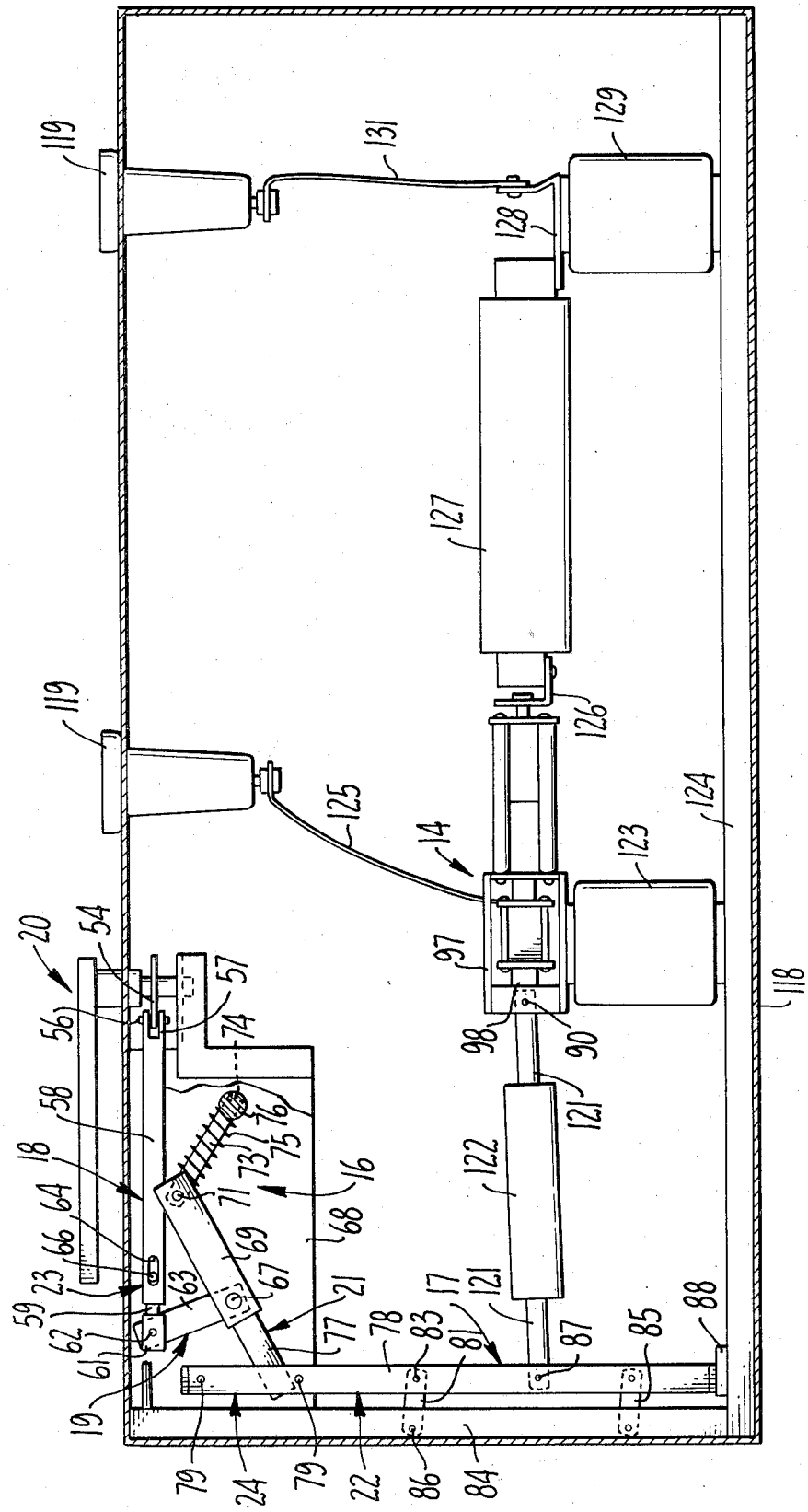

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FIG. 7.

SUBMERSIBLE SWITCH AND DOUBLE TOGGLE, POWER TRANSMISSION MEMBER OPERATING MECHANISM THEREFORE

This is a continuation of Application Ser. No. 214,330, filed Dec. 30, 1971 now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to a SUBMERSIBLE SWITCH AND OPERATING MECHANISM THEREFOR, and more particularly to a switch for medium voltage applications and its toggle-type actuating mechanism.

Urban beautification trends have led to increased demand for underground placement of utilities such as electric power. Heretofore, underground installation of distirbution and feeder systems, particularly in the medium-voltage (up to 23 kv.) range, has involved large installation expense. The components have required expensive separate weatherproof enclosures, and have had more or less permanent connections to the cables.

A further problem encountered with switches of high power-handling capacity is prevention of "teasing", that is, slow or incomplete motion. Slow opening motion under load or slow closing into a shorted circuit causes many problems, including erosion of the contacts, damage to the switch, etc. Firm engagement of the switch contacts is also necessary to provide the desired low resistance path, especially where the basic switching element is of the vacuum switch type where considerable force is required to bring the contacts into butting engagement.

Although switches of the present type may be motor-operated, provision must also be made for manual operation. Despite the high operating pressures involved, the switch must be capable of operation by a moderate amount of manual pressure. Further, where toggle or snap-over mechanisms are used, the manual operating handle must be shielded from the backlash of the mechanism, to prevent injury to the operator. Remote operation of the switch is also desirable, in view of the trend toward centrally controlled switching of power or automatic relayed operation. Previous remotely operable switches of this class have suffered from a complexity and bulkiness of structure which made them unsuitable for underground, unsheltered installation.

SUMMARY OF THE INVENTION

The switch and its operating mechanism of the present invention provide a submersible unit which may be installed as a part of an underground utility system without further weatherproofing, at a significant saving in installation cost. The removable and reconnectable cable connectors allow simple removal of the switch when change is necessary.

The double toggle action of the switch mechanism operates both to positively prevent teasing of the switch and to produce high contact-butting pressures without sacrifice of the ability to be operated by hand. Lost motion connections shield the operator and the motor drive mechanism from any backlash produced by the rapid, forceful motion of the toggles.

The motor operator allows remote operation of the switch by controlling power to the drive motor from a central switchboard or automatic relay, and the motor operator may be pivotally swung away from and out of engagement with the switch to permit manual operation. The switch may also be set up for remote operation by cocking one toggle part way through its motion and restraining the second toggle against motion in response to the first toggle by a remotely releasable latch.

Accordingly, it is a principal object of the present invention to provide a switch of the character described which is reconnectable and self-contained in its weather proofing.

It is a further principal object of the present invention to provide a switch of the character described which is tease-proof and provides high contact-butting pressures while retaining ease of manual operation.

Yet another object of the present invention is to provide a switch of the character described which protects the operator against backlash.

A further object of the present invention is to provide a switch of the character described which is easily convertible from motor driven to manual operation.

Still another object of the present invention is to provide a switch of the character described which is adapted for remote operation.

A still further object of the present invention is to provide a switch of the character described having a simple operating mechanism within the enclosure of the switch.

Further objects and advantages of the present invention will become apparent as the specification proceeds, and the new and useful features thereof will be fully defined in the claims attached hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred form of the present invention is illustrated in the accompanying drawings, forming part of this specification, in which:

FIG. **1** is a cross-sectional side elevation view, with portions broken away, of the switch of the present invention, taken approximately along the plane of lines **1—1** of FIG. **2**;

FIG. **2** is a cross-sectional end elevation view, with portions broken away, taken approximately along the plane of lines **2—2** of FIG. **1**;

FIG. **3** is a fragmentary cross-sectional view taken approximately along the plane of lines **3—3** of FIG. **1**;

FIG. **4** is a fragmentary plan view taken approximately along the plane of lines **4—4** of FIG. **1**;

FIG. **5** is a fragmentary cross-sectional view, with portions broken away, corresponding to the lower left corner of FIG. **1**, showing a modified form;

FIG. **6** is a side elevational cross-section view of the motor operator for the switch;

FIG. **7** is a plan cross-sectional view of an alternative embodiment of the present invention;

FIG. **8** is a fragmentary cross-sectional view with portions broken away corresponding approximately to the upper right corner of FIG. **1**, showing a modified form; and

FIG. **9** is a fragmentary cross-sectional view with portions broken away corresponding approximately to the upper right corner of FIG. **1**, showing another modified form.

While only the preferred forms of the present invention have been shown here, it should be understood that various changes or modifications may be made within the scope of the claims attached hereto without departing from the spirit of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings in detail, it will be seen that the medium voltage submersible switch **11** of the present invention includes an operating mechanism generally indicated at **12**, contained within a submersible enclosure **13**, and a medium power switch means **14**, also enclosed within the enclosure **13**. The operating mechanism **12** includes a first toggle mechanism generally indicated at **16**, and a second toggle mechanism generally indicated at **17**. The first toggle mechanism **16** has first and second operating members **18** and **19** respectively, and a first power transmission member **21**. The second toggle mechanism **17** has a second power transmission member **22**, and has an operative connection to the switch means **14** to open and close the switch means.

The operating mechanism **12** also includes a lost-motion connection **23** between the first operating member **18** and the second operating member **19** to selectively transmit motion between them. A portion of the first operating member **18** generally indicated at **20** is adapted for engagement by a source of motive power, and as shown here, passes from the interior of the enclosure **13** to the exterior. The second operating member **19** is attached to the first toggle mechanism **16** to move that mechanism past its over-center point. The first power transmission member **21** is also connected to the first toggle mechanism **16**, so that it moves in response to the movement of the first toggle mechanism. The first power transmission member **21** and the second power transmission member **22** are connected to transmit the force of the movement of the first toggle mechanism to the second toggle mechanism to cause it to operate and thereby open and close the switch **14**.

In the preferred embodiment, the connection between the first and second power transmission members **21** and **22** is a second lost-motion connection generally indicated at **24**. Since the toggle mechanisms are within the enclosure, the passing of the portion **20** of the first operating member **18** through the wall of the enclosure **13** to the exterior permits operation of the switch **14** from outside the enclosure. The first and second toggle mechanisms shown here are both of the basic "over-center" type having two stable positions. The first and second operating members **18** and **19** coact to form a means effective to move the first toggle mechanism **16** between its two stable positions, and the first and second power transmission members **21** and **22** coact to form a means effective to move the second toggle mechanism **17** between its two stable positions.

Since the connection between the first and second operating members **18** and **19** is a lost motion connection, the speed of motion of the first toggle mechanism **16** is rendered independent of the speed of motion of the first operating member **18** after the toggle mechanism **16** passes its over-center point. Likewise, the speed of motion of the second toggle mechanism **17** is rendered independent of the speed of motion of the first toggle mechanism **16** after the second toggle mechanism **17** passes its over-center point.

The independence of speed of motion produced by the two lost motion connections serves two purposes. The first is to permit the most rapid possible action by the second toggle mechanism in opening the switches by providing high biasing force for the second toggle mechanism and permitting that high force to accelerate the second toggle mechanism, after the over-center point is passed, free of mechanical hindrance posed by any inertia in the remainder of the operating mechanism. Similar freedom of action after the over-center point is passed is given to the first toggle mechanism for the same reason, namely to speed its motion by relieving it of connection with linkage which would otherwise slow that motion.

The second purpose of the lost-motion connections is to protect the switch operator, either motor or human, from the backlash force generated in the snap action of the toggles. Without this protection, wear on the gear train of the motor operator would be excessive, and manual operation would pose a danger of injury to a human operator through transmission of one or more sudden mechanical jolts to the operating handle.

The switch **11** is intended for both manual and motor operation, and for motor operation includes a motor operator mechanism generally indicated at **26** in FIG. **6**. The motor operator mechanism **26** is pivotally mounted on the outside of the enclosure **13** by a hinge structure **27**, and can be pivotally moved about the axis defined by the hinge structure **27** to provide selective engagement and disengagement between the motor operator **26** and the first operating member **18**. To form the engageable parts, the portion **20** of the first operating member **18** extending outside the enclosure **13** includes an elongate channel-shaped handle member **28** attached to a short shaft member **29**, which is journalled in turn in a sealed bearing member **31** which passes through the wall of the enclosure **13**. The handle member **28** is swung through a short arc to rotate the shaft **29** and actuate the remainder of the operating mechanism **12** within the enclosure.

The motor operator **26** is equipped with an elongate member or bar **32** attached to its rotary output shaft **33**, with the bar **32** being of a shape and dimension to engage the handle member **28** by fitting within the channel of the handle member when oriented to lie colinear with the handle member **28**. This engagement provides the operating connection between the motor operator **26** and the first operating member **18** when the motor operator **26** is pivoted toward the enclosure **13** and held in that position. The motor operator **26** is disengaged by pivotal motion away from the enclosure **13** so that the bar **32** slips approximately axially of the shaft **29** out of the channel of the handle **28**.

The motor operator **26** includes a submersible enclosure **34** housing an electric motor **36**, a gear train **37** driven by the motor **36**, and the output shaft **33**, driven by a cogged belt **38** which passes around cogged pulleys **39** and **41** on the output shaft of the gear train **37** and the output shaft **33** respectively. The output shaft **33** is journalled in a sealing bearing **42** which passes through the wall of the enclosure **34**, and at its other end in a bearing **43** fixed to the opposite wall of the enclosure **34**. A limit switch **44** is actuated by a cam member **46** on the shaft **33** to stop the motor at each end of the arc of travel of the bar member **32**, and cause its direction to be reversed on subsequent energization.

The hinge structure **27** which attaches the motor operator **26** to the enclosure **13** is shown here as including a separable hinge **47**, that is, a hinge having a removable pin so that the two leaves may be pulled apart. One leaf is attached securely to an angle bracket **48** which is, in turn, bolted to the enclosure **13**. The other leaf is

securely attached to the enclosure **34** of the motor operator, so that the bringing together of the two leaves and insertion of the hinge pin will pivotally attach the motor operator to the enclosure **13** of the switch. A second hinge structure **49** is placed higher up on the walls of the enclosures **13** and **34** and is similarly formed by a separable hinge **51** having one leaf fixed to an angle bracket **52** which is bolted in turn to the enclosure **13.** Placement of the pin in the hinge **51** fixes the motor operator **26** in engagement with the handle **28** of the switch, and removal of the pin permits the motor operator **26** to be pivoted about the lower hinge **47** to disengage the bar **32** from the handle **28.**

In situations where complete removal of the motor operator **26** is unlikely to be called for, the lower hinge **47** may be of the fixed-pin type. Other structures permitting the disengaging movement of the motor operator **26** may be substituted for the hinge structure **27,** but the structure shown is preferred for reasons of simplicity and reliability. Likewise, other latch structures capable of holding and releasing the engagement of the motor operator **26** with the handle **28** may be substituted for the upper hinge **51** so long as they permit the selective holding and release desired, with the structure shown being preferred for the reasons given above. The motor operator **26** may also include an actuating switch (not shown) to start motor operation at the desired time, or such a switch may be remotely located to govern supply of power to the motor operator **26** via the power supply cable **53.**

Within the enclosure **13** of the switch **11,** the short shaft member **29** bears an arm **54** extending radially outward from the shaft **29.** The arm **54** is pivotally attached by a pin **56** to the yoke **57** at the end of an actuating rod **58.** The acutating rod **58** extends downwardly toward the second operating member **19,** and the lower end of the rod **58** is hollow to receive in a telescoping fashion a stub shaft **59** which projects from a block **61.** The block **61** is in turn pivotally attached by a pin **62** to the bar member **63** which forms the second operating member **19.** The lost-motion connection **23** between the first and second operating members **18** and **19** is formed by an elongate slot **64** formed in the wall of the hollow portion of the actuating rod **58** and a pin **66** fixed to the inner shaft **59,** with the pin **66** projecting through the slot **64.**

The lost-motion connection will transmit motion when the pin **66** engages the top or bottom of the slot **64,** but allows the shaft **59** and hence the bar member **63** to essentially fly free for the length of the slot **64.** The bar member **63** is rigidly attached to a shaft **67** journalled in the walls of subframe **68** within the enclosure **13.** A pair of bar members **69** which form one link of the first toggle mechanism **16** are rigidly attached to the shaft **67** at their lower ends, and pivotally attached to the other link of the first toggle mechanism by a pin **71** passing through their upper ends.

A sleeve **72** is journalled on the pin **71** and a shaft **73** which forms the other link of the first toggle mechanism **16** is rigidly attached to the sleeve **72.** The end of the shaft **73** opposite the sleeve **72** is journalled for axial motion through an aperture **74** which passes transversely through a short shaft **76** journalled for rotary motion in the walls of the subframe **68.** A helical coil spring **75** surrounds the shaft **73** and is compressed between the sleeve **72** and the short shaft **76** to provide the biasing force for the first toggle mechanism **16.**

The first toggle mechanism is moved from the position shown in FIG. **1** to its other stable state by the movement of the handle **28** from the horizontal position shown to a vertical position. This motion causes the arm **54** to move clockwise as seen from the handle **28** side of the tank **13,** pulling the actuating rod **58** upward. The pin **66** will contact the bottom of the slot **64** to transmit the upward motion from the rod **58** to the block **61** and the bar member **63.** The bar member moves counter-clockwise as seen in FIG. **1,** carrying the bar members **69** which form one link of the toggle **16** counterclockwise with it.

As the bar members **69** pass the over-center point, the toggle **16** will snap quickly to its other stable state, that is, with the common point of the two links **69** and **73,** the pin **71,** lying to the left of the vertical centerline running between the shafts **76** and **67.** During the snap motion, the pin **66** will fly vertically free in the slot **64,** but the slot length is selected so that the pin will not travel far enough to contact the top of the slot **64** to transmit the toggle force back to the handle **28.**

The first power transmission member **21** is formed by a bar member **77** rigidly attached to the shaft **67.** The second power transmission member **22** is an elongate bar **78** extending generally parallel to the floor of the enclosure **13.** The first and second power transmission members **21** and **22** are connected by the second lost-motion connection **24,** formed by a pair of pins **79** attached to the bar **78** and extending transversely out from it to capture the bar **77** between them.

The elongate bar **78** acts at the elbow point of the second toggle mechanism **17** by being pivotally connected to a link member **81** which forms the first link of the second toggle **17** and also pivotally connected to a second link member **82** which forms the second link of the second toggle mechanism **17.** The first link **81** is pivotally connected to the bar **78** by a pin **83** and to a channel member **84** which runs along the floor of the tank **13,** by a pin **86.** To facilitate support of the elongate bar **78,** a second link **85** may be provided in parallel with the link **81,** as shown near the left side of FIG. **1,** with the same connections to the bar **78** and the tank **13.**

The second link **82** is attached to the bar **78** by a pin **87** and to the movable portion **98** of the switch **14** by a pin **90.** It is to be noted that the first link **81** and the second link **82** are attached to the bar **78** at different points along the bar **78.** The use of different points of attachment produces a simplified toggle structure of increased ruggedness. The application of force to the second toggle **17** directly at the elbow point of the toggle by the elongate bar **78** produces the most effective leverage in moving the second toggle against a high biasing force.

A stop means **88** engages the elongate bar **78,** as seen at the extreme left of FIG. **1,** so that leftward motion of the elongate bar **78** is halted when the second toggle mechanism is a short distance to the left of the vertical centerline, that is, just beyond the over-center point, of the second toggle mechanism **17,** in the position shown in FIG. **1.** Since this position is one in which the toggle mechanism **17** is near its maximum vertical extension, movement to this position closes the switch contacts of the switch means **14.**

The bistable, self positioning nature of the toggle mechanisms allows the switch **11** to operate without latches or sear pins. However, the provision of a latch

means 89 in the modification shown in FIG. 5 allows the switch to be cocked and left for remote triggering, by engaging the latch means 89 with the elongate bar 78. This engagement permits selective retention of the bar in the switch closed position (the position shown in FIG. 1) in spite of the operation of the first toggle 16 into the position opposite that shown, that is, with the bar member 77 bearing against the right-hand member of the pair of pins 79 rather than the left-hand member. With the first toggle 16 pressing against the right hand pin 89 and the elongate bar 78 held against movement, motive force for operation of the switch is stored, as the first toggle is then unable to complete its motion, halting slightly beyond the over-center point without reaching its stable position beyond the over-center point. The latch means 89 may subsequently be actuated to release the elongate bar 78 and permit it to move to the right to open the switch 14.

The latch means shown in the present embodiment uses a movable latch dog member or latch tooth 92 selectively engageable with a detent means formed by a pin 93 depending from the elongate bar 78. A motive means 91 is attached to the latch tooth 92 to move it into and out of engagement with the detent means 93. As here shown, the motive means is a solenoid actuator 95 secured to the enclosure 13. Since the solenoid 95 is fastened to the interior of the enclosure 13, the latch dog 92 is fixed against movement with respect to the enclosure 13 in the direction of the bias applied to the elongate bar 78. Thus engagement of the latch tooth 92 with the pin 93 halts rightward (as seen in FIG. 1) movement of the bar 78. The latch dog 92 is attached to the moving armature of the solenoid 95, and the solenoid is positioned so that the dog 92 engages the detent 93 at one position of the armature and disengages from the detent at another position of the armature. The solenoid 91 is supplied with its actuating power through leads which pass through the wall of the tank 13 through appropriately sealed openings (not shown). The actuating power may be controlled locally to trigger release of the bar 78, as by supply from the truck of a work crew or from the output of a current transformer, or remotely from a central switchboard. An emergency manual control (not shown) by wire attached to the solenoid armature and extending througe a packing gland in the wall of the enclosure 13 may be provided if desired.

In the embodiment of FIG. 1, three switches 14 are shown, as appropriate to use as an interrupter with the usual three-phase distribution system. It should however, be appreciated that the number of switches may vary from one, as shown in FIG. 7, to many. The switches 14 are of the vacuum interrupter type, operated by axial reciprocation of one end of the switch enclosure to move one contact within the vacuum chamber relative to a fixed contact. The switches 14 are mounted between two strips 94 of an insulating material of high dielectric and mechanical strength, such as a glass fiber-polyester composition, which are each bolted at the left end as shown in FIG. 1 to a bracket member 96 secured to the left end of the enclosure 13, and at the right end to the subframe 68. The fixed portion 97 of each of the switches is in turn bolted to the insulating strip 94. The moveable portion 98 of the switch 14 is reciprocated up and down by the up and down reciprocation of the second link 82 of the second toggle 17, to which it is attached by pin 90.

The position of the second toggle 17 shown in FIG. 1 produces near maximum extension of the link 82 in the upward direction, since the stop 88 is encountered just beyond the over-center point, the point of maximum vertical extension of the upper end of the link 82. The other stable position of the second toggle 17 yields a lower position of the link 82 as the elongate bar 78 passes farther to the right of the over-center point in the second stable position than it passes to the left of the over-center point when in the position shown. The difference in vertical extension of the link 82 in the two stable positions of the toggle is selected to firmly close the contacts of the switch 14 with a high butting pressure in the position shown and to open the contacts a distance sufficient for positive and rapid arc extension in the second stable position. Preservation of the vacuum seal of the switch 14 while permitting the movement of one contact is produced by a number of switch constructions well-known in the vacuum switch art, among which is the use of a metal bellows structure of the type used in a Sylphon device.

One terminal of each switch 14 is connected at the top of the switch to a conductor stud 99 depending from the bottom of connecting sockets 111 mounted in the top plate 112 of the enclosure 13. The lower terminal of each switch 14 is connected by a conductor 113 to the connector stud 114 of connecting sockets 116 also mounted on the top plate 112. Insulating material is interposed between the lower terminal of the switch 14 and the second toggle mechanism 17, such as by forming the link 82 of high dielectric strength material.

The connecting sockets III and 116 may be of any type suitable for submersible, disconnectable and readily reconnectable service at voltage levels in the medium voltage range, over 600 v. and under 23,000 v. Suitable connectors of that type include the ESNA connectors disclosed in U.S. Pat. No. 3,522,404 issued to the present applicant. The tank is customarily filled with a dielectric oil material. Brackets 117 are mounted alongside the connecting sockets 111 and 116, to which an insulator can be temporarily mounted to provide a "parking stand" to receive the unplugged cables after they are disconnected from the sockets 111 and 116.

A modification of the first operating member 18 is shown in the fragmentary view of FIG. 8. In this modification, a shaft 132 equivalent to the short shaft 29 of the first embodiment extends to the left as shown and bears at its left end one member of a pair of bevel gears 133. That bevel gear meshes with the other member of the pair 133, which is borne by a short shaft 134 which extends through a sealing bearing 136 mounted in the top plate 112, to the exterior of the enclosure 13. The short shaft terminates at its upper end in a ring or eye 137. This modification is appropriate for operation by manual turning of a "hotstick" (not shown) having its hook inserted through the eye 137.

Another modification of the first operating member 18 for "hotstick" operation is shown in the fragmentary view of FIG. 9, corresponding to FIG. 8, In this form, the handle member 28 is mounted on one wall of a compartment or "penthouse" 138 and turned to one side from the form shown in FIG. 1-4. The actuating rod 58 is lengthened to extend up into the compartment 138, where it connects to the arm 54 borne by the shaft 29. The shaft 29 passes through the sealed bearing 31 in the rear wall of the compartment 138, and is con-

nected to the handle **28** outside. This form allows both hand and hotstick operation from the top of the tank **13** so that the power cables may be disposed around the sides of the tank **13** without obstruction.

In the embodiment shown in FIG. **7**, the switch **14** and its operating mechanism **12** form part of a fused test switch. As before, the apparatus is contained in a submersible enclosure **118** with submersible connecting sockets **119** essentially similar to the sockets **111** and **116** for connecting the input and output cables to the apparatus. The first toggle mechanism **16** is essentially the same throughout as in the preceding embodiment, and the elongate bar **78** and the first link **81** of the second toggle mechanism **17** are likewise essentially the same and hence carry the same numbers as in the preceding embodiment. The second link **121** of the second toggle **17** shown here is also similar to the second link **82** of the preceding embodiment, but is longer and has an insulating member **122** interposed along its length to provide additional isolation as appropriate to use as a test switch device. The mode of connection of the second link **121** to the switch **14** is the same as in the preceding embodiment and therefore bears the same numbers. The moveable portion **98** is pivotally connected to the link **121** by a pin **90** as before.

The fixed portion **97** of the switch **14** is mounted to the enclosure **13** in a slightly different fashion than in the preceding embodiment, by a standoff insulator **123** bolted to the fixed portion **97** and to a channel member **124** which runs along one side of the enclosure **118.** A conductor **125** connects one terminal of the switch **14** to the socket **119,** and the other terminal of the switch **14** is connected directly by a bracket **126** to one terminal of a high voltage, high current fuse **127.** The other terminal of the fuse **127** is connected to a bracket **128** mounted on a standoff insulator **129** similar to the standoff insulator **123.** The standoff insulator **129** is bolted to the channel member **124,** and a conductor **131** extends from the bracket **128** to the connecting socket **119.** Only one switch **14** is used in the present embodiment, as such test switches are usually used with only a single line at a time, to detect heavy faulting in the line by blowing the fuse **127.**

In the present embodiment, a portion of the enclosure **118** may be made hinged and bolted down to allow easier access to the interior of the enclosure for replacement of the fuse **127.** The enclosure **118** may be filled with dielectric fluid, or may be air filled for convenience of replacement of the fuse **127.**

From the foregoing, it may be seen that a submersible switch and operating mechanism has been provided which combines prevention of teasing with ease of manual operation despite the high contact pressures used. The switch is easily converted from motor to manual operation, and may be triggered remotely. Both the human and the motor operator are shielded from backlash, and the switch has a simple and economically constructed operating mechanism, contained within an entirely self-weatherproofing enclosure equipped with readily releasable and reconnectable totally weatherproof connectors for the power cables.

I claim:

1. An operating mechanism for a medium voltage switch in a submersible enclosure and the like, comprising

a first spring loaded overcenter toggle mechanism having two stable positions,

means for selectively moving said first spring loaded overcenter toggle mechanism between said stable positions, and

a second toggle mechanism connectable to the medium voltage switch and having two stable positions and a power transmission member, said power transmission member comprising an elongate bar acting at the elbow point of said second toggle mechanism and connected to said first spring loaded overcenter toggle mechanism for lost motion actuation thereby said second toggle mechanism comprising a first link pivotally connected to said bar at one end of said link and pivotally connected to said enclosure at the other end of said link, and a second link pivotally connected to said bar at one end of said second link and pivotally connected at the other end of said second link to said switch means to close same in one of said stable positions and open same in the other of said stable positions.

2. An operating mechanism for medium voltage switches as described in claim **1** and wherein said means for selectively moving said first spring loaded overcenter toggle mechanism comprises

a first operating member engageable by a source of motive power,

a second operating member attached to said first toggle mechanism, and

a lost-motion connection between said first operating member and said second operating member, whereby the speed of motion of said first toggle mechanism is rendered independent of the speed of motion of said first operating member after said first toggle mechanism passes its over-center point.

3. An operating mechanism for medium voltage switches as described in claim **1** and wherein said first spring loaded overcenter toggle mechanism comprises a power transfer member connected to said power transmission member associated with said second toggle mechanism by a lost motion connection whereby the speeds of motion of said first and second toggle mechanisms are rendered independent of each other.

4. A medium voltage submersible switch, comprising

a submersible enclosure,

a medium voltage switch means contained within said enclosure,

a first spring loaded overcenter toggle mechanism having first and second operating members and a first power transmission member,

a second toggle mechanism having a second power transmission member comprising

an elongate bar acting at the elbow point of said second toggle mechanism,

said second toggle mechanism comprising a first link pivotally connected to said bar at one end of said link and pivotally connected to said enclosure at the other end of said link, and a second link pivotally connected to said bar at one end of said second link and pivotally connected at the other end of said second link to said switch means to open and close same, and

a lost-motion connection between said first and second operating members for selectively transmitting motion therebetween, said first operating member having a portion thereof adapted for engagement by a source of motive power, said second operating member being connected to said first toggle mech-

anism to move said first toggle mechanism past its overcenter point, said first power transmission member being connected to said first toggle mechanism for movement in response to movement of said first toggle mechanism, said first and second power transmission members being connected to transmit force from said first toggle mechanism to said second toggle mechanism to open and close said switch.

5. A medium voltage submersible switch as described in claim **4** and wherein said first and second power transmission members are connected by a second lost motion connection and said first operating member passes from the interior to the exterior of said submersible enclosure for engagement outside said enclosure to operate said first toggle mechanism, said first toggle mechanism being contained within said submersible enclosure.

6. A medium voltage submersible switch as described in claim **5** and wherein a portion of said first operating member extending on the exterior of said enclosure is formed as a rotable shaft, rotation of which will cause motion of said first operating member, the terminus of said shaft outside said enclosure being formed into an eye loop for engagement by a remote operating tool such as a hot stick.

7. A medium voltage submersible switch as described in claim **5** and wherein said switch further comprises a motor operator mechanism pivotally mounted on the outside of said enclosure and selectively engageable with said first operating member outside said enclosure to move said first toggle mechanism, said selective engagement being provided by motion about said pivotal mounting.

8. A medium voltage submersible switch as described in claim **7** and wherein said first operating member comprises an elongate channel member pivotally mounted on the exterior of said enclosure and communicating mechanically with the interior of said enclosure, and said motor operator mechanism comprises an elongate member lying substantially co-linear with said elongate channel member when said motor operator mechanism is engaged with said first operating member and formed to engage said elongate channel member when brought into substantially co-linear relation therewith to transmit motive force from said motor operator mechanism to said first operating member, whereby said elongate channel member and said elongate member of said motor operator mechanism may be selectively disengaged to permit use of said elongate channel member as a manual operating handle for said switch.

9. A medium voltage submersible switch as described in claim **4** and wherein said switch means comprises a plurality of switches each actuated by said second toggle mechanism.

10. A medium power submersible switch as described in claim **4** and wherein said second link is pivotally attached at one end thereof to said bar at a point along said bar other than the point of pivotal attachment of said first link thereto.

11. A medium voltage submersible switch as described in claim **4,** further comprising a stop means adapted to engage said elongate bar to halt motion of said bar just beyond the over-center point of said second toggle mechanism in the direction which closes said switch.

12. A medium voltage submersible switch as described in claim **4** further comprising a latch means engageable with said elongate bar to selectively retain said bar in the position in which said switch is closed despite movement of said first toggle mechanism in the opening direction, whereby said first toggle mechanism may be operated to bias said elongate bar toward the position in which said switches are opened without moving said bar to said position, and said latch means may be subsequently triggered to release said bar to move under said bias toward the position in which said switch is opened.

13. A medium voltage submersible switch as described in claim **12** and wherein said latch means comprises a detent means formed on said elongate bar, a moveable latch dog member selectively engageable with said detent means, and motive means attached to said latch dog member for moving same into and out of engagement with said detent means, said latch dog member being so fixed against movement with respect to said enclosure in the direction of the bias applied to said elongate bar as to prevent movement of said elongate bar in the direction of said bias when said latch bog member is engaged with said detent.

14. A medium voltage submersible switch as described in claim **13** and wherein said motive means comprises a solenoid actuator mounted on the interior of said enclosure and having said latch dog member attached to the moving armature thereof, said latch dog member engaging said detent at one position of the moving armature of said solenoid and disengaging from said detent at another position of said armature.

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