# United States Patent [19]

**Graybill**

[11] **3,876,846**

[45] **Apr. 8, 1975**


[54] **COMBINATION GROUND AND TEST SWITCH APPARATUS FOR PRESSURIZED-GAS-INSULATED HIGH VOLTAGE SYSTEMS**


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[22] Filed: **Mar. 12, 1974**

[21] Appl. No.: **450,466**

**Related U.S. Application Data**

[63] Continuation of Ser. No. 280,999, Aug. 16, 1972.

[52] **U.S. Cl.** ..... **200/148 B;** 200/148 F

[51] **Int. Cl.** ..... **H01h 33/60**

[58] **Field of Search** ..... 200/148 R, 148 B, 148 D, 200/148 F



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*Primary Examiner*—Robert S. Macon

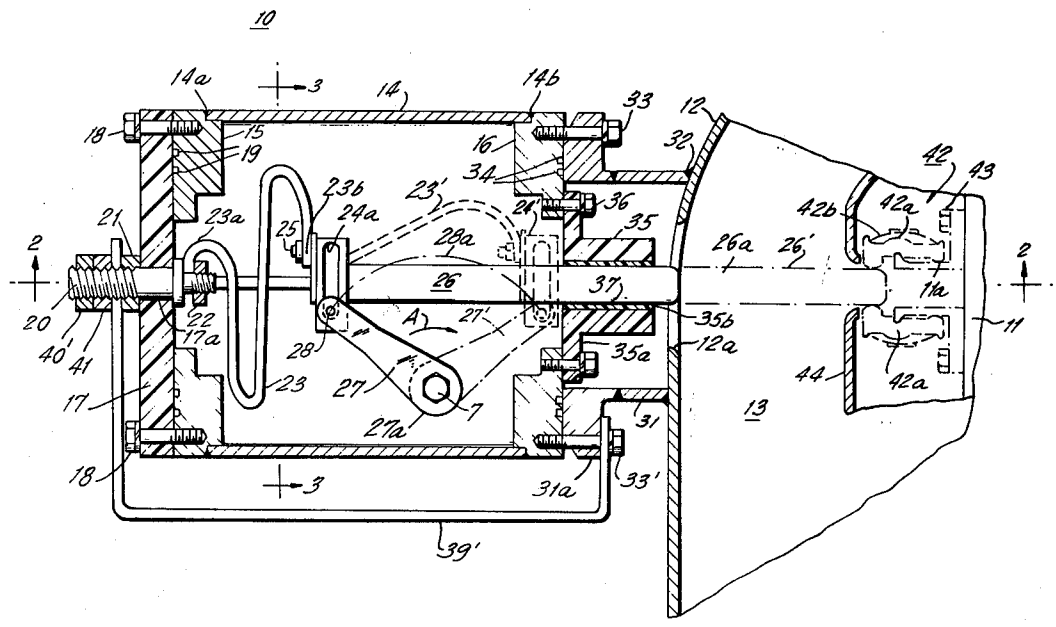
*Attorney, Agent, or Firm*—Ostrolenk, Faber, Gerb & Soffen



[57] **ABSTRACT**

A combination ground and test switch apparatus for pressurized-gas-insulated high-voltage systems capable of selectively electrically grounding and/or testing through the use of a medium voltage electrical source selectively connectible to a system internal conductor which is completely surrounded by a grounded conductor and which is constantly maintained in a pressurized state.


**7 Claims, 3 Drawing Figures**



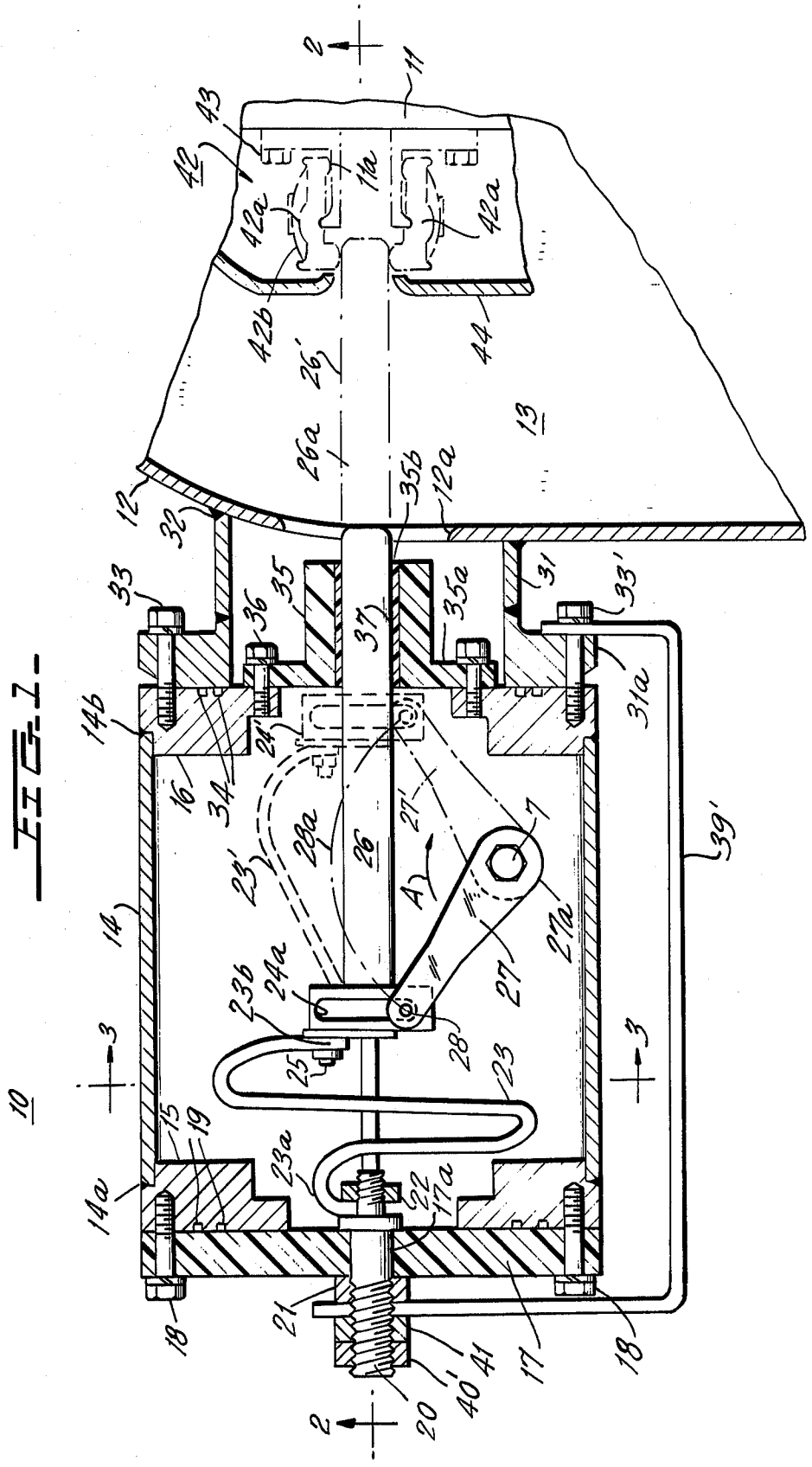

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FIG. 1

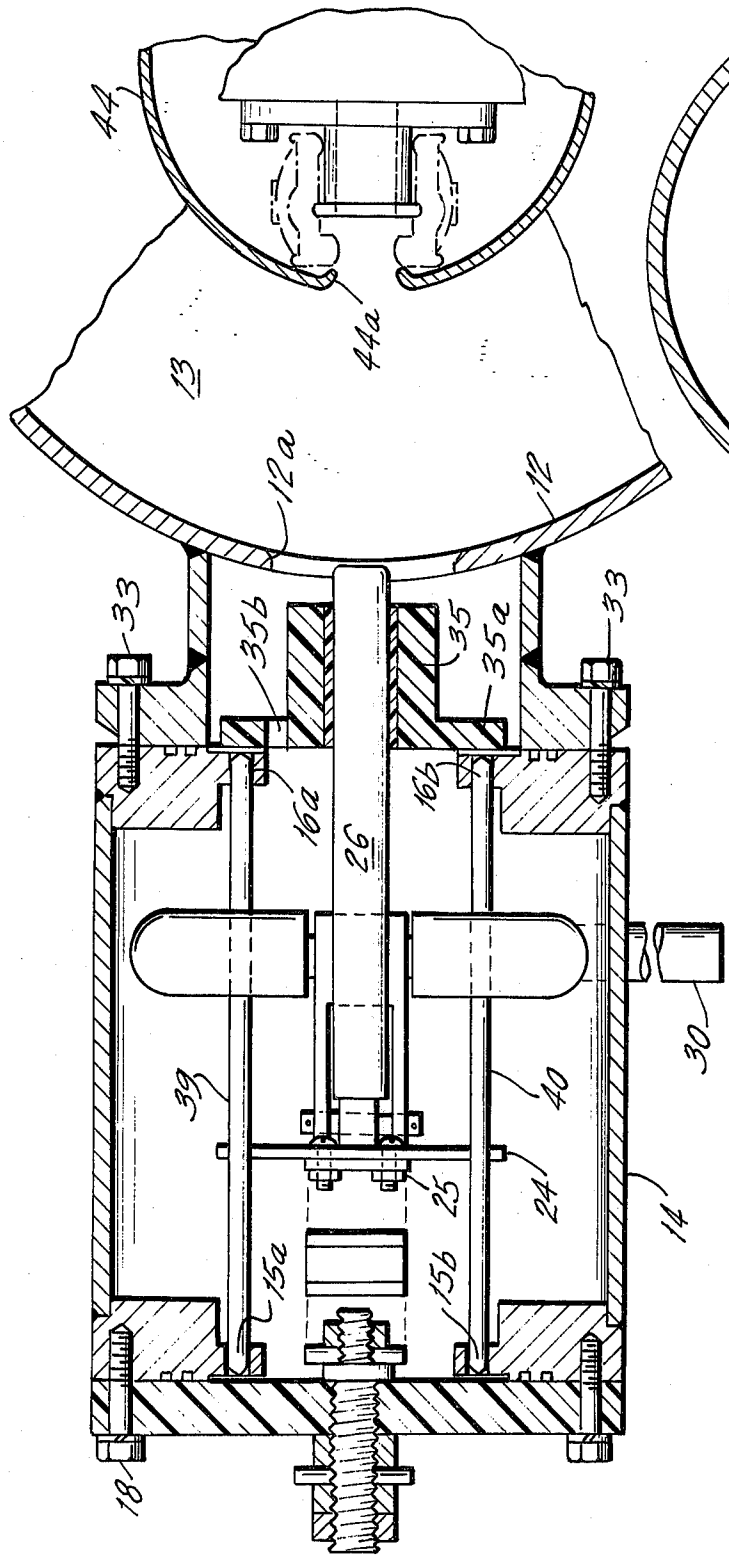

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44a
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12a
12
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35b
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35a
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16a
16b
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24
14
15a
15b
18

FIG. 2.

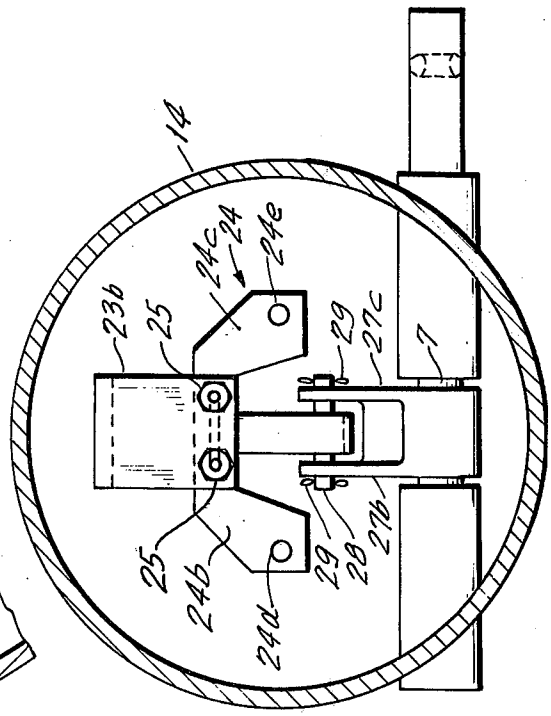

14
23b
25
24c
24
24e
29
27c
7
25
24b
24d
29
29
27b

FIG. 3.

# COMBINATION GROUND AND TEST SWITCH APPARATUS FOR PRESSURIZED-GAS-INSULATED HIGH VOLTAGE SYSTEMS

This is a continuation of application Ser. No. 280,999, filed 16 Aug. 1972.

The present invention relates to pressurized gas-insulated high-voltage systems and more particularly to a novel combination ground and test switch apparatus for testing high-voltage conductors completely enclosed in grounded metal covers without the need for either depressurizing or removing the grounded covers.

## BACKGROUND OF THE INVENTION

In metal-enclosed pressurized-gas-insulated high voltage switchgear, of the type described in U.S. Pat. Nos. 3,546,356; 3,573,342; 3,643,003 and in pending application Ser. No. 234,811, filed Mar. 15, 1972, now abandoned, all of which have been assigned to the assignee of the present application, it is conventional that the high-voltage conductors be completely enclosed in grounded metal housings or covers at all points along the system. The advantages of this construction in both safety and reliability are obvious. There is, however, one decided disadvantage in that it is not convenient to gain access to the enclosed high-voltage conductor for low-voltage tests commonly performed on a routine basis such as, for example, resistance tests on circuit breaker contacts, power-factor tests on transformer insulation, and so forth.

Since it is desirable and even necessary to periodically measure the contact resistance of circuit breakers by the application of a known measured current across two terminals of the circuit breaker for the purpose of measuring the voltage drop between the terminals, it is conventional in outdoor substation design that this can be readily accomplished by clipping the test leads on to the exposed high-voltage conductors at the upper ends of their bushings. However, this is not possible in metal-enclosed pressurized systems since the high-voltage conductors are not exposed at any point along the system.

## BRIEF DESCRIPTION OF THE INVENTION

The present invention is characterized by providing a combination ground and test switch apparatus for pressurized-gas-insulated high-voltage systems and the like which maintains the integrity of the pressurized system and which may be selectively operated to provide either grounding or voltage testing without the need for either depressurizing or removal of any of the system grounded housings or covers.

The present invention comprises a housing joined to the grounded enclosure of a pressurized-gas-insulated high-voltage system and hermetically sealed thereto with an opening provided in the aforesaid grounded housing to provide communication between the interior of the switchgear and the housing affixed thereto. A reciprocally movable switch blade is mounted within said housing and is arranged to be moved to a closed position within the interior of the switchgear equipment for engagement with a jaw structure which is surrounded by an electrostatic shield to reduce dielectric stresses within the switchgear. An operating mechanism which may be safely manipulated from the exterior of the housing is provided for moving the switch blade between its connected and disconnected positions. The end of the switch housing remote from the switchgear grounded housing is provided with a conductive terminal electrically insulated from the test switch housing and is electrically coupled to the movable blade by a flexible conductor which is provided so as to allow for free reciprocal movement of the switch blade without in any way affecting the integrity of the electrical connection therebetween. A conductive ground strap is normally coupled between the aforementioned terminal and the switchgear grounded housing to maintain the conductive components of the switch housing at ground potential during intervals when no tests are being performed. To perform the desired test, the conductive group strap is first removed and the switch blade is operated to the closed position to establish an electrical connection between the aforementioned terminal and the central conductor of the switchgear network. A medium voltage source may then be coupled to the aforementioned terminal for test purposes without the need for either depressurizing the switchgear equipment or removing any of its housings or covers.



It is therefore one object of the present invention to provide a novel test switch assembly and housing adapted for selectively and simply performing tests upon the internal high-voltage conductor of metal-enclosed pressurized-gas-insulated high-voltage switchgear while avoiding the need for either depressurizing the switchgear network or removing any of its housings or covers.

## BRIEF DESCRIPTION OF THE FIGURES

The above, as well as other objects of the present invention will become apparent when reading the accompanying description and drawings in which:

FIG. **1** shows an elevational sectional view of a ground and test switch assembly embodying the principles of the present invention.

FIG. **2** shows a sectional view of the assembly of FIG. **1** looking in the direction of arrows **2—2.**

FIG. **3** shows a sectional view of the assembly of FIG. **1** looking in the direction of arrows **3—3.**

## DETAILED DESCRIPTION OF THE FIGURES

Copending application Ser. No. 234,811 discloses a metal-enclosed pressurized-gas-insulated high-voltage circuit breaker in which the high-voltage conductors are completely enclosed in grounded metal covers at all points. In equipment of this type as well as other components of such a switchgear and/or power distribution and transmission network it becomes desirable and even necessary at periodic intervals to measure the contact resistance of the circuit breakers as well as other components, by application of a known measured current from one terminal of the breaker to the other in order to measure the voltage drop between terminals. Since the central conductors are metal-enclosed within conductive pressurized housings at all point, it is an object of the present invention to provide an assembly **10** of the type shown in FIGS. **1–3** to perform the necessary test procedures without the need for depressurizing the system or removing any portion of the enclosure to gain access to the high voltage conductor. In pressurized gas systems of this type, it is further necessary to provide means for grounding the internal high-voltage conductor to provide complete safety for

personnel at such times when it becomes necessary to open the enclosure and gain access to internal parts for inspection, maintenance or repair. Grounding or earthing switches, which establish a good metal connection between the internal conductor and the grounded metal enclosure are well known in the art. Such grounding switches must be capable of carrying the full ground fault current capability of the electrical system at the point of connection without being damaged or destroyed. The assembly **10** of FIGS. **1–3**, which combines the functions of a grounding switch with those of a test switch, may be adapted for use in establishing an electrical connection with an internal conductor **11** which is energized at a high voltage in normal usage. The grounded metal enclosure **12** serves as the means for retaining the pressurized insulating gas within the hollow space **13** between the conductor **11** and the grounded enclosure **12.** Suitable insulators or spacers formed of a solid material and described in detail in U.S. Pat. No. 3,573,341, for example, act to maintain appropriate spacing and centering of conductor **11** relative to its associated grounded housing **12.**

The test switch assembly **10,** which may be selectively electrically connected with the switchgear high-voltage conductor **11,** comprises a hollow substantially cylindrical shaped housing **14** secured by weldments **14***a* and **14***b* to internal flanges **15** and **16,** respectively. A disc-shaped member **17** formed of a suitable insulating material such as phenolic or epoxy, forms the outer end of the ground and test switch housing and is joined to internal flange **15** by fastening means **18** arranged at spaced intervals about the periphery of the disc. Synthetic resilient O-rings **19** serve to seal and hermetically join disc **17** to the flange **15** of the housing. Disc **17** is provided with a centrally located opening **17***a* for receiving a copper terminal **20** which is preferably cemented in place to prevent gas leakage. A fastening nut **21** threadedly engages the threaded portion of terminal **20** along the exterior of disc **17,** while a fastening nut **22** threadedly engages the opposite threaded portion of terminal **20** for securing the end terminal **23***a* of a flexible metallic conductor **23** arranged in an undulating fashion, as can best be seen in FIG. **1.** The opposite end terminal **23***b* of flexible conductive cable **23** is secured to a clevis assembly **24** by fastening means **25,25.** The clevis assembly is secured to the left-hand end of a switch blade **26** which is mounted for reciprocating action under control of a crank member **27** arranged to pivot about an actuating shaft **7,** which shaft is provided with a polygonal-shaped cross-section, as shown best in FIG. **1,** for mating with an opening **27***a* of similar shape provided within insulating crank **27.** Crank **27** is a bifurcated member having a pair of spaced parallel arms **27***b* and **27***c* (note especially FIG. **3**) which arms are provided with suitable openings for receiving a pin **28** secured between arms **27***b* and **27***c* by cotter pins **29,29.** The clevis assembly is provided with an elongated vertically aligned slot **24***a* adapted to slidably receive pin **28.** Bifurcated crank arm **27** is adapted to move between the solid line representation of FIG. **1** to the dotted line representation **27'**. During such movement, pin **28** traverses an arcuate path represented by dotted line **28***a*. As a result of this movement, the clevis assembly **24** is moved from the solid line representation of FIG. **1,** to the dotted line representation **24'** thereby causing switch blade **26** to move from the solid line representation of FIG. **1** to the dotted line representation **26'**. Due to the flexible characteristics of cable **23,** the cable is free to become elongated as shown by dotted line representation **23'** in FIG. **1** so as to freely permit the clevis assembly and switch blade to move toward the engaged or connected position for test purposes, as will be more fully described.

Internal flange **16** which forms part of the test equipment housing is mechanically and electrically joined to a cylindrical-shaped section **31** joined to the switchgear grounded conductive housing **12** by a weldment, as shown at **32,** and having a flange portion **31***a* joined to internal flange **16** by fastening members **33** arranged at spaced intervals around the periphery of flange **31***a*. Flexible resilient synthetic O-rings **34** provide for air-tight joining between flanges **31***a* and **16** when fastening members **33** are appropriately tightened.

An insulating guide bearing **35** has a flange portion **35***a* joined to the inner portion of flange **16** by fastening means **36** arranged at spaced intervals around flange portion **35***a*. Guide bearing **35** has a central opening **35***b* whose interior surface is provided with a low friction liner **37** which may, for example, be Teflon. Guide bearing **35** acts to guide the movement of switch blade **26** so as to prevent any movement thereof transverse to the longitudinal axis **26***a* of switch blade **26.** In addition thereto, a pair of guide rods **39** and **40** are mounted within the interior of the test switch housing with their opposite ends being mounted within suitable diametrically opposed openings **15***a*-**15***b* and **16***a*-**16***b* provided in flanges **15** and **16,** respectively. Clevis assembly **24** is provided with two wing portions **24***b* and **24***c* each having an opening **24***d* and **24***e*, respectively, for slidably receiving guide rods **39** and **40** to guide the linear movement of the clevis assembly and prevent any twisting movement thereof.

As shown best in FIGS. **1** and **2,** the grounded conductive enclosure **12** is provided with an opening **12***a* to facilitate the free reciprocating movement of switch blade **26.** The hollow interior of the grounded test switch housing is filled with an insulating gas maintained at the same pressure as the gas inside the main enclosure or housing **12.** Guide bearing member **35** is provided with an opening **35***b* to permit the pressurized gas to move freely between the switchgear and test switch enclosures so as to maintain and equalize the pressure within the two enclosures. The three major components of the housing, namely the cylindrical enclosure **14,** disc member **17** and tube and flange member **31** are designed to provide for convenience in manufacturing, assembly and disassembly.

Under normal conditions, a conductive ground strap **39'** is connected between conductive terminal **20** and tube and flange member **31,** as shown best in FIG. **1.** A first end of the strap is mechanically secured to terminal **20** by means of fastening nuts **40'** and **41,** while the opposite end thereof is coupled to flange portion **31***a* by fastening member **33'**. In the arrangement shown in FIG. **1,** it can be seen that the entire ground and test switch assembly is maintained at ground potential, i.e., the potential of grounded conductive housing **12.** In order to ground the internal conductor **1,** shaft **7** is rotated in the direction shown by arrow A in FIG. **1** to move switch blade **26** into the dotted line position **26'** so as to engage a tulip-type jaw contact assembly **42** comprised of a plurality of contact fingers **42***a* arranged at spaced intervals in a radial fashion and having spring members **42***b* urging the contact fingers into

engagement with tubular projection **11***a* secured to conductor **11** by fastening means **43** and to selectively engage the free end of switch blade **26** when it occupies the dotted line position **26'**. Conductive member **44** comprises an electrostatic shield having a smooth exterior surface and an external radius of sufficient dimension so as to prevent the development of internal corona at the operating voltage and so as to reduce flashover voltage due to the concentration of dielectric stress which might otherwise occur at sharp points or edges on the high-voltage parts. The electrostatic shield **44** is provided with a suitable opening **44***a* to permit the free reciprocating movement of switch blade **26.**

In order to ground internal conductor **11,** shaft **30** is rotated in the direction shown by arrow A of FIG. **1** to move switch blade **26** into engagement with the contact assembly **42.** When it is desired to connect any test device having a voltage of up to 10kV (relative to ground potential) to the internal conductor, the grounding strap **39'** is removed and the lead of the test device (not shown for purposes of simplicity) is connected to terminal **20** by removing and reapplying the fastening nuts **40'** and **41.** The bifurcated crank member **27,** as was previously described, is formed of a suitable insulating material to permit movement of the switch blade into and/or out of engagement with central high-voltage conductor **11** without endangering operating personnel.

It can be seen from the foregoing description that the present invention provides a novel grounding and test switch structure for use with metal-enclosed pressurized-gas-insulated high-voltage switchgear and the like wherein grounding of the internal high-voltage conductor and removal of the ground therefrom may be simply and safely performed through the operation of an externally accessible operating mechanism. In addition thereto, the assembly facilitates the application of high-current medium voltage electrical sources to the internal conductor for test and maintenance purposes without the need for either depressurizing the switchgear network or removal of any housings or covers employed therein.

Although there has been described a preferred embodiment of this novel invention, many variations and modifications will now be apparent to those skilled in the art. Therefore, this invention is to be limited, not by the specific disclosure herein, but only by the appending claims.

What is claimed is:

**1.** For use in a metal-enclosed pressurized-gas-insulated high-voltage switchgear system, a double-purpose grounding and test switch assembly capable of grounding a high-voltage internal conductor and of permitting a non-grounded electrical connection to the internal conductor for test purposes, said assembly comprising:

a grounded conductive housing completely surrounding said internal conductor and having an opening provided therein;

a switch housing mechanically and electrically connected to said grounded conductive housing and having an opening at a first end thereof whereby the pressurized interior of the grounded conductive housing communicates with the interior of said switch housing to maintain an equalized gas pressure therebetween;

a reciprocating conductive switch blade;

guide means mounted within said switch housing for guiding said conductive switch blade to move along a substantially linear path and through the grounded conductive housing opening;

the internal conductor including a jaw blade structure;

drive means mounted within said switch housing for moving said conductive switch blade from a first position whereby its free end is disengaged from the jaw contact structure to a second position whereby the free end of said conductive switch blade electrically engages the jaw structure;

a terminal mounted to the free end of said switch housing remote from the grounded conductive housing and electrically insulated therefrom;

flexible conductive cable means positioned within said switch housing and electrically connected between said terminal and the end of said conductive switch blade remote from the jaw structure for permitting free reciprocating movement of said conductive switch blade while maintaining the integrity of a conductive electric path between said terminal and said conductive switch blade;

said guide means including means for electrically insulating said conductive switch blade from the grounded conductive housing and said switch housing;

said drive means including an actuating shaft having one end thereof extending outwardly from said switch housing to provide for movement of said conductive switch blade from and to a position exterior of said switch housing; said terminal being selectively connected to ground potential or to test equipment.

**2.** The device of claim **1** further comprising a conductive strap selectively connectible between said terminal and said switch housing for maintaining said conductive switch blade at the voltage level of said grounded conductive housing.

**3.** The device of claim **1** wherein said drive means further comprises a crank arm formed of an insulating material coupled to said operating shaft for pivoting said crank arm about said operating shaft when said shaft is rotated;

a clevis assembly coupled to the end of said conductive switch blade remote from the internal conductor;

means for coupling the free end of said crank arm to said clevis assembly.

**4.** The apparatus of claim **3** wherein said drive means is further comprised of means for providing an airtight seal in the region where said operating shaft protrudes from said switch housing to prevent the escape of the pressurized gas contained therein.

**5.** For use in a metal-enclosed pressurized gas-insulated high-voltage switchgear system, a double-purpose ground and test switch assembly capable of grounding a high-voltage internal conductor and of permitting a non-grounded electrical connection to the internal conductor for test purposes in which a grounded conductive housing surrounds the internal conductor and has an opening provided therein;

a switch housing mechanically and electrically connected to said grounded conductive housing and having an opening communicating with the opening of the grounded conductive housing whereby the pressurized interior of the grounded conductive

housing communicates with the pressurized interior of said switch housing to maintain an equalized gas pressure therebetween;

a conductive switch blade;

drive means for moving said conductive switch blade from a first position whereby its free end is electrically disengaged from the internal conductor to a second position whereby the free end of said conductive switch blade electrically engages the internal conductor;

an electrical terminal mounted on said switch housing and electrically insulated from said switch housing;

conductive means positioned within said switch housing and electrically connected between said electrical terminal and said conductive switch blade and permitting free movement of said conductive switch blade while maintaining the integrity of a conductive electric path between said electrical terminal and said conductive switch blade;

said conductive switch blade being electrically insulated from said grounded conductive housing and said switch housing;

a conductive strap selectively connectible between said electrical terminal and ground potential for maintaining said conductive switch blade at the voltage level of said grounded conductive housing when said conductive strap is electrically connected to both said electrical terminal and ground potential;

said conductive strap designed to be removable to disconnect the electrical connection between said electrical terminal and ground potential to thereby permit a non-grounded electrical connection to be made from test equipment to the internal conductor through said electrical terminal and said conductive switch blade without the need to depressurize the switchgear system and without the need to remove either said switch housing or the grounded conductive housing.

**6.** The device of claim **5** wherein said switch housing and the grounded conductive housing are mechanically and electrically secured to each other so that they are both maintained at the same ground potential.

**7.** The device of claim **6** wherein said drive means moves a portion of said conductive switch blade through the opening of said switch housing and the opening of the grounded conductive housing to mechanically and electrically engage the internal conductor.

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