Nov. 22, 1966 YOSHIMASA YONEZAWA ETAL 3,287,531

TERMINAL BUSHING HAVING IMPEDANCE
MEANS ASSOCIATED THEREWITH
Filed Sept. 30, 1964

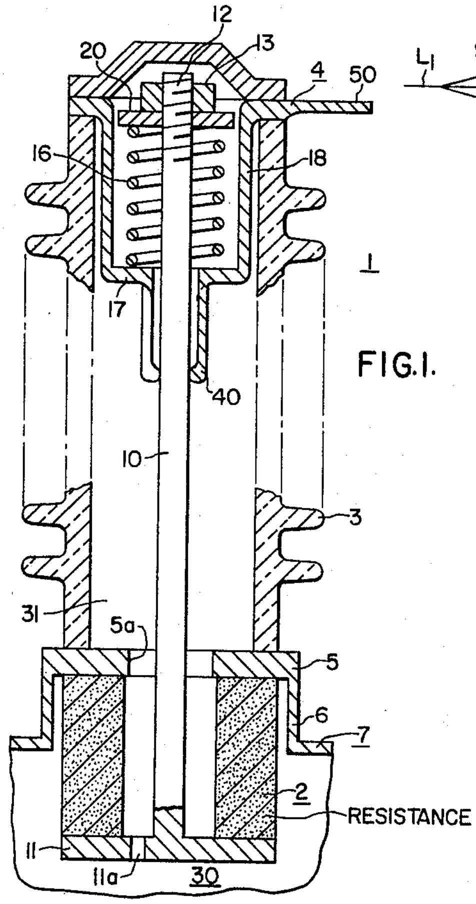



FIG.1.

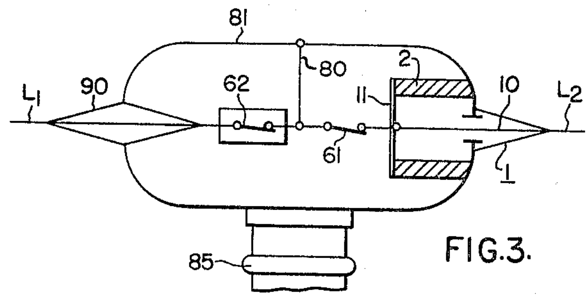



FIG.3.

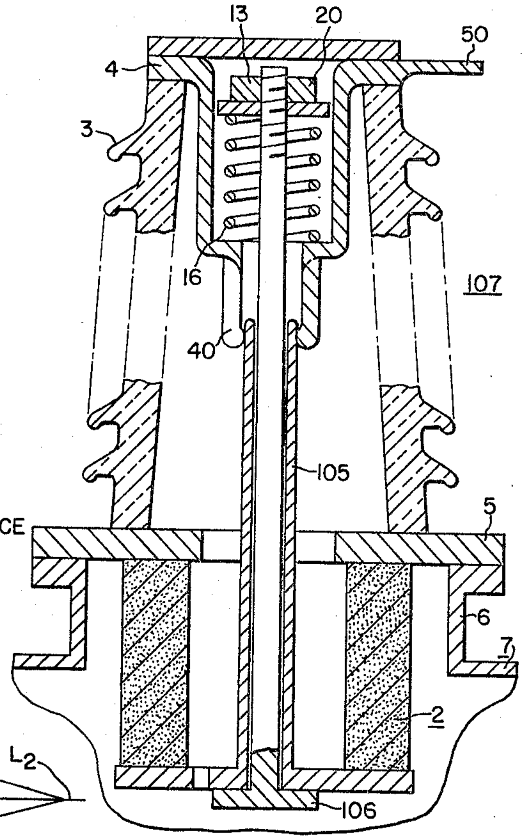
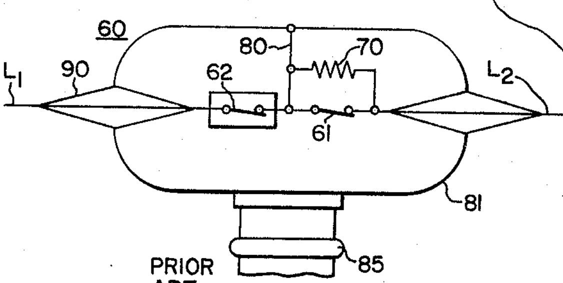



FIG.4.




PRIOR
ART

FIG.2.

WITNESSES

*Theodore F. Wrobel*

*James F. Young*

INVENTORS
Yoshimasa Yonezawa
& Toshio Tanabe
BY
*Willard R. Crout*
ATTORNEY

United States Patent Office

3,287,531

Patented Nov. 22, 1966



3,287,531

# TERMINAL BUSHING HAVING IMPEDANCE MEANS ASSOCIATED THEREWITH

Yoshimasa Yonezawa and Toshio Tanabe, Kashio, Takarazuka-shi, Japan, assignors to Mitsubishi Denki Kabushiki Kaisha, Tokyo, Japan, a corporation of Japan

Filed Sept. 30, 1964, Ser. No. 400,477
Claims priority, application Japan, Dec. 30, 1963, 38/98,915
7 Claims. (Cl. 200—144)

This invention relates to terminal bushings having impedance means associated therewith and, more particularly, to improved constructional features and simplified mounting arrangements therefor.

A general object of the present invention is the provision of an improved terminal bushing having an impedance means constituting an integral component part thereof and of simplified construction.

Another object of the invention is the provision of an improved terminal-bushing structure having impedance means associated with the interiorly-extending end of the terminal bushing and, according to a preferred arrangement, constituting the interiorly-extending casing structure of the terminal bushing.

Another object of the present invention is the provision of an improved and simplified type of circuit-interrupting structure of the type involving a live-tank structure, that is one in which the surrounding tank is at line voltage in the closed-circuit position of the interrupter, and in which improved and simplified terminal-bushing structures are associated therewith.

Another object of the present invention is the provision of an improved terminal-bushing structure in which impedance means is associated therewith, and in which the compressive force exerted axially of the terminal-bushing structure is utilized to advantage for maintaining good contact between the terminal portions of the impedance structure.

Yet a further object of the present invention is the provision of an improved terminal-bushing structure having impedance means associated therewith in which provision is additionally supplied for accommodating differential axial movement of the several parts encountered during operating conditions over a wide ambient temperature range.

An ancillary object of the present invention is the provision of an improved terminal-bushing structure having an associated resistance means taking the place of the usual interiorly-extending insulating casing structure.

Further objects and advantages will readily become apparent upon reading the following specification, taken in conjunction with the drawings, in which:

FIGURE 1 is a vertical sectional view taken through a terminal bushing embodying features of the present invention;

FIG. 2 is a diagrammatic view of a high-voltage circuit-interrupting structure having two breaks in series, with a resistance means shunting one of the breaks for lowering the rate of rise of the recovery-voltage transient;

FIG. 3 is a diagrammatic view, somewhat similar to FIG. 2, but illustrating an application of the novel terminal-bushing structure of FIG. 1 utilized with the type of circuit-interrupting structure of FIG. 2, the contact structure being illustrated in the closed-circuit position; and,

FIG. 4 is a modified type of terminal-bushing structure incorporating the principles of the present invention.

Referring to the drawings, and more particularly to FIG. 1 thereof, it will be noted that the reference numeral **1** generally designates a terminal bushing having an impedance means **2** associated therewith. As shown, an insulating casing **3**, preferably formed of a suitable ceramic



material for weather-proof purposes is provided, being clamped between a terminal structure **4** and an inwardly-extending flange portion **5** of a mounting sleeve **6**, in turn, constituting a portion of a tank structure **7**.

Extending axially through the terminal-bushing structure **1** is a rod-shaped terminal stud **10** having a radially outwardly-extending terminal-flange portion **11** associated therewith. At the upper end of the terminal stud **10**, as viewed in FIG. 1, there is provided a threaded portion **12**, having threaded thereon a nut **13**, which provides adjustment for clamping pressure, as exerted by a compression spring **16**. As shown, the compression spring **16** is interposed between the base **17** of a cup-shaped portion **18** of the terminal structure **4** and a spring washer **20** disposed immediately below the adjustable clamping nut **13**. As a result, the compression spring **16** provides compressive force exerted axially through the weather-proof casing **3** and the interiorly-disposed impedance means **2**. The terminal stud **10**, as is obvious, has tensile stress imposed thereon.

The resistance means **2** is preferably formed of a single cylindrical block of silicon carbide or, for certain applications, the resistance means **2** may comprise a plurality of juxtaposed plates of sintered silicon carbide. Reference may be had to Pirani U.S. Patent 2,205,308, issued June 18, 1940, for a description of a suitable resistance material of silicon carbide, which may provide adequate current-carrying capacity for the resistance means **2**.

With further reference to FIG. 1, it will be noted that an aperture **11***a* is provided through the terminal-plate portion **11**, whereby the medium, such as sulfur-hexafluoride gas ($SF_6$), may pass from the tank interior **30**, through the aperture **11***a* and into the interior **31** of the terminal-bushing structure **1**, so as to provide the necessary dielectric strength between the inwardly-extending portion **5***a* of the supporting flange portion **5** and the rod-shaped terminal stud **10**, which may be at different voltage potentials, as more fully described hereinafter.

To accommodate differential longitudinal expansion between the several component parts of the terminal bushing **1** during operation of the terminal bushing **1** throughout a wide ambient temperature range, there is provided a plurality of sliding contact fingers **40** associated with the terminal-cup structure **18**, which bear radially inwardly upon the external side surfaces of the axially-extending terminal stud **10**. As a result, good contacting engagement is provided between the external terminal pad **50** and the inwardly-extending terminal stud **10**.

With reference to FIG. 2 of the drawings, it will be noted that there is illustrated, somewhat diagrammatically, a high-voltage, high-power, circuit-interrupting structure **60** of the type having a live-tank structure. As is well known by those skilled in the art, a live-tank structure is one having a surrounding metallic tank which is at line voltage in the closed-circuit position of the interrupter. With further reference to FIG. 2, it will be observed that there is provided two serially-related breaks **61**, **62**, which are opened in sequence. Shunting the main break **61** is a resistance **70**, which functions to lower the rate of rise of the recovery-voltage transient, and to improve the power factor of the circuit during an opening operation. As further well known by those skilled in the art, upon the interruption of the arc associated with the main contact break **61**, additional subsequently-opened serially-connected break means **62** is provided to interrupt the residual-current arc, and to provide a final open disconnecting gap in the circuit interrupter in the fully open-circuit position thereof.

Reference may be had to U.S. Patent 2,970,198, issued January 31, 1961, to J. E. Schrameck, and assigned to the assignee of the instant application, and for a general description of a compressed-gas type circuit interrupter involving two breaks in series with a resistance shunting one of the breaks, and in which sequential operation of the two breaks is provided. In addition, reference may be had to U.S. patent application filed October 12, 1961, Serial No. 144,720, now U.S. Patent 3,214,546, issued October 26, 1965, to Winthrop M. Leeds, entitled "Circuit Interrupters," and assigned to the assignee of the instant application, for a further description of a typical type of live-tank high-voltage circuit-interrupting structure involving shunting resistance means.

With reference to FIG. 3, it will be noted that there is provided an application of the terminal-bushing structure **1** of FIG. 1 in the type of high-voltage, high-power circuit-interrupting structure illustrated in FIG. 2. In more detail, it will be noted that the shunting resistance means **70** of FIG. 2 is connected by a connection **80** to the tank structure **81**, and that automatically such a connection is provided by the contacting engagement of the resistance means **2** (FIG. 1) with the tank flange portion **5**. As a result, the terminal-bushing structure **1** of FIG. 1 provides the desirable shunting impedance means **70**, illustrated in FIG. 2, in a simplified and compact arrangement.

As will be obvious, the live-tank structures **81** of FIGS. 2 and 3 are supported an adequate distance up in the air by insulating supporting columns **85**, through which preferably extends operating means, not shown, arranged to provide a sequential operation of the series contacts **61**, **62**. Also, as is obvious, the electrical circuit through the live-tank structures of FIGS. 2 and 3 extend through a terminal bushing **90** to the disconnecting contact **62**, and through the main contact structure **61** through the terminal-bushing structure **1** to the other line connection $L_2$.

It will be noted that there result considerable advantages by the terminal-bushing structure **1** of FIG. 1 incorporating the resistance means **2** as an interiorly-extending casing portion, and making contacting engagement directly with the surrounding tank structure **7**. Among these advantages is the fact that the usual internal insulating casing is eliminated, the cylindrical resistance means **2** taking the place of such previously-required internal casing structure. Moreover, the contacting force required between the impedance means **2** and the tank structure **7** is automatically provided by the compressive force exerted by the compression spring **16**. As a result, additional contacting force provided by a separate spring means is not necessary. Finally, where the terminal-bushing structure **1** is filled with air, or various gaseous fluids, such as $SF_6$ gas under a pressure higher than that of atmospheric pressure, the clamping force exerted through the casing elements may readily be increased in a simplified manner, and also providing additional contacting pressure between the resistance means **2** and its connected terminal portions **5**, **11**.

FIG. **4** illustrates a further modification of the invention, wherein a contacting sleeve **105** may surround an interiorly telescopically-arranged tensile rod **106**. It will be noted that there is no need for the interiorly-disposed tensile rod **106** to be made of a good conducting material, inasmuch as the surrounding contacting sleeve **105** will carry the entire current, which passes through the terminal-bushing structure **107**. The other elements of the modified-type of terminal-bushing structure **107** are analogous to those previously described in connection with the terminal-bushing structure **1** of FIG. 1 and will, therefore, not be repeated. It will merely be noted that the tensile rod **106** may be formed of a cheap material adequate to withstand tensile stress, such as steel, since it has no current-carrying function.

From the foregoing description of the invention it will be apparent that there is provided a novel terminal-bushing structure **1**, **107** incorporating impedance means **2** which may assume the form of a cylindrically-shaped resistance block of, for example, sintered silicon carbide. The impedance means **2** takes the place of the previously-required internal insulating casing structure, and moreover has the advantage of utilizing to advantage the usually-provided compressive force along the terminal-bushing elements to provide good contacting engagement between the impedance means and its end contacting components.



Although there has been illustrated and described specific structures, it is to be clearly understood that the same were merely for the purpose of illustration, and that changes and modifications may readily be made therein by those skilled in the art, without departing from the spirit and scope of the invention.

We claim as our invention:

**1.** A live-tank high-power circuit interrupter including a metallic enclosing tank structure and a pair of interiorly-extending terminal bushings, insulating supporting means for supporting said live-tank up in the air away from ground potential, main contact means and serially-related disconnecting contact means disposed interiorly of said live metallic enclosing tank, operating means for opening said main contact means and said serially-related disconnecting contact means in sequence, impedance means shunting said main contact means and providing a continued current path following opening of the main contact means, one of the terminal bushings having exterior and interior casing elements on opposite sides of the tank structure, said interior casing element being wholly composed of resistance material, and said interior casing element wholly providing said impedance means.

**2.** A live-tank high-power circuit interrupter including a metallic enclosing tank structure and a pair of interiorly-extending terminal bushings, insulating supporting means for supporting said live-tank up in the air away from ground potential, main contact means and serially-related disconnecting contact means disposed interiorly of said live metallic enclosing tank, operating means for opening said main contact means and said serially-related disconnecting contact means in sequence, impedance means shunting said main contact means and providing a continued current path following opening of the main contact means, one of said interiorly-extending terminal bushings utilizing said impedance as an interiorly-situated casing structure therefor, said one of the terminal bushings having exterior and interior casing elements on opposite sides of the tank structure, said interior casing element being wholly composed of resistance material, and said interior casing element wholly providing said impedance means, and compression means for the elements of said one terminal bushing including an axially-extending terminal stud in tension, whereby said compression means imposes compressive contacting force between said interiorly-disposed impedance casing structure and the end terminal portions thereof.

**3.** A terminal-bushing structure including an insulating casing and an impedance casing, and means extending axially interiorly of said terminal-bushing structure for exerting compressive force upon the said two casings.

**4.** The combination of claim **3**, wherein said terminal-stud means includes a tension rod and a surrounding contact sleeve.

**5.** In combination, a terminal bushing having an external weather-proof insulating casing, an internal impedance casing, axially extending generally rod-shaped current-conducting means having a radially outwardly-extending contacting flange portion in juxtaposition relative to the interiorly-extending end of said internal impedance casing, and conducting flange supporting means interposed between said insulating casing and said internal impedance casing.

**6.** The combination of claim **5**, wherein said generally rod-shaped circuit-conducting means includes a tensile rod, an enveloping current-conducting contact sleeve, and sliding contact fingers making sliding contacting engagement with the outer surface of the contact sleeve.

**7.** In combination, tank means including an apertured flange means, a terminal-bushing having an external terminal extending into said tank means through said apertured flange means and including an external weatherproof insulating casing and an internal casing element composed wholly of resistance material axially-extending generally tubular current-conducting means having a radially outwardly-extending contacting flange portion at one end thereof in juxtaposition relative to the interiorly-extending end of said internal casing element, conducting means interconnecting the other end of said tubular current-conducting means with said external terminal, and



means including an axially-extending tension means disposed within said tubular current conducting means imposing compressive stress on said insulating and resistance casing elements.

No references cited.

ROBERT K. SCHAEFER, *Primary Examiner.*