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Grunert et al.

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[54] **SHORTING DEVICE FOR GENERATOR OUTPUT LINES**

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[52] **U.S. Cl.** ..... **200/144 B**

[51] **Int. Cl.** **H01h 33/66**

[58] **Field of Search** ..... 200/144 B, 146 R

[56] **References Cited**

UNITED STATES PATENTS

3,399,286 8/1968 Kerr, Jr. ..... 200/144 B

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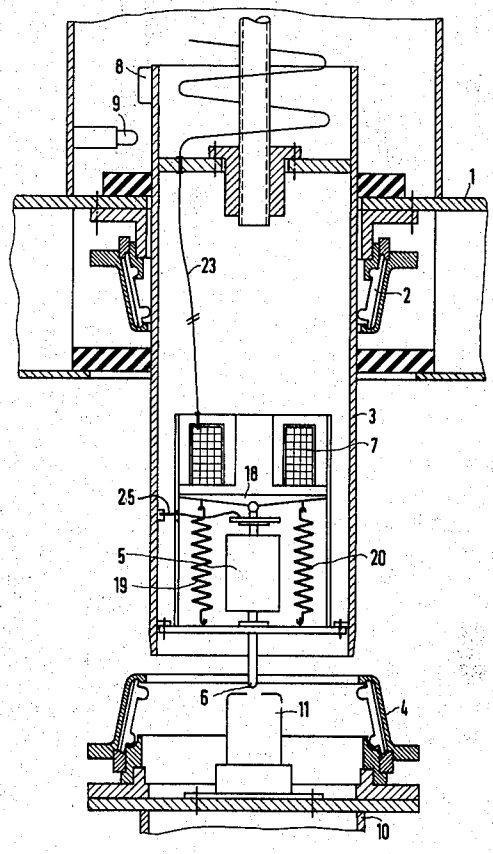
[57] **ABSTRACT**

A shorting device for generator output lines in which a hollow, cylindrical movable contact arm, is used to provide short circuit current carrying capability and has inserted inside it a vacuum switching tube having an extending contact which is used as a lead contact for the main contact arm in order to carry any voltages and currents present due to the residual voltage of the generator thereby avoiding the need for stopping of the generator or using reverse excitation prior to closing the contact arm.

4 Claims, 7 Drawing Figures



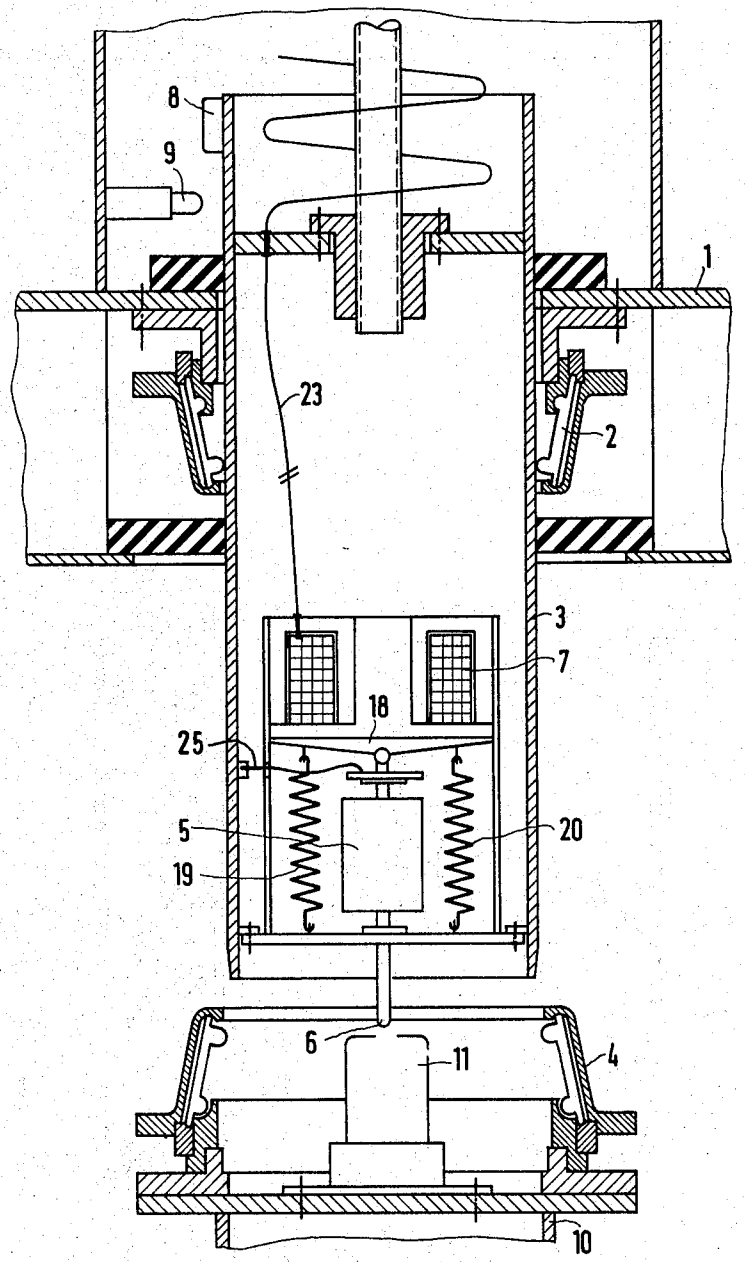


Fig.1

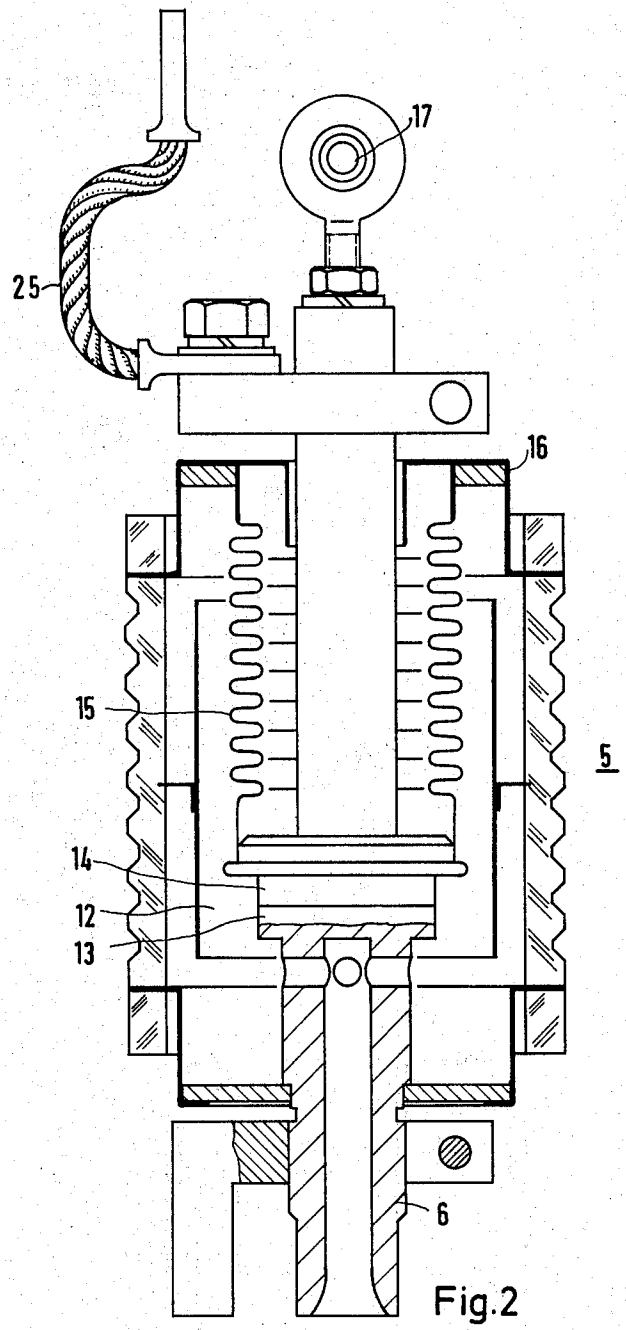


Fig.2

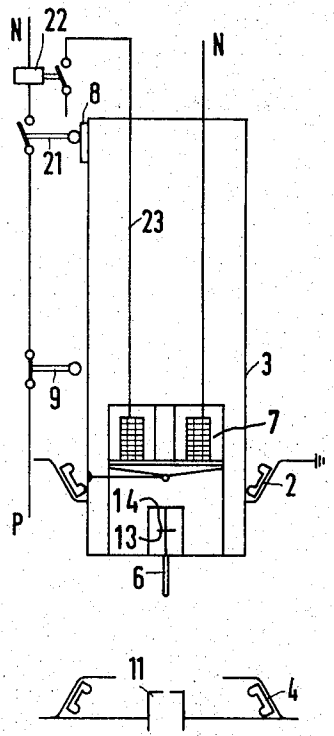


Fig.3a

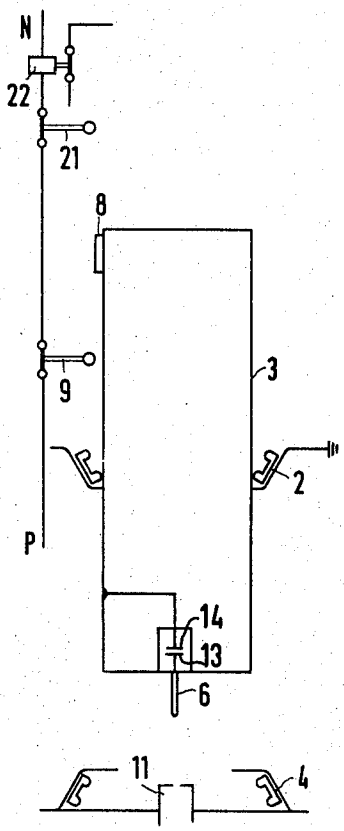


Fig.3b

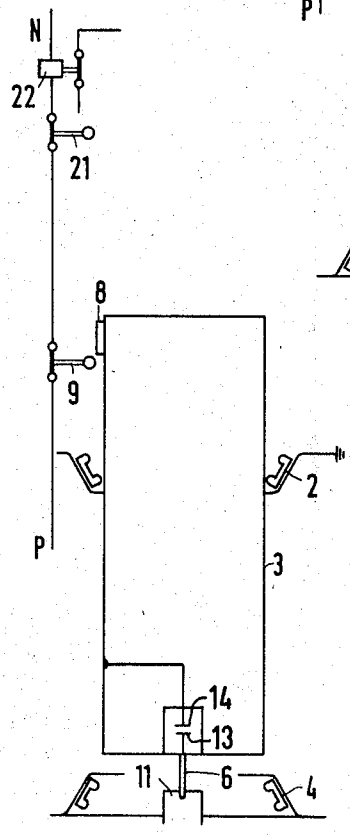


Fig.3c

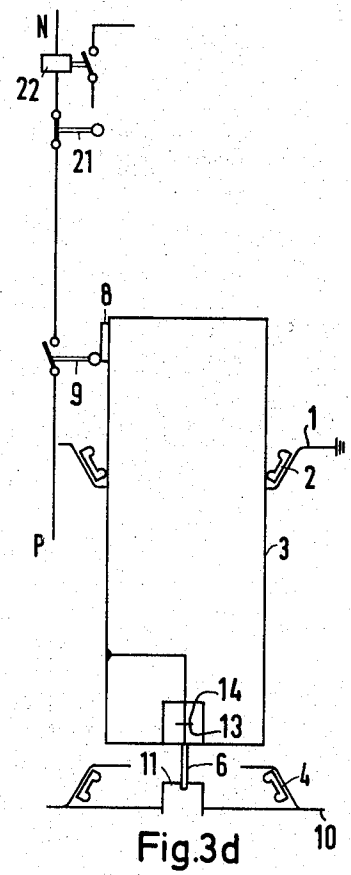


Fig.3d

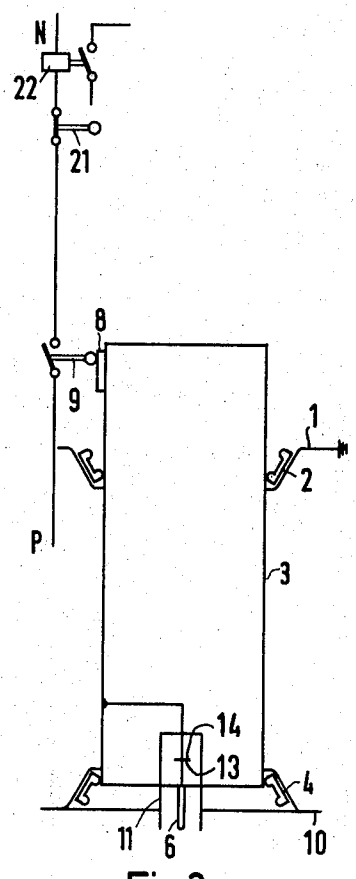


Fig.3e

SHORTING DEVICE FOR GENERATOR OUTPUT LINES

BACKGROUND OF THE INVENTION

This invention relates to shorting devices for generators in general and more particularly to an improved shorting device which includes a vacuum switching tube with an extending contact.

When generators are started up or when maintenance work is performed on them, the bus bars on which the generator output is provided and which are connected to the generator terminals must be short circuited by means having a capability of carrying an extremely high short circuit current. During normal operation when these contacts are in an open condition, they must be sufficiently insulated from the generator bus bars so that arcing will not occur. One type of contact arm known in the prior art is shown in German design Pat. No. 1,993,592. As shown thereon, the contact arms are arranged on a carriage and mate with contacts on the bus bar when the carriage is moved toward the bus bar.

If bus bars such as this are used as generator output lines, it is necessary that prior to connecting a shorting device, all voltage be removed from the bus bars. To accomplish this, either the generator must have a reverse excitation device which, when the excitation is shut off, will cancel the residual voltage of the generator, or the generator must be stopped if no such device is installed. It should be noted that the shorting devices described herein are used only during maintenance, starting up, adjustment work on the generator protection system and activities similar thereto. In some cases, the shorting connection must be established and opened several times in sequence.

SUMMARY OF THE INVENTION

The present invention provides a shorting device which allows eliminating the time required in the prior art devices having reverse excitation or in which the generator was stopped. In addition, it eliminates the necessity and expense associated therewith of having a power circuit breaker which is capable of both carrying a possible short circuit current on the generator output lines and also of switching a voltage of the magnitude of the residual voltage of the generator.

The shorting device of the present invention solves this problem by using a hollow cylindrical contact arm which has inserted inside it a vacuum switching tube. The vacuum switching tube is arranged so that it has an extending contact which will make contact with an advance contact on the bus bar prior to contact by the main contact arm, which vacuum switching tube can switch the residual current of the generator in the presence of the residual voltage so that it is no longer necessary to stop or de-excite the generator. The vacuum switching tube is connected to operate in response to limit switches on the contact arm to provide the required switching operation.

Although shown as a switching unit for a single phase, a vacuum contactor with three switching tubes instead of individual vacuum switching tubes for each phase can be used. In that case, each of the vacuum switching tubes is connected electrically to one contact pin.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**, is a elevation view partially in cross-section of a shorting device according to the present invention.

FIG. **2**, is a elevation view partially in cross-section of the vacuum switching tube of the shorting device of FIG. **1**.

FIGS. 3A to 3E are schematic diagrams illustrating the sequential operation of the shorting device of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. **1**, the contact arm **3** of the present shorting device is electrically coupled to a shorting bus bar **1** with means provided so that the contact arm **3** may move relative to the shorting bar **1** in order to make contact with a mating contact **4** electrically connected to the generator output bus bar **10.** The coupling of the contact arm **3** to the shorting bar **1** is made through a contact cage **2** in conventional fashion. Means not shown will be provided to move the contact arm **3** in and out with respect to the mating contact **4** in well known fashion. The contact arm **3** will preferably be a hollow cylindrical member and has mounted inside it a vacuum switching tube **5.** Vacuum switching tube **5** has an actuating coil **7** and an extending contact **6** which extends from the end. Within the mating contact **4** is an advance contact **11** adapted to mate with the extending contact **6.** As shown and as will be explained in more detail below, contact **6** will engage contact **11** prior to the contact arm **3** engaging mating contact **4.** The contact arm **3** contains a projection **8** on its upper end above the shorting bar **1.** Projection **8** is arranged to contact a limit switch **9.** A second limit switch similar to limit switch **9** is located above the projection **8** and will be described below in connection with FIG. **3.** Although in the illustrated embodiment the contact arm **3** is arranged to move relative to the shorting bar **1,** an arrangement wherein the contact arm **3** is rigidly coupled to the shorting bar **1** and means provided to move the assembly comprising the shorting bar **1** and contact arm **3** relative to the mating contact **4** can be provided. With such an arrangement the limit switch **9** would have to be repositioned to make the desired contact to be described below.

FIG. **2** shows the vacuum switching tube **5** of FIG. **1.** The contact pin **6** extends out from an evacuated chamber **12** and is rigidly coupled within the chamber to a contact plate **13.** Contact plate **13** normally rests directly against a second contact plate **14** which is connected to the upper cover plate **16** of the vacuum switching tube **5** through a bellows **15.** The plate **14** is also mechanically connected through a plunger having an eye **17** which extends out from the top of the vacuum switching tube **5.** As shown on FIG. **1,** the eye **17** is connected to an armature which is operated by the actuating coils **7** to move the plunger (and thus the contact **14**) up against the force of the springs **19** and **20** when the actuating coils **7** are energized thereby opening contacts **13** and **14.** An electrical connection from the plunger assembly to contact arm **3** is made via a connecting line **25** shown in FIGS. **1** and **2** which, will cause the extending contact **6** to be connected to the contact arm **3** when the contacts **13** and **14** are closed.

The operation of the shorting device of the present invention is illustrated by the schematic diagrams of FIGS. 3*a* through 3*e*. FIG. 3*a* shows the contact arm **3** in the fully opened position. The spacing between contact arm **3** and mating contact **4** is such that sufficient insulation is provided to prevent arcing even at the full generator voltage. In this position the projection **8** on the contact arm **3** operates a limit switch **21**. Limit switch **21** is connected in series with a second limit switch **9** and with a relay coil of relay **22**. The contact of relay **22** provides the power to the actuating coils **7** of FIG. **1**. In the position shown with the limit switch **21** opened, the relay **22** is de-energized and its contact opened thereby causing the vacuum switching tube **5** contacts **13** and **14** to be closed, i.e., the springs **19** and **20** of FIG. **1** are holding the plunger down thereby causing the contacts **14** and **13** to be held together. Thus, the extending contact **6** is electrically connected to the contact arm **3**, and through contact arm **3** to the shorting bar **1**. As the contact arm **3** is moved toward the closed position it will approach the mating contact **4**. This is illustrated by FIG. 3*b*. After a small amount of motion, the projection **8** will no longer hold open the switch **21** and this switch will close allowing relay **22** to operate closing its associated contacts to operate the actuating coils **7** which will thereby open the contacts **13** and **14** in the vacuum switching tube **5**.

As shown in FIG. 3*c*, the extending contact **6** will then engage the advance contact **11** with the contacts **13** and **14** within the vacuum switching tube **5** still open. At this position, the projection **8** has still not made contact with the limit switch **9**. However, after a small amount of further motion and before the contact arm **3** engages the mating contact **4** the projection **8** opens the limit switch **9** as shown on FIG. 3*d*. This will in turn de-energize the relay **22** allowing its contact to open which in turn will cause the contacts **13** and **14** to close connecting the generator bus **10** through the contacts **6** and **11**, **13** and **14**, and the contact arm **3** and its contact cage **2** to the grounding bar **1**. Because the contacts **13** and **14** are contained within a vacuum, they are capable of switching the high residual voltage present on the generator bus without the arcing which would occur if the large contact arm **3** was used for this purpose. Thus, they effectively remove the residual voltage and current in a safe and effective manner. FIG. 3*e* shows the final position of the switching device in its fully closed position. Now that the residual voltage and current have been removed, the contact arm **3** continues on its downward path and mates with the mating contact **4** without any danger of arcing. The generator bus **10** is now connected to the grounding bar **1** through mating contact **4**, contact arm **3** and contact cage **2** in a manner such that it is capable of carrying the full short circuit current which may be obtained from the generator output.

When the switching device is opened, the above described sequence is followed in reverse, i.e., the contact arm **3** is withdrawn from mating contact **4**, the limit switch **9** closes opening the contacts **13** and **14** as shown on FIG. 3*c*, the contact **6** disengages from the contact **11** as shown in FIG. 3*b*, and finally, the contact art comes to its final resting place as shown on FIG. 3*a*. At this point the relay **22** is de-energized thereby de-energizing the actuating coils and the contacts **13** and **14** remain at rest in a closed position.

Thus, an improved shorting device for generator bus bars which uses a vacuum switching tube to short out the residual voltage on the generator and a heavy contact arm for carrying the full short circuit current has been shown. Although a specific embodiment has been illustrated and described, it will be obvious to those skilled in the art that various modifications may be made without departing from the spirit of the invention which is intended to be limited solely by the appended claims.

What is claimed is:

1. A shorting device for shorting an output bus bar of 1 generator to a shorting bar comprising:

a. a contact arm electrically connected to the shorting bar;

b. a mating contact electrically connected to the output bus bar;

c. means to permit said contact arm to move in and out of engagement with said mating contact;

d. a vacuum switching tube having a set of contacts in an evacuated chamber one of which is connected to said contact arm and another connected to an extending contact, said switching tube mounted for motion along with said contact arm;

e. an advance contact electrically coupled to said mating contact and arranged to mate with said extending contact, the arrangement being such that upon moving said contact arm from an open to a closed position, said extending contact will engage said advance contact before said contact arm engages said mating contact; and

f. means to operate said set of contacts in said evacuated chamber such that said contacts are open over the portion of movement during engaging and disengaging corresponding to that just prior to engagement and just before disengagement of said extending contact with said advance contact and closed during the portion of remaining movement where said extending contact is engaging said advance contact but said contact arm is not engaging said mating contact.

2. A shorting device according to claim **1**, wherein said vacuum switching tube contacts in said chamber are opened and closed by an actuating coil and said operating means comprise:

a. a projection on said contact arm;

b. at least one limit switch arranged to be operated by said projection; and

c. means responsive to actuation of said switch to operate the actuating coil, whereby as said arm moves to and from said mating contact said contacts within said chamber will be operated.

3. The invention according to claim **2** wherein said vacuum switching tube is arranged so that said contacts in said chamber are normally closed when no voltage is applied to said actuating coil and wherein, first and second limit switches are provided, said first limit switch placed to engage said projection and to de-energize said actuation coils at the point where said extending contact is just engaging said advance contact and said second limit switch is arranged to engage said projection and de-energize said actuating coils when said contact arm is in a fully open position whereby said actuating coils will be energized and said contacts within said chamber open over the portion of motion between said contact arm being fully open and the point where said extending contact first engages said advance contact.

4. The invention according to claim **3**, wherein said advance contact is attached inside said mating contact.

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