Sept. 20, 1960

D. F. WINTER ET AL

2,953,628

HIGH-VOLTAGE BUSHING

Filed April 3, 1958

FIG. 1.

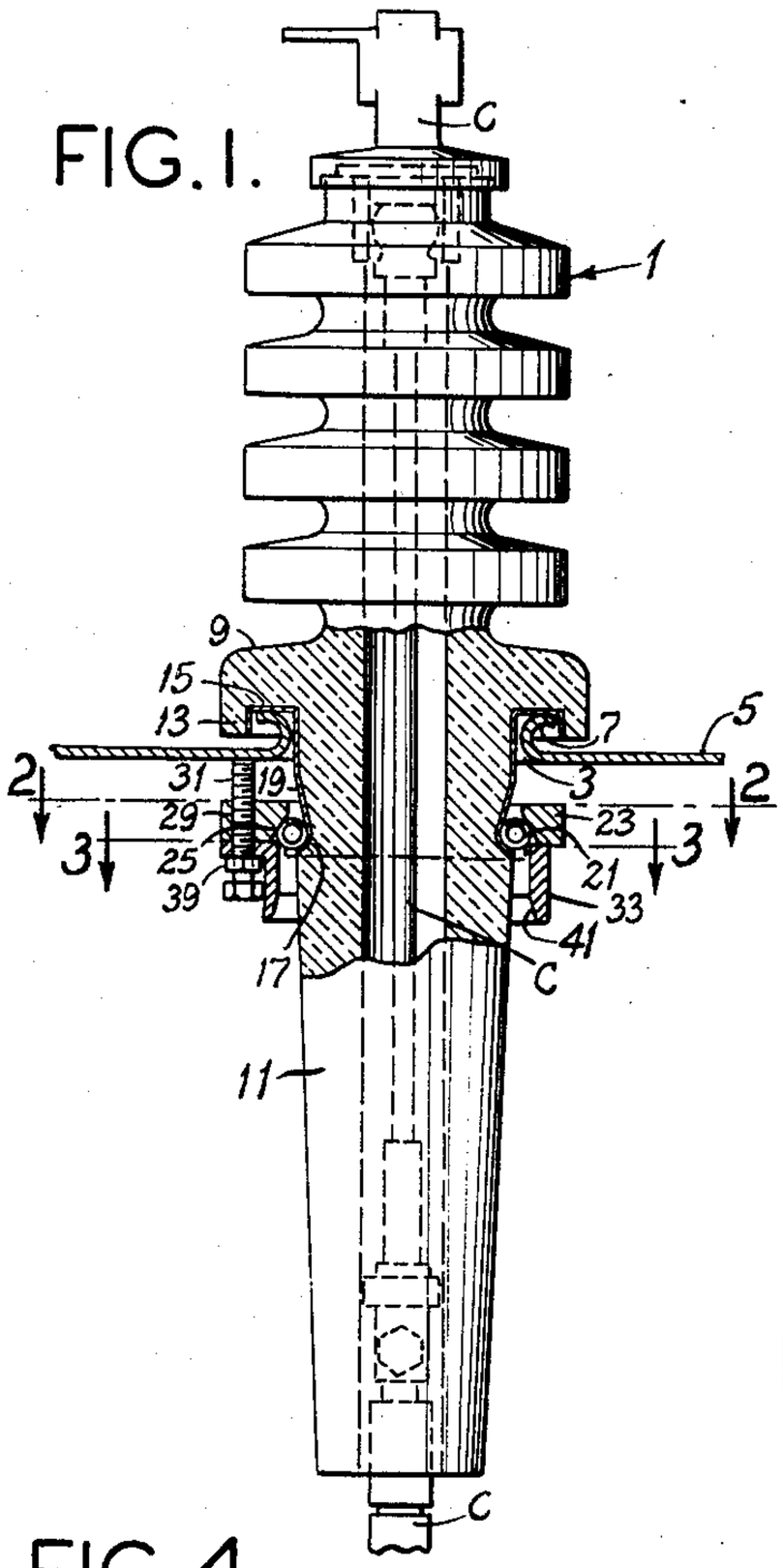


FIG. 2.

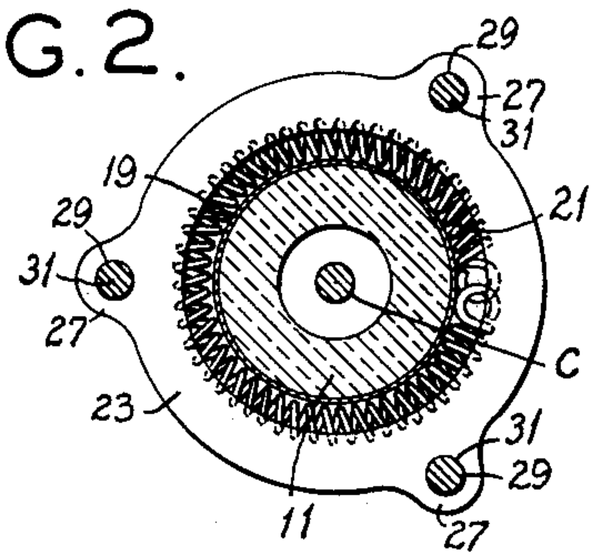


FIG. 3.

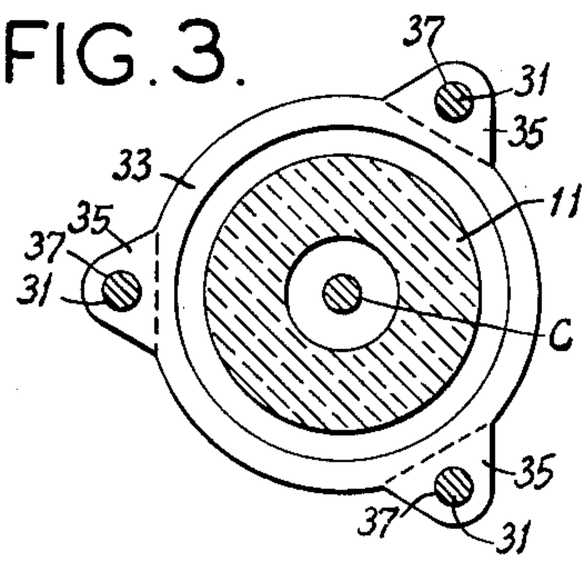


FIG. 4.

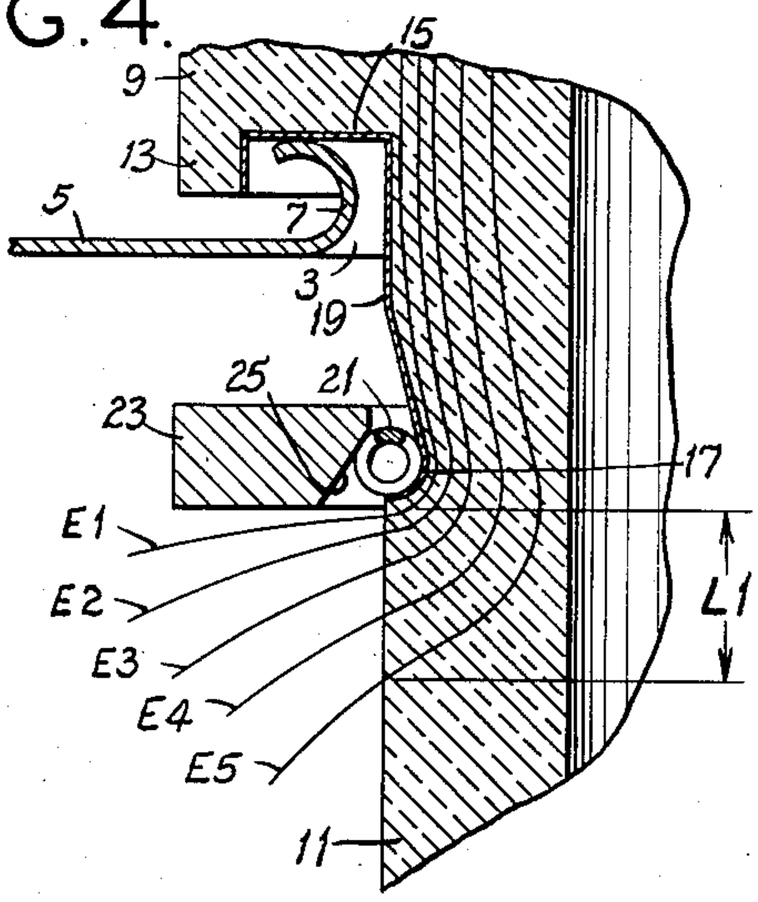
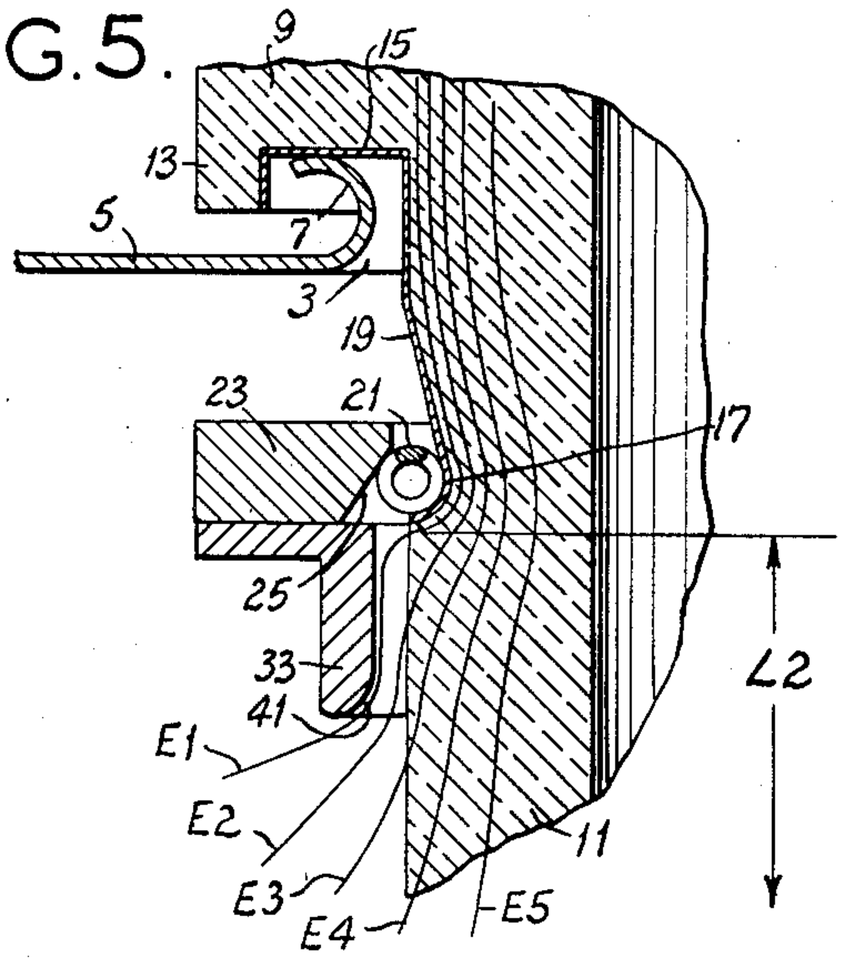


FIG. 5.



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HIGH-VOLTAGE BUSHING

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1 Claim. (Cl. 174—142)

This invention relates to high-voltage bushings, and more particularly to a construction for high-voltage bushings for transformers and the like.

Among the several objects of the invention may be noted the provision of a high-voltage bushing construction for use in a transformer or other electrical apparatus where a high-voltage conductor must be carried through a metal wall, which bushing construction includes means for inhibiting corona discharge between the exterior of the bushing and the wall and also between the exterior of the bushing and means for fastening the bushing to the wall; the provision of such means which is particularly useful in conjunction with bushing fastening means of a type comprising a spring ring snapped into a groove in the bushing and a clamping ring having wedging engagement with the spring ring; and the provision of such means which is economical as regards both manufacture and installation. Other objects and features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the following claim.

In the accompanying drawings, in which one of various possible embodiments of the invention is illustrated,

Fig. 1 is a view in elevation with parts broken away and shown in section of a bushing construction equipped with corona-inhibiting means of this invention installed on a transformer tank cover;

Figs. 2 and 3 are enlarged transverse sections taken on lines **2—2** and **3—3**, respectively, of Fig. 1;

Fig. 4 is a section illustrating equipotential lines and the voltage gradient along the shank of the bushing with a corona-inhibiting shield of this invention omitted; and,

Fig. 5 is a section illustrating equipotential lines and the voltage gradient along the shank of the bushing with the corona-inhibiting shield of this invention in place.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Referring to the drawings, there is indicated at **1** a tubular dielectric (porcelain) bushing clamped in position in an opening **3** in the sheet metal cover **5** of a transformer tank. Only a portion of the cover **5** is shown, and none of the tank proper, since they are of conventional construction. The cover **5** has an upwardly extending annular bead **7** around the opening **3**. The bushing has a flange **9** bearing on the bead **7** outside the cover and a shank **11** extending down into the tank through the opening **3**. Flange **9** has a downwardly extending peripheral rim **13** providing in conjunction with shank **11** an annular groove **15** receiving the bead **7**. Below the flange **9**, the shank **11** has an annular peripheral groove **17**. The surface of the bushing within the groove **15** and down the shank **11** to and including the groove **17** has a conductive coating **19**, e.g., a metallic glaze of copper or other metal, or an electrically conductive material such as Aqua-dag.

Snapped into the groove **17** is a coiled spring clamping

ring **21**, which may be formed, for example, from stainless steel wire. Surrounding the spring ring **21** is a metal keeper plate or clamping ring **23**. The opening **25** in this clamping ring is of conical form convergent in upward direction, of larger diameter than spring ring **21** at the bottom and of smaller diameter than spring ring **21** at the top. The clamping ring **23** bears down on the spring ring **21** in wedging engagement therewith. The clamping ring **23** has radial ears **27** having tapped holes **29** receiving screws **31** which are threaded upward in holes **29**. The upper ends of the screws engage the tank cover **5** for forcing the clamping ring **23** in downward direction firmly to clamp the bushing in place.

In accordance with this invention, an annular metallic corona-inhibiting skirt or shield **33** is provided on the bottom of the clamping ring **23** surrounding the shank **11** of the bushing and projecting inwardly from the clamping ring. This shield comprises a sleeve-like relatively thin cylindrical ring having outwardly extending radial ears **35** at its upper end provided with untapped holes **37** aligned with holes **29** in the clamping ring ears **27**. The shield **33** is of somewhat larger internal diameter than the portion of the shank **11** below the groove **17** and is held centered in respect to the shank and spaced from and out of direct contact with the shank by means of the screws **31** and by nuts **39** threaded up on the screws against the ears **35** and holding the ears **37** against the bottoms of clamping ring ears **27**. The internal surface of the corona shield **33**, toward the lower end of the shield, is flared away from the bushing as indicated at **41** in the direction toward the inner end of the bushing.

The coating **19**, being in contact with the tank cover **5**, is grounded to the tank. The shield **33** is grounded to the tank via clamping ring **23**, spring **21** and coating **19**, and also by screws **31**.

Fig. 4 illustrates the electric field pattern in the region of the spring **21** and clamping ring **23**, such as exists upon high-voltage energization of high-voltage conductor C which extends through the bushing, without the corona shield. The field is represented by equipotential lines indicated at **E1**–**E5**, line **E1** being the lowest potential line and **E5** the highest potential line of the five lines shown. It will be observed that these lines curve relatively sharply starting generally at the level of the lower edge of the conductive coating **19** and pass out of the shank **11** of the bushing within a relatively short portion of the length of the shank indicated at **L1**. The result is that there is a relatively high-voltage gradient along the length of the shank **11** below the spring **21** and clamping ring **23** which is apt to result in corona discharge.

In contrast, Fig. 5 illustrates the electric field pattern in the region of the spring **21** and clamping ring **23** with the corona shield **33**, the equipotential lines again being designated **E1—E5**. It will be observed that the shield **33** acts to distort the equipotential lines so that, below the lower edge of the conductive coating **19**, they curve out of the shank **11** much more gradually than in the absence of the shield, their exit being spread over a distance such as indicated at **L2** in Fig. 5 which is much longer than distance **L1** of Fig. 4. The result is that there is a relatively low-voltage gradient along the length of the shank **11** below the lower edge of coating **19** so that the corona threshold with the shield is much higher than without it.

It is to be understood that the interior of the bore of bushing **1** may include a conductive coating such as the metallic glaze shown at reference numeral **19**.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above con-

structions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

We claim:

In a transformer comprising a metal tank provided with an opening for a bushing, a tubular dielectric bushing extending through the opening, said bushing having a high-voltage conductor extending therethrough, said bushing having a flange on the outside of the tank engaging the tank, said bushing having an annular peripheral groove on the inside of the tank, a spring ring in the groove, a keeper plate surrounding the bushing and engaging the spring ring, screws threaded in the keeper plate engaging the tank for forcing the keeper plate inward, said bushing having an electrically conductive coating on its exterior extending inwardly from outside the tank to and terminating at said spring ring, said coating being grounded to the tank, and an annular metallic

shield carried by said keeper plate and projecting inwardly therefrom beyond the inner end of said conductive coating, said shield surrounding the bushing and being larger than the portion of the bushing which it surrounds so as to be completely spaced from the bushing, said shield having an internal surface which flares away from the bushing in a direction toward the inner end of the bushing, and said shield being grounded to the tank.

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