

Aug. 21, 1945.

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2,383,018

FLEXIBLE BUSHING

Filed March 3, 1943

2 Sheets-Sheet 1

FIG. 2.

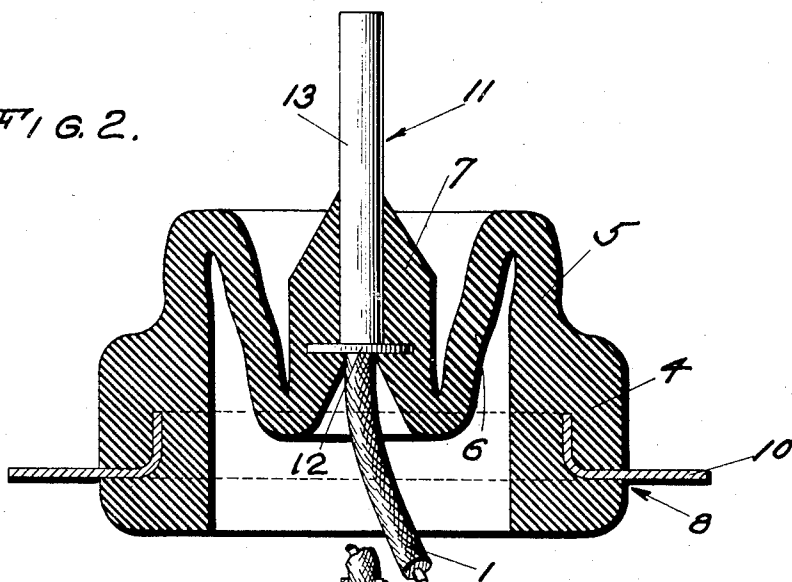
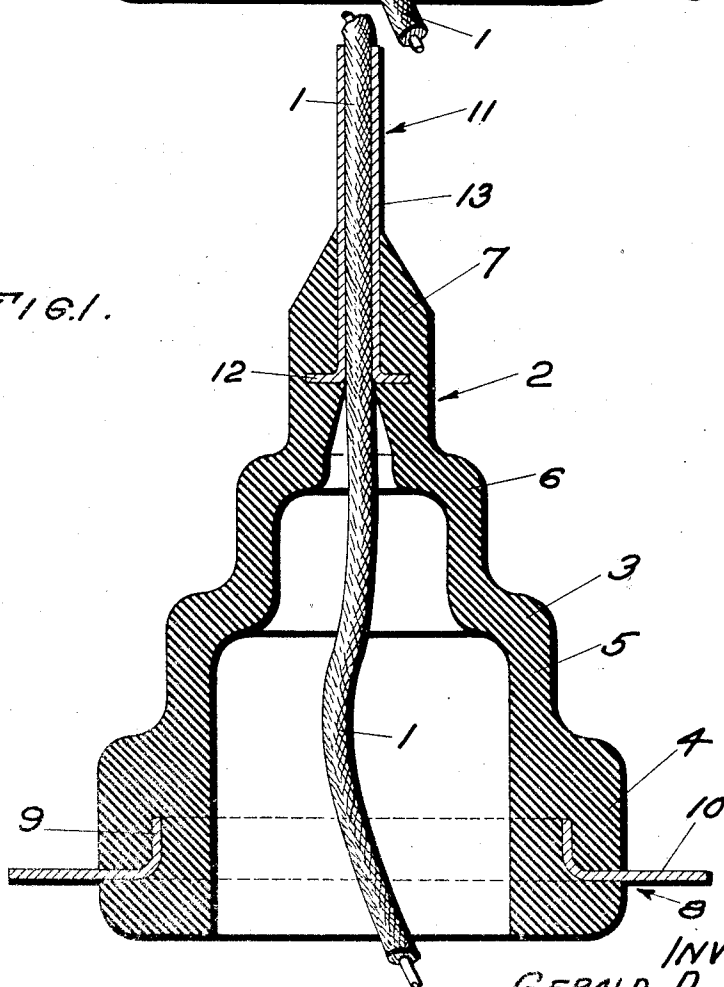


FIG. 1.



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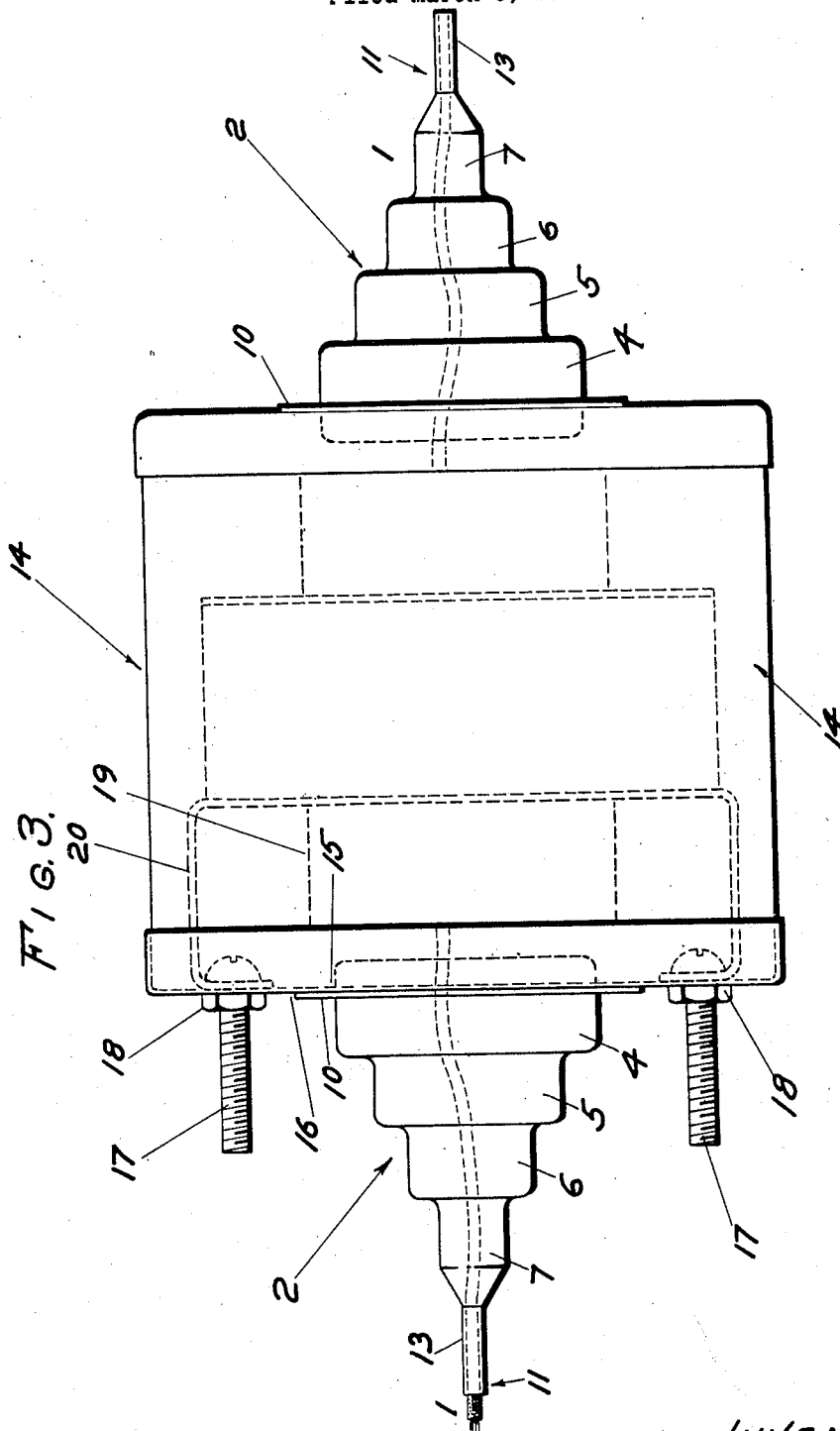
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FLEXIBLE BUSHING

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Application March 3, 1943, Serial No. 477,897

7 Claims. (Cl. 174—167)

This invention relates to lead-in bushings, and particularly to a lead-in bushing providing a flexible and expansible hermetic seal for a terminal or other conducting member at its point of entry into a case, container or other housing.

In apparatus of the type to which the invention relates, it is frequently necessary to enclose some element, such as a coil, in a hermetically sealed housing or container to prevent the loss of fluid filling, such as oil, from the container or to prevent the entrance thereto of air or moisture from the atmosphere. Such lead-in connections must provide a good insulation for the conductor at the point where it passes through the metallic walls of the container while at the same time the opening through the wall must be sealed against leakage in spite of the expansion and contraction of the fluid in the container or housing.

As at present constructed, expansion and contraction of the fluid within a transformer casing or other coil housing may cause a considerable difference in the pressure between the interior and the exterior of the housing. Accordingly the lead-in bushing is subjected to considerable strain and must be built to withstand such strains and at the same time provide good casing insulation between the conductor and the metallic walls of the casing.

It is among the objects of the present invention to obviate the above mentioned defects by providing a lead-in bushing which is capable of expansion and contraction as the fluid contents of the container expand and contract with changes in temperature thereby normalizing the pressure within the container and preventing the same from being subjected alternately to high internal and external strains and at the same time provide for a hermetically sealed and insulated joint between the conductor and the walls of the container or housing.

It is a further object of the invention to provide a flexible and expansible lead-in bushing which will expand and contract in an axial direction without lateral warping such as would tend to throw the conductor toward or against the metallic walls of the housing.

The above and other objects and features of the present invention will be more apparent to those skilled in the art from a consideration of the following detailed description taken in conjunction with the accompanying drawings in which:

Fig. 1 represents a longitudinal section through a bushing constructed in accordance with the

present invention, the same being shown in its full expanded position;

Fig. 2 shows a similar view of the same bushing in a contracted position; and

Fig. 3 shows, in side elevation, a coil housing equipped with lead-in bushings constructed in accordance with the present invention.

In the drawings reference numeral 1 indicates an electric conduit or terminal adapted to be connected to a coil, transformer or other electrical device in the interior of a housing sealed by a bushing 2. The bushing 2 is formed of a collapsible member 3 of flexible, insulating material. Preferably, but not necessarily the material is also resilient as for example, rubber or neoprene. The collapsible member 3 is of a general conical form tapering from a heavy base portion 4, by a series of flexible stepped portions 5 and 6, to a tip 7.

An insert 8 formed of a metallic ring having an internal flange 9 and outwardly projecting portion 10 is molded into the base portion 4 so that the flange 9 forms a bent portion firmly embedded in the base 4. The projecting portion 10 extends outwardly beyond the circumference of the base 4 thus providing a mounting flange for the bushing. Preferably this mounting flange is positioned a short distance from the end of the bushing 2 whereby a small portion of the bushing will project into the housing when said bushing is mounted thereon. The lower stepped portion 5 has the same internal diameter as the internal diameter of the base 4, but has substantially less thickness than said base portion so that this portion 5 will be somewhat less rigid than the base. The external diameter of the stepped portion 6 is somewhat less than the internal diameter of the portions 4 and 5 for reasons that will subsequently appear. The external diameter of the tip 7 is somewhat less than the internal diameter of the stepped portion 6 so that this tip 7 may collapse or telescope into the stepped portion 6 in a manner hereinafter described.

The tip 7 is provided with a metallic insert 11, having a flange 12 projecting at right angles to a tubular stem 13. The flange 12 is firmly embedded in the rubber or other insulating material forming the tip 7. The tubular stem 13 extends axially through the tip 7 and projects beyond the outer end thereof to provide an eyelet, through the otherwise solid tip of the bushing, which eyelet is adapted to accommodate the electric conduit 1.

As shown in Fig. 3 the bushing 2 is adapted to be mounted upon a housing 14 for a transformer

or other electrical device. An opening 15 is provided in any convenient wall of the housing 14, which opening is approximately the same diameter as the external diameter of the base portion 4 of the bushing, whereby that part of the base portion 4 between the flange 10 and the adjacent end of the bushing projects into the housing forming a pilot projection for centering the bushing in the opening. The surface of the flange 10 is adapted to conform with the surface of the end wall or cover 16 and is brazed, soldered, or welded to the wall thereby forming a fluid-tight seal. In the form shown, the housing 14 is provided with two bushings, one on each of the two end plates, or cover 16. It will be readily understood that as many bushings may be provided as required by the number of the lead-in connections and that these bushings may be mounted on the same side of the housing or in any convenient position. It will also be appreciated that if the side wall of the housing 14 has a curved surface or other configuration at the point where it is desired to mount the bushing the insert 8 will be constructed to conform to such surface.

The conductor 1 passing through the eyelet formed by the insert 11 may be of the type having an outer insulating coating of some resilient material, such as rubber, and in that case it is preferable that the internal diameter of the passage through the tubular stem 13 be somewhat less than the normal external diameter of the insulated conductor so that in forcing the conductor through the eyelet the resilient material will be somewhat compressed to form a fluid-tight joint. The housing 11 is provided with the usual mounting studs 17 which have been rendered fluid-tight by soldering around the mounting nuts 18. In the form shown a coil 19 is mounted in the container 14 by means of the usual coil clamps 20, but it will be readily appreciated that the bushings 2 may serve any housing in which it is desired to hermetically seal an electrical device having terminal connections leading to the exterior of the housing. It will be understood that the housing 14 is completely sealed, the end covers 16 having been soldered, welded, or brazed to the body portion 21 of the housing.

In operation, the space around the coil 19 within the housing 14 is completely filled with oil or other insulating fluid so that the bushings 2 are in the expanded position shown in Fig. 1 when the temperature of the insulating fluid is at about the maximum working temperature, usually 100° C.

It will be understood that in the preferred form the device is capable of further expansion beyond the position shown in Fig. 1 due to the resilience of the rubber, neoprene of similar elastic material, which is the preferred material for forming the collapsible member 3. Accordingly the elastic material may be expanded still further to take care of some further increase beyond the usual maximum working temperature of the oil or other insulating fluid. When in the expanded position shown in Fig. 1, the collapsible member 3 is not under stress, that is to say, that in this position the rubber or other resilient material is in the form in which it was molded and not in a distorted position due to either internal or external pressure. Thus in expanding outwardly to a position corresponding to the maximum normal working temperature of the insulating fluid the material of the collapsible member 3 is not placed under stress or stretched. At lower temperatures

the oil or other fluid contracts tending to create a subatmospheric pressure within the container 14 and the atmospheric pressure therefore tends to collapse or telescope the bushings 2 inwardly thus maintaining substantially the same pressure upon the interior of the container 14 as the atmospheric pressure on the exterior thereof. For this reason neither the container itself nor the bushings 2 are subjected to great differences of pressure between the interior and exterior thereof and accordingly the housing 14 may be made of thinner material and of less rugged construction than has heretofore been possible. In collapsing from the position shown in Fig. 1 to the position shown in Fig. 2, the material of member 3 is neither stretched nor compressed except for a slight outward stretching of the side walls of the outer stepped portions as the internal portions collapse or telescope therethrough.

At the minimum temperature, which may be as low as 40° C., the bushing will be collapsed to the position shown in Fig. 2. In this position the tip 7 has receded into the portion 6 which in turn has receded into the lower stepped portions 5 and 4. At all times during the collapse of the bushing, from the position occupied at 100° C. and the position occupied at 40° C., insert 11 moves substantially axially of the bushing. It is undesirable for the bushing to collapse in such a manner that the side walls thereof tend to flatten out rather than to telescope.

Since the tip 7 has external diameter less than the diameter of the stepped portion 6, the portion 6 tends to act as a lateral guide and support for the tip 7 as the tip is forced downwardly into the stepped portion 6. The portion 6 simultaneously tends to collapse into the portion 5, which portion 5 is of sufficient internal diameter to accommodate the portion 6 therein and support the partially collapsed parts against lateral deformations until the upper portion of the bushing has fully collapsed into the lower portion thereof. If the walls of the bushing are not properly constructed, for example if the bushing were constructed in the form of a plain cone instead of the stepped construction shown, then the side walls of the bushing would tend to flatten out under atmospheric pressure and in so flattening the stem 13 in the conductor 1 would tend to fall against the side walls of the container thereby running the risk of short-circuiting the conductor.

Although but one embodiment of the invention has been disclosed herein other embodiments within the scope of the appended claims will be obvious to those skilled in the art from a consideration of the form shown.

What is claimed is:

1. A lead-in bushing comprising a cup-shaped member of flexible insulating material, said member having an enlarged hollow base portion, a reduced tip and a hollow stepped portion between said base and said tip, said stepped portion having an external diameter less than the internal diameter of said base portion, and an internal diameter greater than the external diameter of said tip, whereby, when the pressure on the external surface of said cup-shaped member is greater than the pressure on the internal surface thereof, said tip will collapse into said stepped portion and said stepped portion will collapse into said base portion.

2. A lead-in bushing comprising a cup-shaped member of flexible insulating material, said member including an enlarged hollow base, a reduced

tip and a hollow stepped portion between said base and said tip, said stepped portion having an external diameter less than the internal diameter of said base, and an internal diameter greater than the external diameter of said tip, whereby when the pressure on the external surface of said cup-shaped member is greater than the pressure on the internal surface thereof, said tip will collapse into said stepped portion and said stepped portion will collapse into said base portion and a conductor extending through said tip.

3. In combination with a hermetically-sealed, fluid-filled housing having an opening for an electrical connection, a lead-in bushing comprising a collapsible member of flexible insulating material, said collapsible member tapering by successive stepped cylindrical portions from a heavy base portion to a projecting tip, all of said stepped portions except said tip defining hollow cylindrical chambers, a conductor extending through said tip, a metallic member embedded in said insulating material and having a portion projecting beyond the periphery thereof forming a flange for mounting said collapsible member on said housing in a position to close said opening, whereby expansion and contraction of the fluid in said housing causes successive steps of said collapsible member to telescope into and out of each other to maintain the pressure in said housing substantially constant.

4. A lead-in bushing comprising a hollow tubular base portion of insulating material, a hollow intermediate portion of the same material connected to said base by a flexible stepped portion and of lesser external diameter than the internal diameter of said hollow base portion, a tubular end portion of lesser external diameter than the internal diameter of said hollow intermediate portion, and connected to said intermediate portion by a second flexible stepped portion, said intermediate portion being sufficiently flexible to collapse into and nest in said hollow base portion in response to a greater pressure on the exterior of said bushing than on the interior thereof, said tubular end portion being adapted to nest in said intermediate portion, and a conductor sealed in said tubular end portion and movable therewith.

5. A lead-in bushing comprising a base portion of insulating material having a central cylindrical chamber therein, an intermediate hollow cylindrical portion of flexible insulating material connected to said base by a flexible stepped portion and having an external diameter less than the internal diameter of said cylindrical chamber in said base portion, said base portion having a greater rigidity than said intermediate portion, and a cylindrical tip of lesser diameter

than the internal diameter of said intermediate cylindrical portion, whereby, when the pressure on the exterior surface of said bushing is greater than the pressure on the internal surface thereof, said intermediate portion will recede into said base portion and be guided and supported against lateral displacement by said base portion and said tip will recede into said intermediate portion and be supported against lateral displacement by said intermediate portion.

6. In combination with a hermetically-sealed, fluid-filled housing having an opening for an electrical connection, a lead-in bushing comprising a hollow tubular base portion of insulating material adapted to be integrally attached to said housing in sealing relation to said opening, a hollow intermediate portion of the same material as said base connected thereto by a flexible stepped portion and having a lesser external diameter than the internal diameter of said hollow base portion, a tubular end portion of lesser external diameter than the internal diameter of said hollow intermediate portion, connected to said intermediate portion by a second flexible stepped portion, said intermediate portion being sufficiently flexible to collapse into and nest in said hollow base portion in response to a contraction of the fluid contents of said housing, said tubular end portion being adapted to nest in said intermediate portion, and a conductor sealed in said tubular end portion and movable therewith.

7. In combination with a hermetically-sealed, fluid-filled housing having an opening for an electrical connection, a lead-in bushing comprising a base portion of insulating material having a central cylindrical chamber therein, said base portion being attached to said housing in sealing relation to said opening, an intermediate hollow cylindrical portion of flexible insulating material connected to said base by a flexible stepped portion and having an external diameter less than the internal diameter of said cylindrical chamber in said base portion, said base portion having a greater rigidity than said intermediate portion, and a cylindrical tip of lesser diameter than the internal diameter of said intermediate cylindrical portion, and connected thereto by a second flexible stepped portion, whereby, when the pressure on the exterior of said housing is greater than the pressure on the interior thereof, said intermediate portion will recede into said base portion and be guided and supported against lateral displacement by said base portion, and said tip will recede into said intermediate portion and be supported against lateral displacement by said intermediate portion.

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