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LEAD-IN BUSHING

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FIG. 1.

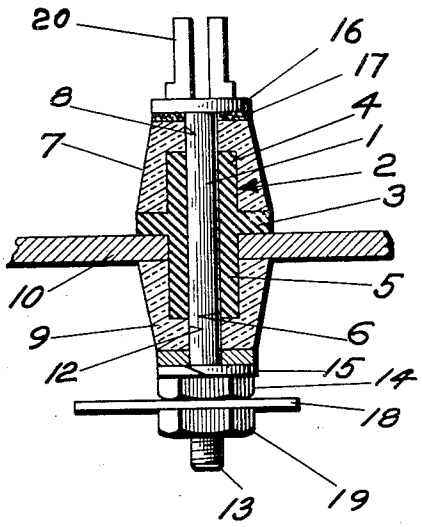
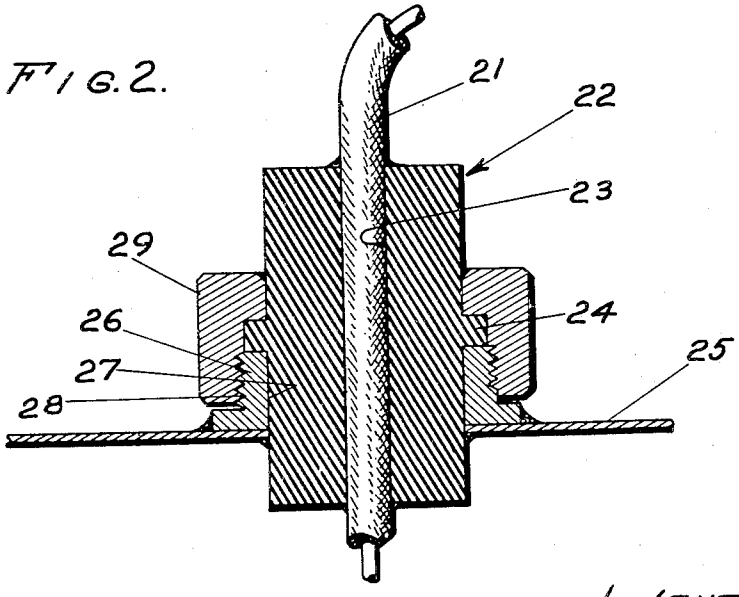


FIG. 2.



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LEAD-IN BUSHING

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4 Claims. (Cl. 174—153)

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This invention relates to a lead-in bushing and particularly to a bushing for providing a high electrical insulation and an hermetic seal to a terminal or other conducting member at its point of entry into a case, container or similar housing.

In many types of electrical apparatus, for example, transformers, it is desirable or necessary to enclose some element, such as a coil, in a housing. Frequently the housing should be hermetically sealed 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. The lead-in connections for such apparatus must be well insulated from the metallic walls through which they pass, while at the same time the opening must be sealed against leakage even at considerable differences in pressure between the interior and the exterior of the container.

As at present constructed lead-in bushings for such apparatus are a frequent source of trouble, due to the fact that expansion or contraction of the conducting member, resulting from temperature changes, so loosens the seal that leakage is permitted between the conductor and the insulating bushings, or between the bushings and the surrounding wall. Also if the apparatus is subjected to vibration, as when associated with heavy machinery, the seal is likely to become loose or the insulation broken.

It is among the objects of the present invention to provide a lead-in bushing which will be free from the above-mentioned defects and which will provide an effective hermetic seal against considerable pressure and regardless of temperature variations and other adverse conditions.

It is a further object of the invention to provide a lead-in bushing which will constitute an effective seal while at the same time maintaining a high electrical insulation.

Other objects and features of the present invention will be apparent to those skilled in the art from a consideration of the following detailed description taken in conjunction with the accompanying drawing in which:

Fig. 1 shows a longitudinal section through a lead-in bushing constructed in accordance with the present invention; and

Fig. 2 shows a similar view of a modified form of the invention.

In the drawing, reference numeral 1 indicates an electric conductor which extends through a bushing 2 of rubber or other similar resilient

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insulating material. The bushing 2 has an integral circumferential flange 3 of the same material which divides the bushing 2 into two end portions 4 and 5. In the instance shown, the end portions 4 and 5 are of unequal length for reasons which will hereafter become clear. A passage or bore 6 extends longitudinally through the bushing 2 and in the preferred form of the invention this passage is of slightly less internal diameter, in its normal contracted state, than the exterior diameter of the conductor 1. In a commercial embodiment of the invention a difference of .010 to .014 inch has been used successfully, although it will be understood that this difference may vary in wide limits except that the member 2 should not be strained by the insertion of the conductor 1 to an extent approaching its elastic limit. A shell, which in this instance is formed of a cup-shaped member 7 of porcelain or other non-resilient, insulating material, is provided with an interior surface conforming in shape to and fitting with the exterior surface of the end portion 4 of the bushing 2. An opening 8 in the base or end portion of the cup-shaped member 7 is adapted to register with the passage 6 of bushing 2 when the cup 7 is assembled in position on the end portion 4. A second cup-shaped member 9, similar to the cup-shaped member 7, has interior surfaces adapted to conform to the exterior surfaces of the end portion 5 of bushing 2, except that its depth is slightly less than the length of this end portion 5. This difference provides a short space between the flange 3 and the end or lip of the cup-shaped member 9, permitting the parts to be assembled with a panel 10, which may be the wall of any receptacle, therebetween. An opening 12 in the base or end portion of the cup 9, similar to the opening 8 in the end portion of cup 7, is adapted to register with this last-mentioned opening and with the passage 6 when the parts are assembled. One end of the conductor 1 is screw-threaded, as indicated at 13, in order to accommodate a nut 14 and spacer washers 15, one of which may be a lock washer. The opposite end of the conductor 1 is provided with an enlargement or head 16, and a slotted or forked portion 20, forming a terminal connection. A washer 17, preferably of cork, is provided between this head and the shell 7. A terminal 18 may be attached to the conductor 1 by means of a nut 19.

The device above described may be assembled readily by inserting the bushing 2 into an opening in the panel or housing 10, so that the circum-

ferential flange 3 engages a portion of the panel surface surrounding the opening. The cup-shaped member 7 may then be placed over the end portion 4 and the cup 9 may be placed over the end portion 5. Since the end portion 5 is of somewhat greater length than the depth of the cup 9, this end portion will be of sufficient length to completely fill the interior of the cup 9 even after passing through the panel 10. Thus the end portion 5 is preferably of a length equal to the depth of the cup plus the thickness of the panel 10. The conductor 1 may now be inserted through one of the openings, such as the opening 8 in the end portion 7, and through the passage or bore 6 in the bushing 2 and thence through the opening 12 in the base or end of the other cup 9. Although the passage 6 through which the conductor 1 is forced is preferably of slightly less diameter than the diameter of the conductor 1, the conductor may nevertheless be pressed through this passage due to the resilience of the bushing. Where the conductor 1 is screw-threaded, as indicated at 13, this forcing of the conductor through the bushing may be effected by turning the conductor and applying slight pressure thereon. By thus forcing the conductor 1 through the bushing 2 the bushing is expanded so that it exerts an outward pressure on the interior walls of the cup-shaped insulators 7 and 9. This pressure is exerted outwardly against both the internal side walls of the members 7 and 9 as well as in the direction of the bottom or end walls thereof. If now the cup-shaped members are forced together by tightening the nut 14, then the entire internal surface area of the members 7 and 9 is subjected to considerable pressure. Also the entire surface area of the conductor 1 within the bushing 2 is subjected to a similar pressure from the compressed resilient material comprising the bushing 2. Thus leakage either along the surface of the conductor 1 through the passage 6, or leakage around the exterior surface of the bushing, that is between the bushing 2 and the interior walls of the cup-shaped members 7 and 9 or between the bushing and the panel 10, is impossible even though a considerable pressure difference may exist between the two sides of the panel 10.

It will be understood that in the preferred form of the invention as described, the dimensions of the member 2, before the insertion of the conductor 1 through the passage 6, are about the same or only slightly less than those of the space within and between the two cup-shaped members 7 and 9. Upon forcing the conductor 1 through the passage 6, the member 2 expands radially and longitudinally so that its diameter or its length or both are slightly greater than the corresponding dimensions of the space within the members forming the shell. Thus when the two shells are forced together by tightening the nut 14 the material of the bushing 2 is not only drawn into intimate contact with the electric conductor 1 by the tension of the expanded resilient material of which the bushing is composed, but it is also forced inwardly into intimate contact with the conductor 1 by the compressive action of the outer shell.

In some applications of the present invention it is desirable to construct the bushing 2 so that in its normal unexpanded state it is slightly larger in at least one dimension than the corresponding dimension of the space within and between the two cup-shaped members forming the shell. In such a construction, with the bushing 2 normally larger in at least one dimension than the corresponding dimension of the space which it is intended to fill, it will be seen that the material thereof will be forced inwardly under considerable pressure and that this pressure may supplement the forces resulting from the fact that the conductor 1 is of greater diameter than the bore 6 of the bushing.

In places where it is seldom necessary to remove the bushing from panel 10, the surfaces between the conductor 1 and the bushing 2 and between the bushing and the insulating members 7 and 9 may be coated with suitable cements for making a rubber-to-metal or a rubber-to-porcelain seal as required. The use of such cements facilitates the assembly of the parts, since the cement is at this time in a fluid condition, and therefore facilitates the insertion of the conductor 1 through the bore 6, and its subsequent hardening strengthens the seal.

It will be apparent that the form of the invention above described, while providing an hermetic seal and also providing a high electrical insulation between the conductor 1 and the metallic wall 10 of the housing, also permits a certain flexibility between the conductor 1 and the panel 10. Thus, the conductor 1 can move slightly relative to the panel in response to a vibration or shock without breakage of the porcelain or other non-flexible portion of the insulation. Although the distortion permitted by this form is not great, it is sufficient to permit the use of the lead-in bushing under conditions of moderate vibration and where the same is likely to be subjected to moderate shock.

Under conditions where it is desired to have a high degree of flexibility of the conductor through the panel wall, I prefer to use the form shown in Fig. 2. Referring to this figure, reference numeral 21 indicates the conductor; 22 indicates a bushing of rubber or insulating material similar to the bushing 2 described in the previous form. As shown, the conductor 21 comprises a lead-wire having a soft rubber or other insulating coating. In a commercial construction the outer diameter of such a conductor is about $\frac{3}{16}$ of an inch. The bushing 22 is provided with a passage or bore 23 extending longitudinally therethrough and having an internal diameter slightly less than the external diameter of the conductor 21. As in the previous form the bushing 22 is provided with a circumferential flange 24 positioned intermediate the two ends thereof. The panel 25 is provided with a bushing-retaining shell which in this case is formed of an annular boss 26 which may be made integrally with the panel 25 or rigidly affixed thereto as by soldering and welding. The boss 26 has an internal bore 27 of approximately the same internal diameter as the normal, unexpanded, external diameter of the bushing 22. The boss 26 is externally screw-threaded as indicated at 28 and a nut 29 is provided with an internally threaded portion to coact with the threaded portion 28 of the boss 26.

In the assembly of this form of the device the bushing 22 is inserted through the bore 27 with which it normally has a snug, but not necessarily a forced, fit. If the conductor 21 is then drawn through the bore or passage 23 of the bushing 22, the bushing will be expanded so that it will have a tight or forced fit with the bore 27 of the annular boss 26. The nut 29 may thereupon be tightened to securely clamp the circumferential flange 24 of the bushing 22 against the upper end surface of the annular boss 26. In this form of the device the bushing 22 has end portions ex-

tending beyond the panel 25 and beyond the upper edge of the nut 29 for a sufficient distance to permit considerable flexing of the projecting ends of the bushing and the conductor contained therein. The upper internal edge of the nut 29 is somewhat beveled to facilitate the flexing of the bushing 22 without tending to shear or cut the same.

It will be apparent that the form just described provides for an hermetic seal against some pressure, while at the same time providing for greater flexibility of the conductor. In this form also the surface between the conductor 21 and the bore 23 of the bushing 22 may be coated with a cement, and such cement in its liquid state will also facilitate the insertion or the drawing of the conductor 21 through the bore 23. Such cement should be a suitable rubber-to-rubber cement, while a suitable rubber-to-metal cement may be used between the bushing 22 and the bore 27 of the boss 28.

Although but two embodiments of the invention have been described, it will be obvious to those skilled in the art that many other embodiments and modifications may be made in accordance with the principles herein described and within the scope of the appended claims. For example, the two cup-shaped members 7 and 9 forming the non-resilient shell of insulating material need not be of the same size and shape. One shell may be smaller than the other, while the two end portions of the rubber bushing 2 are the same size thus providing accommodation space for the plate or panel 10 between the rim of the smaller cup and the circumferential flange 3. Furthermore, the outer confining shell may be formed of a single cup-shaped member instead of two as shown, or the outer confining shell may cover merely the circumference of the bushing 2 without covering the end portions of the bushing.

While in the preferred form shown in Fig. 1 the outer shell is of non-conducting material, it will be understood that in cases where high insulation is not required this shell may be separate from the casing or housing served by the lead-in, or it may be formed as a boss or similar portion integral with or rigidly attached to the housing. In any case the outer enclosing shell should be of sufficient length to confine or restrain the circumferential expansion of the resilient bushing on the insertion of the conductor therethrough.

The words "conforming in shape" as used in the specification and following claims are intended to mean that the parts so characterized have surfaces of the same general contour. Thus if the resilient bushing is cylindrical the confining shell will also have a substantially cylindrical coacting surface. The words "fitting with" are intended to include either a loose or a tight fit, except the fit should not be so loose that the bushing will not expand into contact with the confining shell upon insertion of the electric conductor therethrough. Where a tight fit is used, the expansion of the bushing upon the insertion of the conduit effects a correspondingly greater pressure.

What is claimed is:

1. A lead-in bushing, comprising a member of resilient material having a passage extending longitudinally therethrough, an electric conductor having a diameter greater than the normal contracted diameter of said passage but sufficiently small to permit the conductor to be forced through said passage without exceeding the

elastic limits of said material, an outer shell having an interior surface conforming in shape to and fitting closely with an exterior surface of said resilient member when said member is in its normal unexpanded state, a flange on said member, and means for compressing said flange against and retaining it on a rim of said shell whereby when the parts are assembled said conductor expands said resilient member to exert radial pressure upon the interior walls of said shell and thereby avoids leakage between said conductor and said resilient member or between said member and said shell.

2. A lead-in bushing for supporting an electric conductor passing through an aperture in a plate comprising a member of resilient material having a passage extending longitudinally therethrough, an electric conductor having a diameter greater than the normal contracted diameter of said passage but sufficiently small to permit the conductor to be forced through said passage without exceeding the elastic limits of said material, an outer shell comprising a pair of cup-shaped members of non-resilient, non-conducting material having interior surfaces conforming in shape to and fitting closely with exterior surfaces of said member when said member is in its normal unexpanded state, a flange on said member, and means including said conductor for compressing said flange between a rim of one of said cup-shaped members and a plate of said housing, whereby on assembly said conductor expands said resilient member to exert radial pressure upon the interior walls of said outer shell and thereby avoids leakage between said conductor and said resilient member or between said resilient member and said outer shell.

3. A lead-in bushing including an insulating member of elastic material having a passage extending longitudinally therethrough and centrally thereof, a flange projecting circumferentially of said member, an electric conductor extending through said passage and having a greater diameter than the normal contracted diameter of said passage, whereby said insulating member is expanded and the material thereof placed under tension by the insertion of said conductor through said passage and contracts to provide a fluid-tight joint with said conductor under varying temperature and pressure conditions, a panel having an opening therethrough means to secure said flange in sealing relation to said opening comprising a member bearing upon said flange on one side of said panel, a member bearing upon said panel on the opposite side thereof, and means on said conductor for applying pressure to said two last-named members in the direction of said panel to compress said flange between said panel and the one of said two last-named members bearing upon said flange.

4. A lead-in bushing including an insulating member of elastic material, a flange projecting circumferentially of said member intermediate the ends thereof and of the same material, an electric conductor extending through said passage and having a greater diameter than the normal contracted diameter of said passage, whereby said insulating member is expanded and the material thereof placed under tension by the insertion of said conductor through said passage and contracts to provide a fluid-tight joint with said conductor under varying temperatures and pressure conditions, a panel having an opening therethrough, means to secure said flange in seal-

ing relation to said opening comprising a cup-shaped member of non-resilient non-conducting material defining a space conforming approximately to the shape and the normal unexpanded dimensions of the portion of said insulating member on one side of said flange and having the edge of its open end bearing upon said flange, a second cup-shaped member of non-resilient non-conducting material defining a space conforming approximately to the shape and the normal unexpanded dimensions of the portion of said insulating member on the opposite side of said flange, and having the edge on its open end bearing upon said panel, each of said cup-shaped members having openings in the closed ends thereof for the passage of said conductor therethrough, and means on said conductor for applying pressure to said cup-shaped members in the direction of said panel to compress said flange between said panel and one of said cup-shaped members.

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