Sept. 16, 1952

W. G. JAMES

BUS BAR BUSHING STRUCTURE FOR ELECTRICAL APPARATUS CASINGS

2,611,002

Filed April 26, 1949

3 Sheets-Sheet 1

Fig. 1.

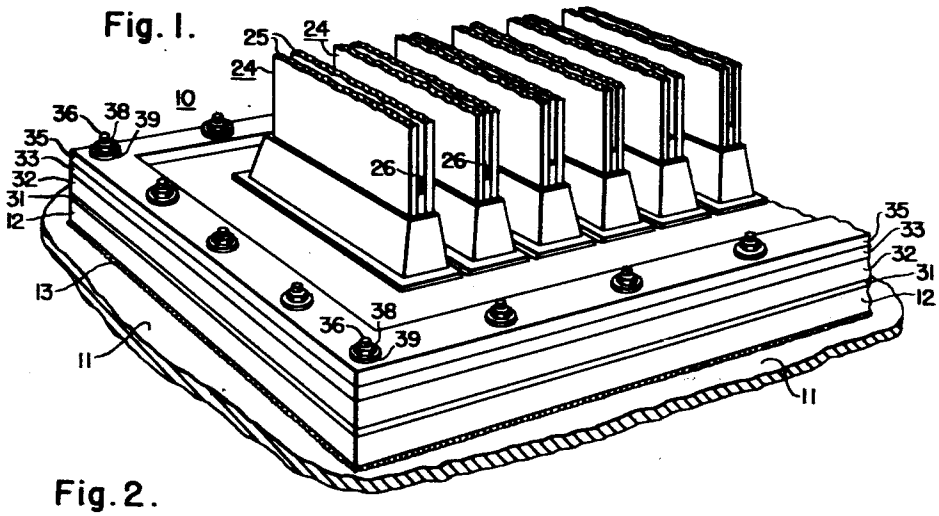
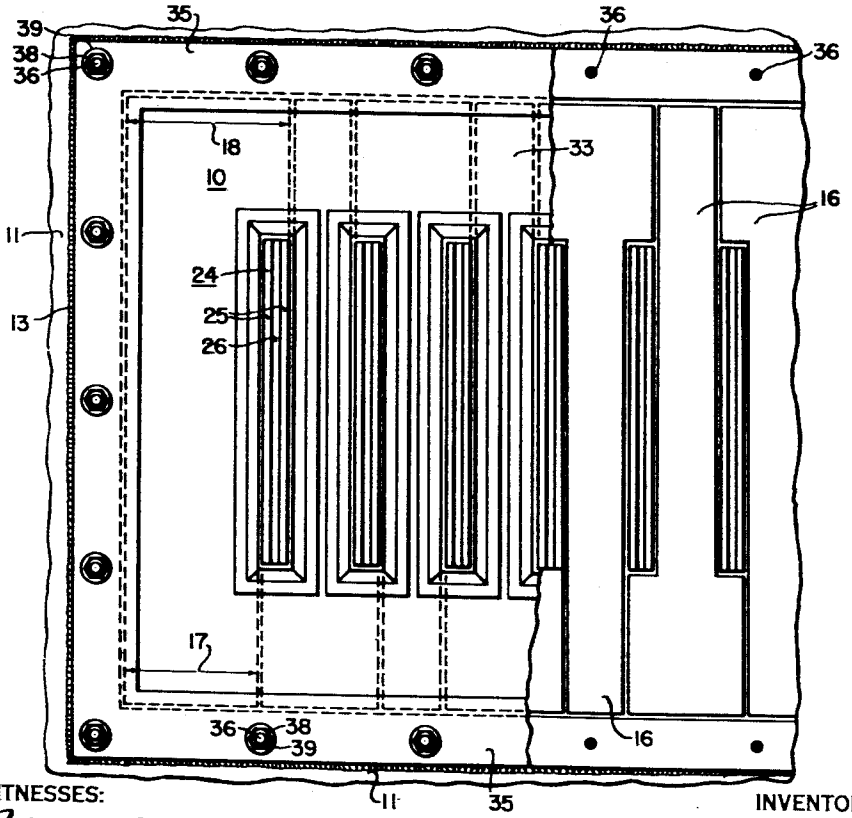


Fig. 2.



WITNESSES:

Robert C. Baird.

Wm. L. Groome

INVENTOR

William G. James.

BY Franklin E. Hardy

ATTORNEY

Sept. 16, 1952 W. G. JAMES 2,611,002

BUS BAR BUSHING STRUCTURE FOR ELECTRICAL APPARATUS CASINGS

Filed April 26, 1949 3 Sheets-Sheet 2

Fig. 3.

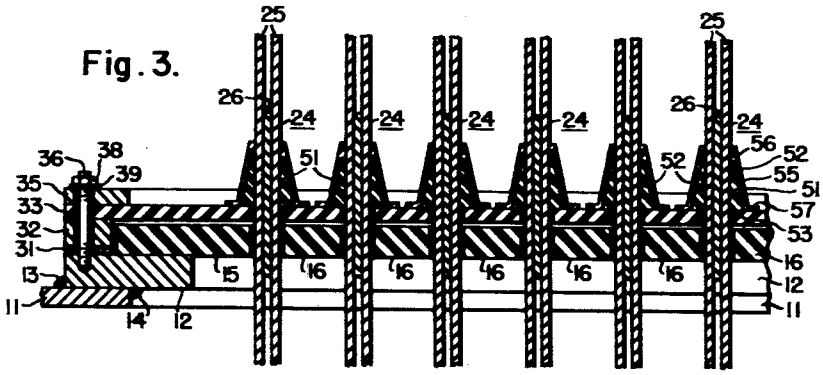


Fig. 4.

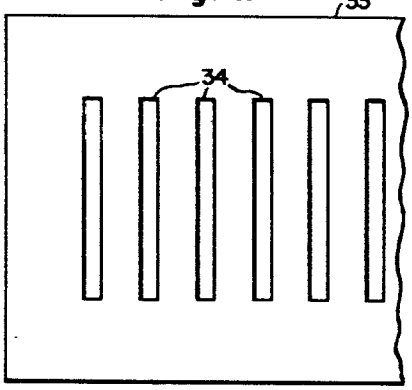


Fig. 5.

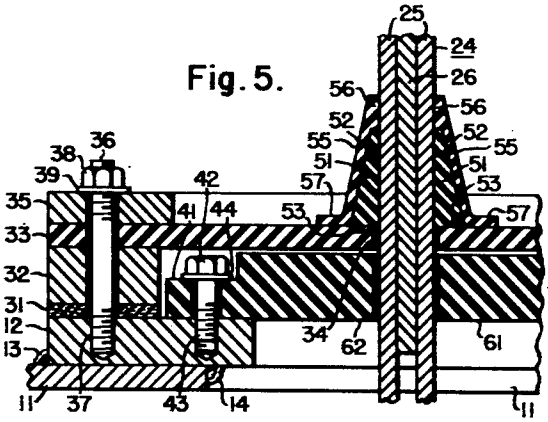
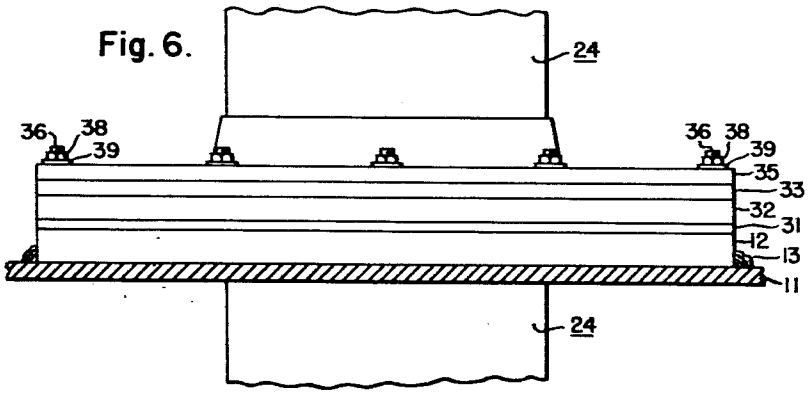


Fig. 6.



WITNESSES:

Robert C. Baird

Wm. L. Groome

INVENTOR

William G. James.

BY Franklin E. Hardy

ATTORNEY

Sept. 16, 1952 W. G. JAMES 2,611,002

BUS BAR BUSHING STRUCTURE FOR ELECTRICAL APPARATUS CASINGS

Filed April 26, 1949 3 Sheets-Sheet 3

Fig. 7.

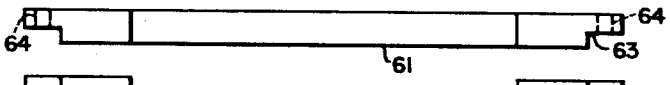


Fig. 8.

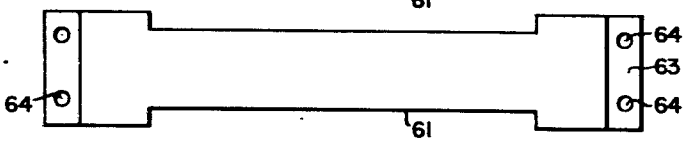


Fig. 9.

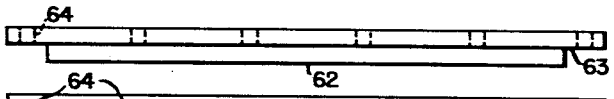


Fig. 10.

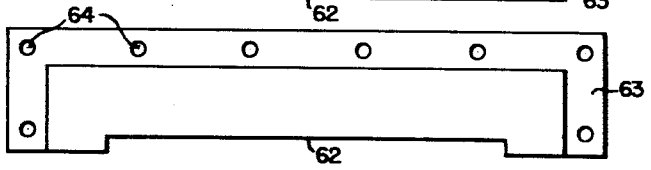


Fig. 11.

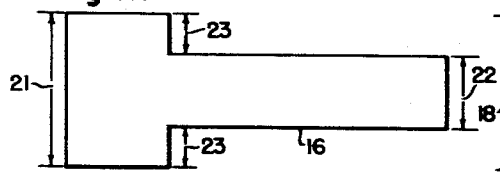


Fig. 12.

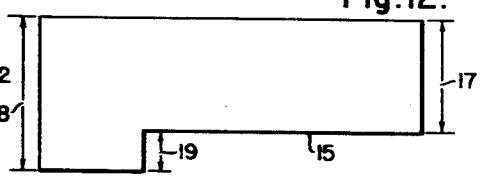


Fig. 13.

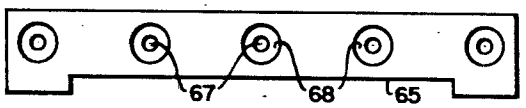


Fig. 14.

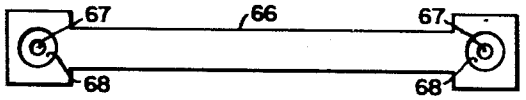
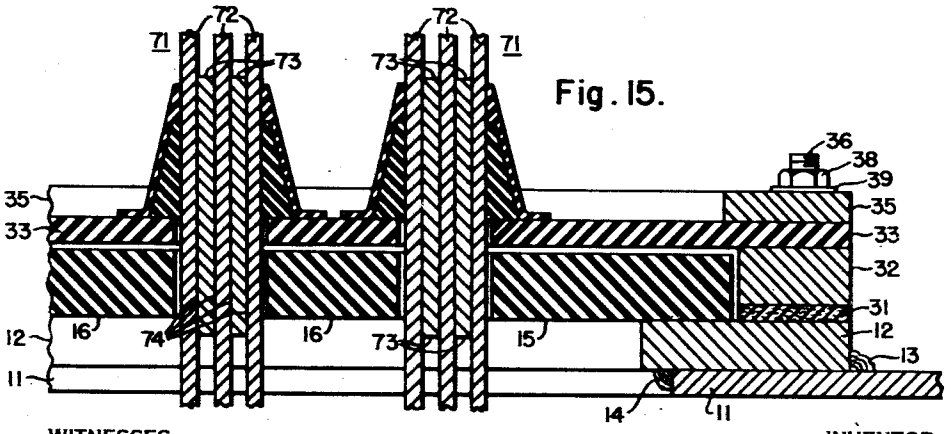


Fig. 15.



WITNESSES:

Robert C. Baird.

Dew le Groome

INVENTOR

William G. James.

BY Franklin E. Hardy

ATTORNEY

Patented Sept. 16, 1952

2,611,002

UNITED STATES PATENT OFFICE

2,611,002

BUS BAR BUSHING STRUCTURE FOR ELECTRICAL APPARATUS CASINGS

William G. James, West Middlesex, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application April 26, 1949, Serial No. 89,786

4 Claims. (Cl. 174—18)

1

My invention relates to electric induction apparatus such as transformers and particularly to the method and means for tightly sealing the terminal conductors of such apparatus in the location where they pass through the cover or wall of the casing or tank in which such apparatus is enclosed.

In certain transformers, such as furnace transformers, the low-voltage terminal conductors are large in cross sectional area and carry high current at low voltage. Such conductors commonly consist of a number of bus bars spaced apart and checked in parallel circuit relation.

It is desirable that the space within the transformer tank or casing be tightly sealed from the space outside of the casing so that air and moisture from without will not enter the tank and so that oil and gas under limited pressure will be retained within the tank.

It is an object of the invention to provide a bushing assembly for transformers adapted for carrying heavy current that is simple in construction, has good insulating characteristics, that forms a tight seal that will prevent the leakage of oil or gas from the apparatus casing and that will prevent the passage of air or moisture into the apparatus casing.

The invention is particularly adapted for use with low voltage bus bar bushing assemblies such as are used in furnace transformers. A bus bar bushing assembly for such use should, in addition to the above stated objects of the invention, have the following characteristics:

It should require a minimum of space, have a high resistance to corrosion, not absorb moisture and should be elastic and withstand temperatures ranging from minus 50° centigrade to plus 75° centigrade without cracking or losing its elasticity.

The bushing assembly should not be affected by oil or oil fumes to any great extent or by acids or alkalies, it must be capable of bonding well to copper.

The sealed bus bar bushing assembly structure should be of such construction that it can be left in place without breaking the seal when the cover to the transformer is removed and it must be capable of withstanding an internal pressure of eight pounds within the transformer casing. It should be capable of being applied to a transformer in the field either as an improvement to transformers not originally provided with such bushing assembly, or in case of repairs to the transformers.

It is a further object of the invention to provide a low-voltage bus bar bushing assembly having the above-indicated desirable characteristics.

2

Other objects and advantages of the invention will appear from the following description of certain preferred embodiments thereof, reference being had to the accompanying drawings in which:

Figure 1 is a perspective view of a portion of the cover of a transformer casing provided with a low-voltage bushing assembly structure constructed in accordance with the invention;

Figure 2 is a plan view of the bushing assembly structure shown in Figure 1 with portions broken away;

Figure 3 is a view in vertical section through the structure shown in Figs. 1 and 2;

Figure 4 is a plan view of a portion of a sheet of insulating material used in the bushing assembly structure;

Figure 5 is a view in enlarged vertical section generally similar to Fig. 3 with slight modifications;

Figure 6 is an end view of the bushing assembly shown in Figs. 1 and 2;

Figures 7 and 8 are edge and plan views, respectively, of an intermediate spacer member for use in one embodiment of the bushing assembly of the invention;

Figures 9 and 10 are edge and plan views, respectively, of an end spacer member for use with a plurality of intermediate spacer members having the form shown in Figs. 7 and 8;

Figures 11 and 12 are plan views of an intermediate spacer member and an end spacer member, respectively, for use in one embodiment of the bushing assembly of the invention;

Figures 13 and 14 are plan views of an intermediate spacer member and an end spacer member, respectively, for use in one embodiment of the bushing assembly of the invention; and

Figure 15 is a vertical sectional view similar to Fig. 3 showing another embodiment of the invention.

Referring to the drawings and particularly to Figures 1, 2, 3 and 6 thereof, a bushing assembly 10 is shown mounted on a cover 11 of a transformer casing or tank. The assembly comprises a rectangular steel cover flange 12 welded to the transformer casing cover 11, as best shown at 13 and 14 in Figs. 3 and 5, which cover flange is shown as extending about the rim of a rectangular opening in the cover of the transformer casing through which the low voltage bus bars extend. The cover flange 12 acts as a base or

foundation for supporting the entire bushing assembly structure. An insulating platform is provided for covering the opening in the transformer cover and supporting the entire bushing assembly structure. The platform comprises a supporting structure formed of a plurality of rigid spacer members of insulating material, such as press board, and an insulating rubber mat supported on the spacer members. An end spacer member 15, formed of solid insulating material and having the general shape shown in Fig. 12, is provided at each end of the rectangular opening in the casing and is supported on the cover flange 12. A series of intermediate spacer members 16 having the general shape shown in Fig. 11, are placed between the two end spacer members 15 and are also supported at their opposite ends on the cover flange 12 as best shown in Figure 2. The end spacer members 15 may be L-shaped as shown in Figure 12 having a width 17 for the greater portion of its length, and a width 18 at a widened portion at one end. The dimension 19, which is the difference between the dimensions 18 and 17, corresponds to the thickness of an individual bus bar 24 that extends upwardly between the spacer members of the platform. The intermediate spacer members 16 are T shaped. The dimension 21 across the outer end of the spacer member corresponds to the distance between the centers of the bus bars 24, the dimension 22, indicating the width of the narrow end of the spacer member, corresponds to the distance between adjacent faces of bus bars 24, and the dimension 23 corresponds to the width or thickness of the bus bars. As best shown in Figure 2, the spacers are arranged in accordance with a pattern such that the wide ends of the T-shaped spacers alternate from one side to the other side of the rectangular opening in the casing cover so that openings in the platform between the spacer members are provided having the correct dimensions to accommodate the several bus bar terminal conductor leads in the desired spaced relation with respect to one another and with respect to the edges of the opening in the casing cover. The lengths of the spacing members 15 and 16 correspond substantially to the width of the rectangular cover opening with a slight overlap in length so that the ends of the spacer members may rest on and be supported by the cover flange 12. The bus bars 24 are shown as being formed of two sheets 25 of conducting material, such as copper, spaced apart and braised to a shorter bar 26 extending through the bushing.

A gasket 31 is provided, extending about the plurality of slabs of spacer members 15 and 16 between the outer rim of the cover flange 12 and a steel spacer ring 32 which also surrounds the spacer members 15 and 16.

A rectangular mat 33 of oil and oxygen resistant synthetic elastomer or rubber sheet, such, for example, as polychloroprene or silicone rubber, is provided over the plurality of slabs of spacer members 15 and 16 and is provided with a plurality of rectangular slots 34 positioned to accommodate the passage of the bus bars 24 therethrough. The mat 33 assists in sealing the opening in the casing cover to prevent the passage of liquid or gas therethrough. The mat extends over the entire casing cover opening and to the outer margin of the spacer ring 32 between the spacer ring 32 and a clamp ring 35. A series of stud members 36 best shown in Figs. 1, 2, 3 and 5 are provided for passing through suitable openings in the clamp ring 35, the rubber mat 33, the spacer ring 32, the gasket 31 and are screw-threaded within bores 37 in the cover flange 12 as best shown in Figure 5. Nuts 38 and washers 39 are provided and are screw-threadedly attached to the stud members 36 and for applying pressure to the clamp ring 35 to force it toward the cover flange 12 so as to bring pressure between these two members to press the rim of the mat 33 tightly between the cover ring 35 and the spacing ring 32 and to press the gasket 31 tightly between the spacer ring 32 and the cover flange 12 to provide a tight seal between the bushing structure assembly and the apparatus casing to prevent the passage of liquid or gas therebetween.

The edges of the spacer members that rest on the cover flange 12 may be cut back to provide a shoulder 41 shown in Fig. 5 or shoulder 63 as shown in Figs. 7, 8, 9 and 10 to provide a space for accommodating the head 42 of a bolt 43 and washer 44 for attaching the spacer members directly to the cover flange 12.

A plurality of rubber bushing sleeves 51 are provided, one for each of the bus bar terminal leads and are shown as tapering from a greater width at the bottom to a lesser width at the top. The bushing sleeves 51 may be formed of an oil and oxygen resistant synthetic elastomer or rubber such, for example, as polychloroprene, butadiene-styrene, butadiene-acrylonitrile, or silicone elastomers and are cemented to the bus bar lead surface 52 to secure a strong and lasting bond between the sleeve 51 and the bar 25. The bushing sleeves 51 are also cemented to the mat 33 along the surfaces 53 to provide a strong bond between them.

After the bus bar terminal leads 24, the bushing sleeves 51 and the mat 33 have been assembled as above-described, a rubber tape of uncured synthetic rubber is applied as shown at 55 in Fig. 3 and Fig. 5 and is wound about the bushing sleeve 51 forming a cover for the bushing sleeve which extends over the adjacent parts of the structure including the bus bar as shown at 56 and the mat 33 as shown at 57. This uncured rubber tape when applied is an unvulcanized vulcanizable rubber with accelerators and sulphur or a sulphur compound therein for causing it to vulcanize at room temperature beyond the tacky stage in twenty-four hours after being applied and exposed to the air and to complete its cure without heat application forming a sealed closure bonded with the bus bar 24, bushing sleeve 51, and the mat 33.

In some cases, the sleeve 51 may be omitted and the uncured synthetic rubber applied directly to the surfaces of the bus bar 24 and the mat 33 forming a bond with these members.

In the embodiments of the invention illustrated in Figs. 1, 2, 3, 4 and 6, the plurality of slabs of spacer members comprising the supporting structure of the platform correspond to the spacer members 15 and 16 shown in Figs. 12 and 11, respectively. The L-shaped spacer members 15 of Figure 12 are used at the two ends of the group of spacer members and the intermediate T-shaped members 16 are used intermediate to the two end members and are arranged in accordance with the pattern shown in Figure 2.

Figures 7 and 8 are an edge view and a side view, respectively, of an intermediate spacer member 61 and Figs. 9 and 10 are an edge view and a side view, respectively, of an end spacer member 62. The spacers 62 and 61 may be used in place of the spacers 15 and 16, respectively,

which have been previously described. The spacer members 61 and 62 have cut away portions along their outer edges to provide shoulders 63 through which holes 64 are provided for accommodating the heads 42 of bolts 43 as shown in Figure 5.

Figs. 13 and 14 are plan views of another modified form of end spacers 65 and intermediate spacers 66 that may be used in place of the spacers 15 and 16 shown in Figs. 12 and 11, respectively. The spacers 65 and 66 are provided with holes 67 for receiving the shafts of bolts or screws for attaching them to the cover flange 12. Enlarged recesses 68 are provided for receiving the heads of the bolts or screws, thus providing spaces for countersinking them.

Fig. 15 is a vertical sectional view generally similar to Fig. 3, illustrating a bus bar bushing structure that differs from that shown in Fig. 3 mainly in the use of bus bar terminal leads 71 that are formed from three sheets of bars 72 that are spaced apart by two shorter bars 73. The several bars are braised together at the surfaces 74 forming a single conducting lead member.

It will be apparent to those skilled in the art that modifications in the structure illustrated and described may be made within the spirit of the invention and I do not wish to be limited otherwise than in accordance with the scope of the appended claims.

I claim as my invention:

1. In a bus bar bushing structure for a plurality of terminal conductor leads extending between the inside and the outside of an electrical apparatus casing having an opening therein, an insulating platform closing the opening in the casing and provided with a plurality of spaced apart openings therein for accommodating the plurality of terminal conductor leads extending therethrough, said platform comprising a plurality of slabs of spacer members of insulating material forming the supporting structure of the platform, the slabs of spacer members extending across the opening in the casing and adjacent the terminal conductor leads to position them in their desired position within the opening in the casing, said platform including an insulating rubber mat extending along the outside of the plurality of slabs of spacer members and provided with a plurality of spaced-apart openings therein for accommodating the plurality of terminal conductor leads, gasket means between the outer edge of the platform and the casing adjacent the edge of the casing opening to prevent the passage of liquid or gas therebetween, and means for tightly sealing the terminal conductor leads in the openings in the insulating platform to prevent the passage of liquid or gas between the leads and the platform, said sealing means comprising an oil and oxygen resistant synthetic rubber bushing sleeve about each of the leads extending through the platform, said sleeve being cemented to the lead and to the platform about the lead, and a synthetic rubber tape forming a band positioned over the bushing sleeve and over a portion of the lead extending from the other end of the bushing sleeve.

2. In a bus bar bushing structure for a plurality of rectangular shaped bus bar terminal conductor leads extending between the inside and the outside of an electrical apparatus casing having a rectangular opening therein, a rectangular insulating platform closing the opening in the casing and provided with a plurality of spaced apart rectangular openings therein for accommodating the plurality of terminal conductor leads extending therethrough, said platform comprising a plurality of slabs of spacer members of insulating material forming the supporting structure of the platform, the slabs of spacer members extending across the opening in the casing and adjacent the terminal conductor leads to position them in their desired position within the opening in the casing, said platform including an insulating rubber mat extending along the outside of the plurality of slabs of spacer members and provided with a plurality of spaced-apart openings therein for accommodating the plurality of terminal conductor leads, gasket means between the outer edge of the platform and the casing adjacent the edge of the casing opening to prevent the passage of liquid or gas therebetween, and means for tightly sealing the terminal conductor leads in the openings in the insulating platform to prevent the passage of liquid or gas between the leads and the platform, said sealing means comprising an oil and oxygen resistant synthetic rubber bushing sleeve about each of the leads extending through the platform, said sleeve being cemented to the lead and to the platform about the lead, and a synthetic rubber tape forming a band positioned over the bushing sleeve and over a portion of the platform about one end of the bushing sleeve and over a portion of the lead extending from the other end of the bushing sleeve.

3. In a bus bar bushing structure for a plurality of terminal conductor leads extending between the inside and the outside of an electrical apparatus casing having an opening therein, an insulating platform closing the opening in the casing and provided with a plurality of spaced apart openings therein for accommodating the plurality of terminal conductor leads extending therethrough, said platform comprising a plurality of slabs of spacer members of insulating material forming the supporting structure of the platform, the slabs of spacer members extending across the opening in the casing and adjacent the terminal conductor leads to position them in their desired position within the opening in the casing, said platform including an insulating rubber mat extending along the outside of the plurality of slabs of spacer members and provided with a plurality of spaced apart openings therein for accommodating the plurality of terminal conductor leads, means for tightly sealing the terminal conductor leads in the openings in the insulating platform to prevent the passage of liquid or gas between the leads and the platform, said sealing means comprising an oil and oxygen resistant synthetic rubber bushing sleeve about each of the leads extending through the platform, said sleeve being cemented to the lead and to the platform about the lead, and a synthetic rubber tape forming a band positioned over the bushing sleeve and over a portion of the platform about one end of the bushing sleeve and over a portion of the lead extending from the other end of the bushing sleeve.

4. In a bus bar bushing structure for a plurality of rectangular bar terminal conductor leads extending between the inside and the outside of an electrical apparatus casing having a rectangular opening in the cover thereof, a cover flange on the casing cover outlining the rim of the opening and forming a supporting base for the bushing structure, an insulating platform

closing the opening in the casing cover and provided with a plurality of spaced apart openings therein for accommodating the plurality of bus bar terminal conductor leads extending therethrough, said platform comprising a supporting structure formed of a plurality of rigid spacer members extending across the opening in the casing cover between or adjacent to the bus bar terminal leads and having their opposite ends resting on the cover flange, and an insulating rubber mat positioned upon the slabs of spacer members having a plurality of spaced apart rectangular slots therein for accommodating the plurality of terminal conductor leads, a spacer ring surrounding the plurality of slabs of spacer members and supported on the cover flange, a gasket between the spacer ring and the cover flange, the edge of the rubber mat extending over the spacer ring, and means for tightly sealing the platform to the casing cover to form a tight joint therebetween comprising a clamp ring positioned above the spacer ring and edge of the rubber mat and means for connecting the clamp ring to the cover flange and applying pressure between the spacer ring and cover flange on opposite sides of the gasket and between the clamp ring and the spacer ring on the opposite sides of the rim rubber mat, and means for tightly sealing the terminal conductor leads in the openings in the insulating platform to prevent the passage of liquid or gas between the

leads and the platform, said sealing means comprising an oil and oxygen resistant synthetic rubber bushing sleeve about each of the leads extending through the platform, said sleeve being cemented to the lead and to the platform about the lead, and a synthetic rubber tape forming a band positioned over the bushing sleeve and over a portion of the platform about one end of the bushing sleeve and over a portion of the lead extending from the other end of the bushing sleeve.

WILLIAM G. JAMES.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
410,054	Waldron	Aug. 27, 1889
1,027,404	Deibel	May 28, 1912
1,323,721	Pocock	Dec. 2, 1919
2,098,908	Ambruster	Nov. 9, 1937
2,247,088	Hill	June 24, 1941
2,252,026	Oettinger	Aug. 12, 1941
2,264,405	Poitros	Dec. 2, 1941
2,280,711	Machlett et al.	Apr. 21, 1942
2,368,503	Unger	Jan. 30, 1945
2,454,962	Brown	Nov. 30, 1948
2,523,082	Wilson	Sept. 19, 1950