Jan. 15, 1963 B. A. BARENGOLTZ 3,073,891

ROTATABLE INSULATING BUSHING

Filed July 6, 1959

2 Sheets-Sheet 1

Fig. 1.

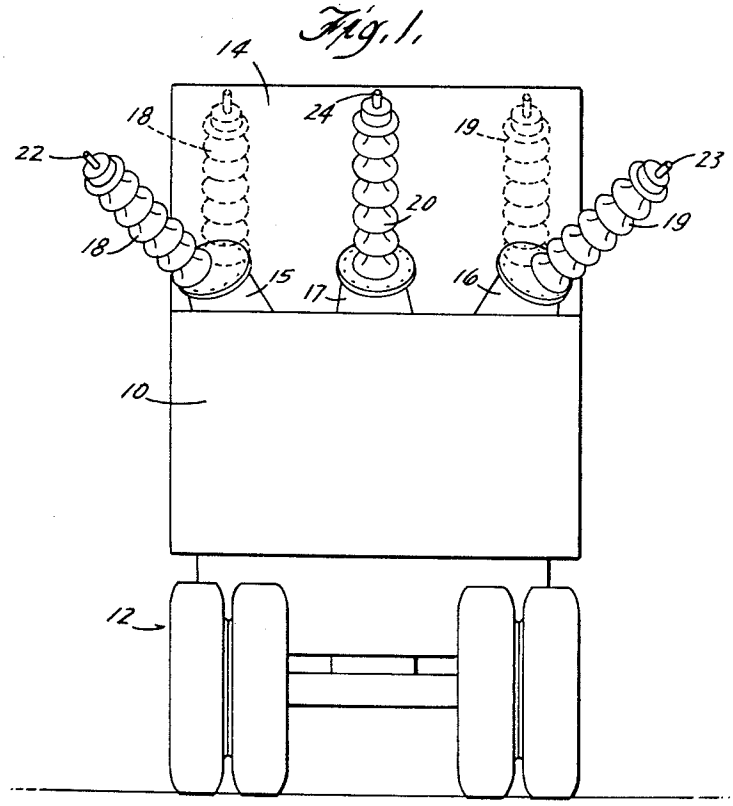

Fig. 2.

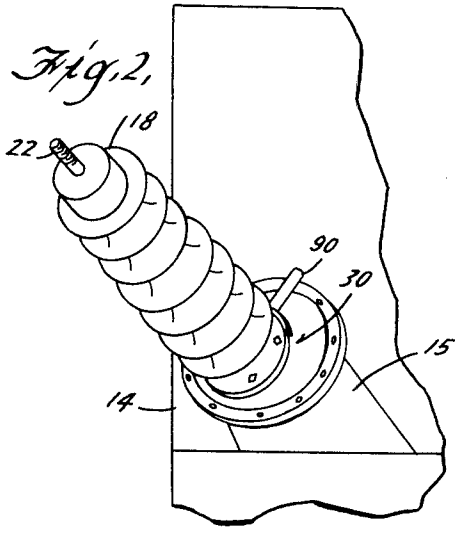

Fig. 3.

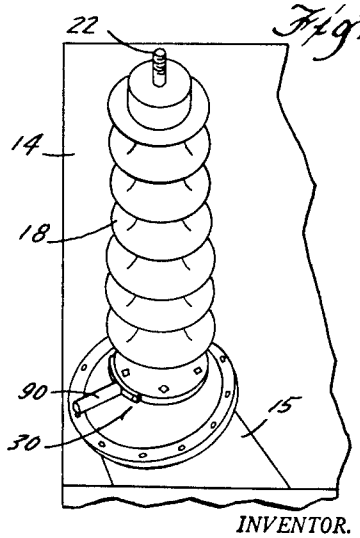

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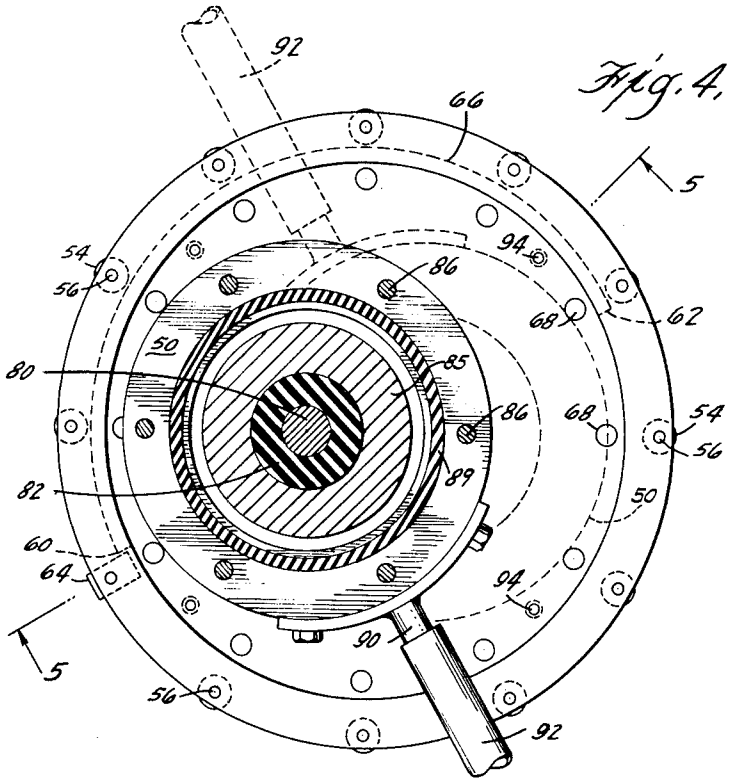
Fig. 4.



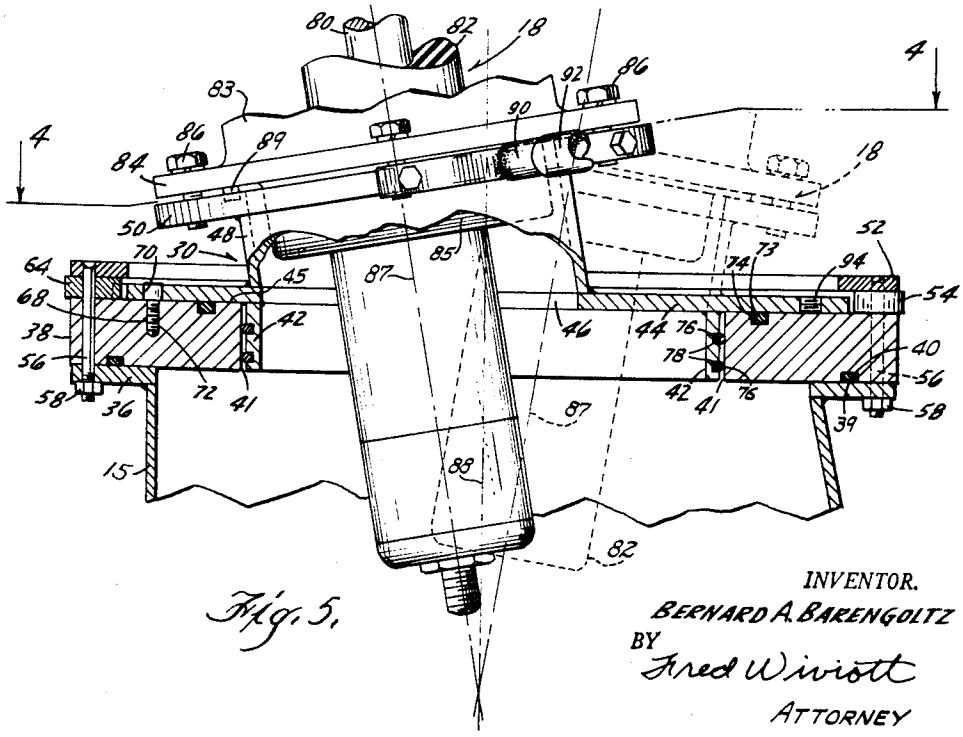


Fig. 5.

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ROTATABLE INSULATING BUSHING

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13 Claims. (Cl. 174—161)

This invention relates to encased electrical apparatus and more particularly to bushing support means for such apparatus.

Mobile substations are widely used by electrical utilities to replace permanent installations in the event that the damage resulting from a serious fault is not immediately repairable, thereby enabling the restoration of service with a minimum delay. In addition, this type of equipment is utilized to maintain service during routine maintenance or replacement of existing substations or to service new customers while permanent installations are being installed. Such mobile substations generally include a transformer and its associated switching and protective equipment which are usually mounted on a highway trailer and moved by conventional tractors. As a result, such equipment must conform to state highway regulations as to weight, height and width. These regulations generally require that the over-all width of the vehicle, including overhang, shall not exceed some fixed value, generally 96 inches. In some instances, however, this width does not allow sufficient electrical clearance between the terminals of the transformer's high voltage bushings. As a result, the electrical rating of the transformer must be limited or the high voltage bushings must be removed during transit.

Removal of the high voltage bushings at the beginning of each trip generally involves the following procedure: breaking the transformer seal; removing and storing the transformer oil; removing and crating the high voltage bushings; anchoring the high voltage leads; covering the high voltage bushing apertures; and purging and filling the transformer with dry nitrogen. In addition, substantially the reverse of this procedure is necessary upon arrival at the point of use. It can thus be seen, therefore, that such removal and replacement is quite costly and time consuming.

It is an object of the invention to provide a casing for electric apparatus having bushing support means which allows adjustment in the angle and direction of inclination of the bushing relative to the casing. It is a further object of the invention to provide such a bushing support means which is adapted to receive a standard electrical bushing.

It is another object of the invention to provide a casing for electrical apparatus having bushing support means which allows the direction of inclination of said bushing to be changed with respect to the casing so that the over-all width of the device may be decreased during shipment while the over-all electrical clearance may be increased during use.

It is a still further object of the invention to provide a sealed casing for electrical apparatus with bushing support means which allows the bushing's direction of inclination to be changed while the casing remains sealed.

These and other objects of the invention will become apparent in the detailed description of the invention taken in conjunction with the drawings in which:

FIG. 1 shows a mobile substation incorporating the instant invention;

FIGS. 2 and 3 show bushing support means according to the instant invention and its associated bushing in their operative and shipping positions respectively;

FIG. 4 shows a top view partly in section taken along line 4—4 of FIG. 5 of bushing support means according to the instant invention; and

FIG. 5 is a side view partly in section taken along line 5—5 of FIG. 4 of the bushing support means according to the instant invention.

In general terms, the invention comprises a casing for an electrical apparatus having an opening for receiving an electrical bushing, and bushing support means adjacent said opening and rotatable on said casing for mounting a bushing in said opening with the axis thereof inclined relative to the rotational axis of said support means so that rotation of the bushing support means will change the direction and/or the angle of inclination of the bushing with respect to the casing. In addition, according to another aspect of the invention, the bushing support means also includes sealing means disposed between the bushing support means and the casing so that the casing remains sealed during the rotation of the bushing.

In a more specific form of the invention, the opening in said casing is defined by a cylindrical surface while the bushing support means includes a sleeve portion telescopically engaging this surface for rotation therein about an axis substantially parallel to the axis of the opening. The bushing support assembly also includes a mounting plate affixed to the outer edge of the sleeve member for rotation therewith and being in sliding engagement with the outer surface of the casing. The mounting plate has an aperture formed therein which is eccentrically disposed relative to the sleeve portion and whose diameter is less than the diameter thereof. A tube portion is affixed to the mounting plate with its axis inclined relative to the axis of said sleeve and surrounding the aperture therein. A support flange is affixed to the sleeve portion and lies in a plane substantially perpendicular to the axis thereof. Affixed to the support flange is a standard electrical bushing having a mounting flange intermediate its ends and whose portions on opposite sides of said flange are coaxial. The invention may also include stop means which limits the rotation of the bushing support assembly to a prescribed angle. In addition, the invention may include clamping means for holding the bushing support means in each of the extremes of its angle of rotation and retaining means affixed to the casing and slidably engaging the outer surface of the mounting plate for preventing movement thereof in an axial direction relative to the opening.

Referring now to the drawings in greater detail FIG. 1 illustrates a mobile substation having a trailer, designated generally by the numeral 10, which is suitably mounted on front and rear on carriages 12 (only one of which can be seen in the drawing), and which carries an electrical transformer within a sealed casing 14. Rigidly mounted on transformer casing 14 are two outer tubular extensions 15 and 16 and a central extension 17, upon each of which is mounted a conventional high voltage bushing 18, 19 and 20 respectively.

In order to maintain proper electrical clearance between the terminals 22 and 23 of the outer electrical bushings 18 and 19 respectively and terminal 24 of central bushing 20, it is necessary that these outer bushings extend obliquely from the central bushing during periods of operation, as shown by the full lines in FIG. 1 and by FIG. 2. As a result, the upper ends of bushings 18 and 19 extend beyond the sides of the trailer 10 whereby the normal highway width requirements are exceeded. This situation is alleviated by utilizing bushing support means according to the instant invention wherein the outer bushings 18 and 19 are moved to a transport position shown by the dotted lines in FIG. 1 and in FIG. 2 so that they are within the outer extremities of the trailer 10.

Referring now to FIGS. 4 and 5 the bushing support

assembly designated by the general reference numeral 30 is mounted on the left hand tubular extension 15 of the transformer casing 14 and supports a conventional high voltage bushing 18, it being understood that the right hand bushing support assembly is a mirror image of that shown in FIGS. 4 and 5. An outwardly extending annular flange 36 surrounds the upper end of tubular extension 15 for supporting an annular bearing and support member 38. The juncture between bearing member 38 and flange 36 is sealed by an annular gasket 39 disposed in a circumferential groove 40 formed in the lower surface of bearing member 38. An aperture for receiving bushing 18 is defined by the inner cylindrical surface 41 of bearing member 38.

The bushing support assembly 30 includes a sleeve member 42 which is coaxial with and telescopically received in surface 41 and an apertured mounting plate 44 welded to the upper edge of sleeve member 42 and in slidable engagement with the upper surface 45 of bearing member 38. As can be seen in FIGS. 4 and 5 the aperture 46 in mounting plate 44 has a smaller diameter than that of sleeve portion 42 and is eccentrically disposed relative thereto. A tube portion 48 having an inner diameter equal to the diameter of aperture 46 is welded to the upper surface of mounting plate 44 and in registry with aperture 46. As shown in FIG. 5 the upper and lower edges of tube portion 48 are non-parallel so that its axis is inclined relative to the axis of the sleeve 42. A support flange 50 is suitably affixed to the upper edge of tube portion 48 and lies in a plane which is substantially perpendicular to the axis thereof. Surrounding support plate 44 and supported vertically thereabove by a plurality of spacer members 54 is an annular retaining ring 52. A plurality of spaced apart bolts 56, suitably affixed to the lower surface of retaining ring 52, extend through aligned openings in and suitably affixed to spacers 54, bearing plate 38 and flange 36 and each bolt 56 threadably receives a nut 58 at its lower end for holding the assembly together.

A pair of radially extending shoulders 60 and 62 are disposed on substantially opposite sides of support plate 44 to define a semi-circular portion of increased diameter which extends below retaining ring 52 so that axial movement of bushing support assembly 30 is limited. In addition, the shoulders 60 and 62 provide stop engaging means which are cooperable upon rotation of the assembly with a stop member 64 integral with one of the spacers 54 to limit the angle of rotation of the assembly to substantially 180°.

The bushing support assembly 30 is securable to bearing plate 38 in each of its operative and transport positions by means of a plurality of bolts 68 which extend through clearance holes 70 in plate member 44 and which threadably engage corresponding tapped holes 72 in bearing member 38. A continuous annular gasket 73, disposed within an annular groove 74 on the upper surface of bearing plate 38, provides the major seal for the device when the assembly is in either of these positions. In order to maintain the casing 14 in a sealed condition during rotation of the bushing support assembly 30, a pair of annular gaskets 76 are disposed in a pair of axially spaced circumferential grooves 78 formed in the outer surface of sleeve portion 42 and compressed between these grooves and the annular surface 41 of bearing plate 38.

The high voltage bushing 18 is of a conventional type and includes a conductive central stud 80 surrounded by a sleeve of insulating material 82, a shell 83 of suitable insulating material such as porcelain and a metallic mounting flange 84 suitably secured to the outer surface of said insulating sleeve by means of a metallic collar 85. A plurality of bolts 86 secure mounting flange 84 of bushing 18 to the support flange 50 of bushing support assembly 30. It can be seen from FIG. 5 that the axis 87 of bushing 18 will be substantially coincident to the axis of tubular portion 48 so that said bushing assembly will be

inclined relative to the axis of rotation 88 of the bushing support assembly 30. In addition, it can be seen that since the support assembly 30 is adapted to receive a bushing 18 whose portions on either side of mounting flange 84 are coaxial, there is no necessity to utilize a modified type of angular bushing in this assembly.

An annular gasket 89 is disposed between support flange 50 and mounting flange 84 to provide a hermetic seal therebetween. To facilitate rotation of the assembly a wrench member 90 is bolted to the exterior surface of support flange 50 and is adapted to telescopically receive a standard extension member 92.

While the transformer is in use, bushing 18 will be in the position shown in full in FIGS. 1, 4 and 5 and in FIG. 2, with the radially extending shoulder 60 in engagement with stop 64. When it is desired to move the transformer to another location, bolts 68 are removed freeing the bushing support assembly 30 for rotation relative to the tubular bushing support means 15. In order to facilitate freedom of movement between support plate 44 and bushing ring 38 a set screw 94 is provided in each of a plurality of threaded holes in support plate 44 and each bears against the upper surface of bearing member 38. Rotation of set screws 94 moves support plate 44 away from bearing member 38 to facilitate movement therebetween. Extension 92 is then placed over the end of wrench 90 and the assembly is rotated in a clockwise direction as viewed in FIG. 4 from the position shown full in FIGS. 1, 4 and 5 and in FIG. 2 to the position shown dotted in FIGS. 1, 4 and 5 and in FIG. 3. This brings radially extending shoulder 62 into engagement with stop 64 and openings 70 in support plate 44 into registry with different ones of the tapped holes 72 in bearing assembly 38. Bolts 68 are then reinserted and the seal between the upper surface 45 of bearing plate 38 and lower surface of support plate 44 is then reestablished. When the assembly reaches its destination bolts 68 are again removed and the assembly is rotated in a counterclockwise direction as viewed in FIG. 2 from the position shown dotted in FIGS. 1, 4 and 5 and in FIG. 3 to the position shown full in FIGS. 1, 4 and 5 and in FIG. 2, whereupon bolts 68 are again reinserted and the device is again ready for operation.

It can thus be seen that by mounting the outer bushings 18 and 19 in such a manner that their axes are inclined relative the rotational axes of the support assemblies, the direction and angle of inclination of the bushing relative to the transformer casing 14 can be changed. In this manner the upper ends 22 and 23 of these bushings, which for proper electrical clearance must extend beyond the sides of the trailer 10 during operation, may be moved within the outer extremities thereof so that its over-all width is within normal highway clearance requirements. In addition by mounting these outer bushings eccentrically relative to their axes of rotation they may also be physically displaced inwardly upon rotation. Also, the bushing support assembly according to the instant invention is adapted to receive a standard bushing so that the additional expense involved in the use of a non-standard bushing is not encountered.

While the invention is disclosed with relation to mobile substations, it will be understood by those skilled in the art that it has application to normally stationary devices as well. For example such bushing support assemblies could be utilized on conventional power type transformers so that the necessity of removing the bushings during shipment from the factory is eliminated.

Although only a single embodiment of the instant invention is shown and described a number of modifications will become apparent to those skilled in the art once applicant's inventive concept is known. It is, therefore, intended to cover in the appended claims all such modifications which fall within the true spirit of the invention.

I claim:

1. In combination with a casing for an electrical ap-

paratus having an opening therein, the margin of said opening defining a cylindrical surface, a rotatable bushing support assembly having a sleeve portion telescopically engaging said surface for rotation therein about an axis substantially parallel to the axis thereof, a mounting plate affixed to the outer edge of said sleeve portion and overlying the portion of said casing defining said opening for rotation with said sleeve portion and having an aperture registering with said opening, a straight, outwardly extending tube portion affixed to said mounting plate and surrounding said aperture, the axis of said tube portion being inclined relative to the axis of said sleeve portion, an annular support flange affixed to said tube portion and lying in a plane substantially perpendicular to the axis thereof, a straight electrical insulating bushing having a mounting flange intermediate its ends, clamping means for affixing said mounting flange to said support flange, said straight insulating bushing so affixed to said support flange extending coaxially through said straight tube portion and through said aperture and into said opening and the portions of said bushing on either side of said mounting flange being substantially coaxial, said mounting plate being selectively rotatable between first and second positions whereby rotation of said sleeve portion and mounting plate will change the position of said bushing with respect to said casing.

2. In the combination defined by claim 1 wherein said sleeve portion has a cylindrical surface opposed to said cylindrical surface defined by the margin of said opening, one of said opposed cylindrical surfaces has at least one circumferential groove therein, and including resilient continuous gasket means within said groove compressed between said opposed cylindrical surfaces for hermetically sealing between said bushing support assembly and said casing during rotation of said mounting plate, and means engaging said casing for releasably clamping said mounting plate in said first and second positions.

3. In combination with a sealed casing for an electrical apparatus having at least one opening formed therein, wherein the margin of said opening defines a cylindrical surface, a bushing support assembly having a sleeve portion telescopically engaging said surface for rotation therein about an axis substantially parallel to the axis thereof, a mounting plate affixed to the outer edge of said sleeve portion and slidably engaging the outer surface of said casing for rotation with said sleeve portion, a tube portion affixed to said mounting plate and surrounding said aperture, the axis of said tube portion being inclined relative to the axis of said sleeve portion, a support flange affixed to said tube portion and lying in a plane substantially perpendicular to the axis thereof, an electrical bushing having a mounting flange intermediate its ends, clamping means for affixing said mounting flange to said support flange, the portions of said bushing on either side of said mounting flange being coaxial whereby rotation of said bushing support means will change the direction of inclination of said bushing with respect to said casing, and retaining means affixed to said casing and slidably engaging the upper surface of said mounting plate for preventing movement of said support assembly axially of said opening.

4. In combination with a sealed casing for an electrical apparatus having at least one opening formed therein, wherein the margin of said opening defines a cylindrical surface, a bushing support assembly having a sleeve portion telescopically engaging said surface for rotation therein about an axis substantially parallel to the axis thereof, a mounting plate affixed to the outer edge of said sleeve portion and slidably engaging the outer surface of said casing for rotation with said sleeve portion, said mounting plate having an aperture formed therein which is eccentrically disposed relative to said sleeve and having a diameter less than the diameter thereof, a tube portion affixed to said mounting plate and surrounding said aperture, the axis of said tube portion being inclined relative to the axis of said sleeve portion, a support flange affixed to said tube portion and lying in a plane substantially perpendicular to the axis thereof, an electrical bushing having a mounting flange intermediate its ends, clamping means for affixing said mounting flange to said support flange, the portions of said bushing on either side of said mounting flange being coaxial, stop means mounted on the surface of said casing and disposed adjacent the edge of said mounting plate, said mounting plate having spaced apart stop engaging means so that the rotation of said bushing support means is limited to a prescribed angle, clamping means engaging said casing and said bushing support means for holding the latter in each of the extremes of its angle of rotation, retaining means affixed to said casing and slidably engaging the upper surface of said mounting plate for preventing movement of said support assembly axially of said opening, and gasket means disposed between sleeve portion and said opening so that said casing remains sealed during rotation of said assembly.

5. In combination, an enclosing casing for electrical apparatus mounted on wheels for transportation and having side portions extending generally in the direction of transportation, said casing having a pair of horizontally spaced apart circular openings in a portion thereof generally transverse to said side portions, straight elongated insulating bushings in said openings, means mounted on said casing adjacent each opening for rotatably supporting the corresponding bushing in said opening, each of said means including a sleeve portion, an annular mounting plate portion, and an outwardly extending straight tubular portion secured together with the apertures therein in register and in register with said opening, said sleeve portion telescopically engaging the margin of said circular opening for rotation therein about the axis of said opening, said annular mounting plate portion overlying the portion of said casing defining said opening and being affixed to the outer end of said sleeve portion for rotation therewith about said axis of said opening and said straight tubular portion being affixed to said mounting plate portion with its axis oblique to the said axis of rotation of said sleeve and mounting plate portions, an annular support flange on said tubular portion perpendicular to the axis thereof, said straight insulating bushing extending through the registering apertures in said sleeve, mounting plate and tubular portions and being coaxial with said tubular portion and having a mounting flange intermediate its ends adjacent said support flange, means for clamping said mounting flange against said support flange, the portions of said insulating bushing on opposite sides of said mounting flange being coaxial, each said support means being selectively rotatable between first and second positions and rotation of said support means between said first and second positions displacing the outward end of said bushing in a direction generally transverse to said direction of transportation, rotation of both said support means from said second to said first positions displacing the outward ends of said bushings laterally beyond said casing side portions and increasing the electrical clearance between the outward ends of said bushings and rotation of said support means from said first to said second positions moving said outward bushing ends laterally inward of said opposed casing side walls and reducing the overall dimensions of said apparatus.

6. In combination, an enclosing casing for electrical apparatus mounted on wheels for transportation and having a pair of horizontally spaced apart openings in a portion thereof generally transverse to the direction of transportation, whereby said openings are spaced apart in a direction across the width of a road along which said casing is transported, elongated straight insulating bushings disposed in said openings, means mounted on said casing adjacent each said opening for rotatably mounting the corresponding bushing in said opening, each said

means including a member closing said opening and having an aperture therein registering with said opening and said member being rotatable about the axis of said opening and means on said member and engaging said bushing intermediate its ends for mounting said bushing with its axis inclined to said axis of said opening and also inclined to the axis of rotation of said member, said bushing so mounted on said member extending through said aperture and into said opening and having a first straight portion extending outwardly from said casing coaxial with a second straight portion extending inwardly of said casing and into said opening, said member being selectively rotatable between first and second positions and rotation of said support means between said first and second positions displacing the outward end of said bushing in a direction generally transverse to said direction of transportation and varying the spacing between the outward end of said bushing and the outward end of the other bushing in a direction across the width of said road along which said casing is transported.

7. In the combination defined by claim 6 wherein each said bushing support means includes continuous resilient gasket means surrounding said opening and compressed between said rotatable member and said casing for sealing between said support means and said casing during rotation of said support means between said first and second positions.

8. In a combination, an enclosing casing for electrical apparatus mounted on wheels for transportation and having a pair of horizontally spaced apart openings in a portion thereof generally transverse to the direction of transportation, whereby said openings are spaced apart in a direction across the width of a road along which said casing is transported, elongated, straight insulating bushings disposed in said openings, means for rotatably mounting said bushings independently in said openings, each said means including a member closing said opening and being rotatable about the axis of said opening and having an aperture therein registering with said opening and a straight, outwardly extending, tubular portion surrounding said aperture and also surrounding a portion of said bushing intermediate its ends, the axis of said tubular portion being oblique to the axis of said opening and to the axis of rotation of said member, means engaging said bushing intermediate its ends for supporting said bushing on said straight tubular porton in coaxial relation therewith, said bushing so supported on said tubular portion having a first straight portion extending outwardly of said casing coaxial with a second straight portion extending through said aperture and into said opening and inwardly of said casing, rotation of said member displacing the outward end of said bushing in a direction generally transverse to said direction of transportation and varying the spacing between the outward end of said bushing and the outward end of the other bushing in a direction across the width of said road along which said casing is transported.

9. In a combination, an electrical apparatus casing having an opening therein, a straight insulating bushing disposed in said opening and having a cylindrical housing surrounding a central conductor, means for rotatably mounting said bushing in said opening including a bushing mounting member overlying portions of said casing defining said opening, said member having an aperture therein registering with but eccentrically disposed relative to said opening and said member rotatable relative to said casing about the axis of said opening, means engaging said bushing intermediate its ends for supporting said bushing on said mounting member so that said bushing extends through said aperture and into said opening with its axis oblique to the axis of said opening, a first straight portion of said bushing housing extending outwardly of said casing and being coaxial with a second straight portion of said housing extending into said opening and inwardly of said casing, said bushing mounting member being selectively rotatable between first and second positions to vary the position of said bushing relative to said casing, and continuous resilient gasket means surrounding said opening and compressed between said bushing mounting member and said casing.

10. In a combination, an electrical apparatus casing having an opening therein, a straight insulating bushing disposed in said opening and having a cylindrical housing surrounding a central conductor, means for rotatably mounting said bushing in said opening including a plate overlying portions of said casing defining said opening and having an aperture therein registering with said opening and being rotatable relative to said casing about the axis of said opening, an outwardly extending straight tubular member integral with said plate and surrounding said aperture and also surrounding said bushing intermediate its ends, the axis of said straight tubular member being inclined relative to the axis of rotation of said plate and to the axis of said opening, means engaging said bushing intermediate its ends for supporting said bushing on said tubular member is coaxial relation thereto, said bushing housing having a first straight portion extending outwardly of said casing coaxial with a second straight portion extending inwardly of said casing and through said aperture and into said opening, said integral mounting plate and tubular member being selectively rotatable between first and second positions to vary the position of said bushing relative to said casing.

11. In a combination, an electrical apparatus casing having an opening therein, a straight insulating bushing disposed in said opening and having a cylindrical housing surrounding a central conductor, means for rotatably mounting said bushing in said opening including a plate overlying portions of said casing defining said opening and having an aperture therein registering with said opening and being rotatable relative to said casing about the axis of said opening, means engaging said bushing intermediate its ends for mounting said bushing on said plate so that said bushing extends through said aperture and into said opening with its axis inclined relative to said axis of said opening and also inclined relative to the axis of rotation of said plate, said bushing housing having a first straight portion extending outwardly of said casing coaxial with a second straight portion extending inwardly of said casing and into said opening, said mounting plate being selectively rotatable between first and second positions to vary the position of said bushing relative to said casing.

12. In the combination defined by claim 11 wherein the margin of said opening defines a cylindrical surface and including a sleeve portion affixed to said plate and telescopically engaging said cylindrical surface and continuous resilient gasket means surrounding said sleeve portion and compressed between said sleeve portion and said cylindrical surface for sealing between said bushing mounting means and said casing during rotation of said plate between said first and second positions.

13. In combination, an electrical transformer casing mounted on wheels for transportation and having opposed side portions extending generally in the direction of transportation and end portions generally transverse to said side portions and to the direction of transportation, said casing having three generally tubular portions registering with the interior of said casing and extending outwardly from one of said end portions and being spaced apart in a direction transverse to the direction of transportation so that two of said generally tubular portions are disposed adjacent said side portions, straight insulating bushings disposed in said generally tubular portions, means supported on each of said two outward generally tubular portions for rotatably mounting the corresponding bushing in said generally tubular portion, each said means including a member closing said generally tubular portion and rotatable about an axis generally parallel to the axis thereof

and having an aperture therethrough and means for mounting said straight bushing on said member so it extends through said aperture and into said generally tubular portion with its axis inclined to the axis of rotation of said member, said bushing having a first straight portion extending from said member outwardly of said casing coaxial with a second straight portion extending from said member into said generally tubular portion, rotation of said member displacing the outward end of said bushing in a direction generally transverse to the direction of transportation, said members being selectively rotatable betwen a first position wherein the spacing between the outward end of said bushings associated with said two outward generally tubular portions is greater than the dimension of said casing in a direction generally transverse to said direction of transportation and a second

position wherein said spacing is less than said dimension of said casing.

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