May 9, 1933. F. S. SMITH 1,907,599

TERMINAL CONSTRUCTION

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Fig. 1.

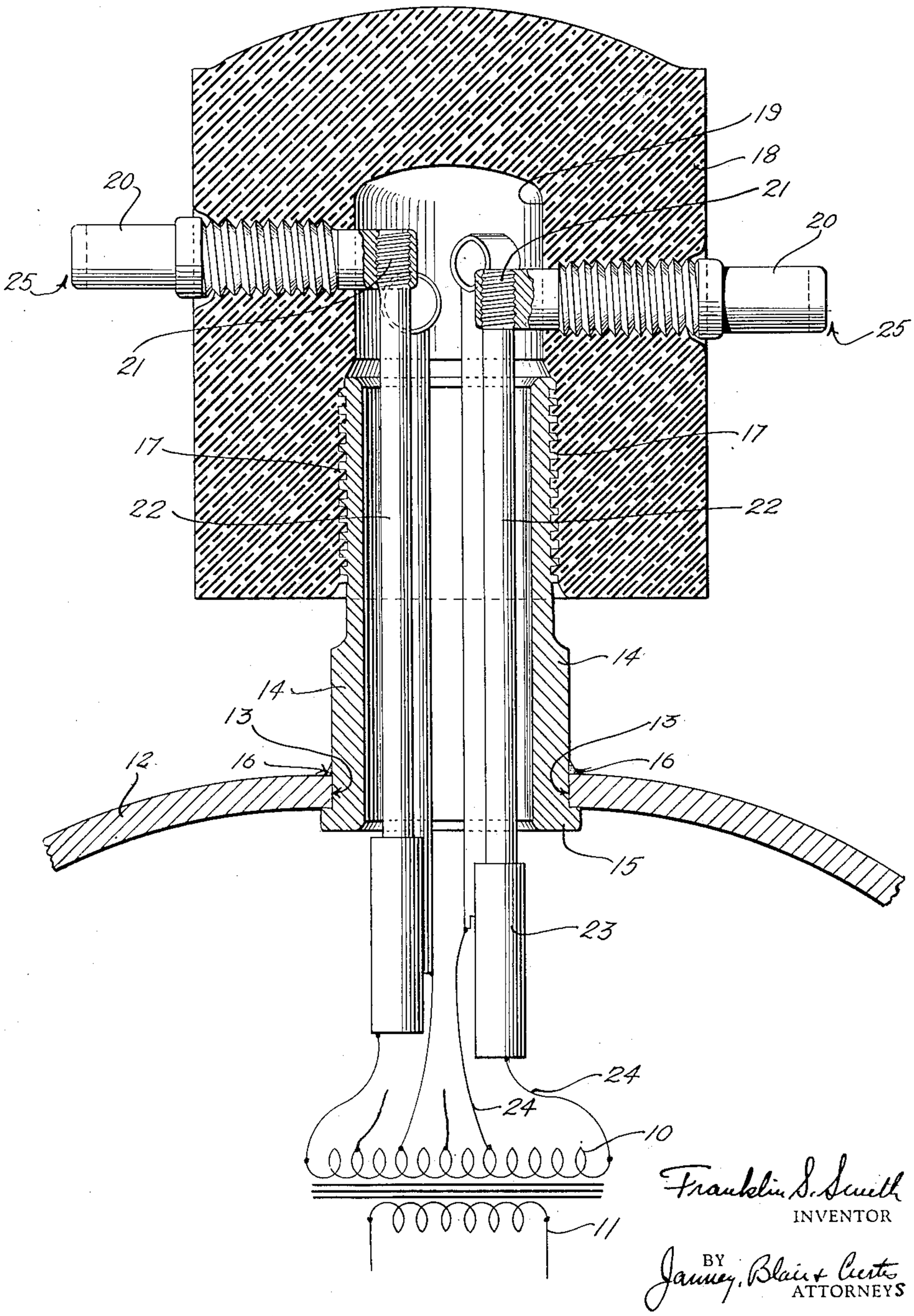

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Fig. 2

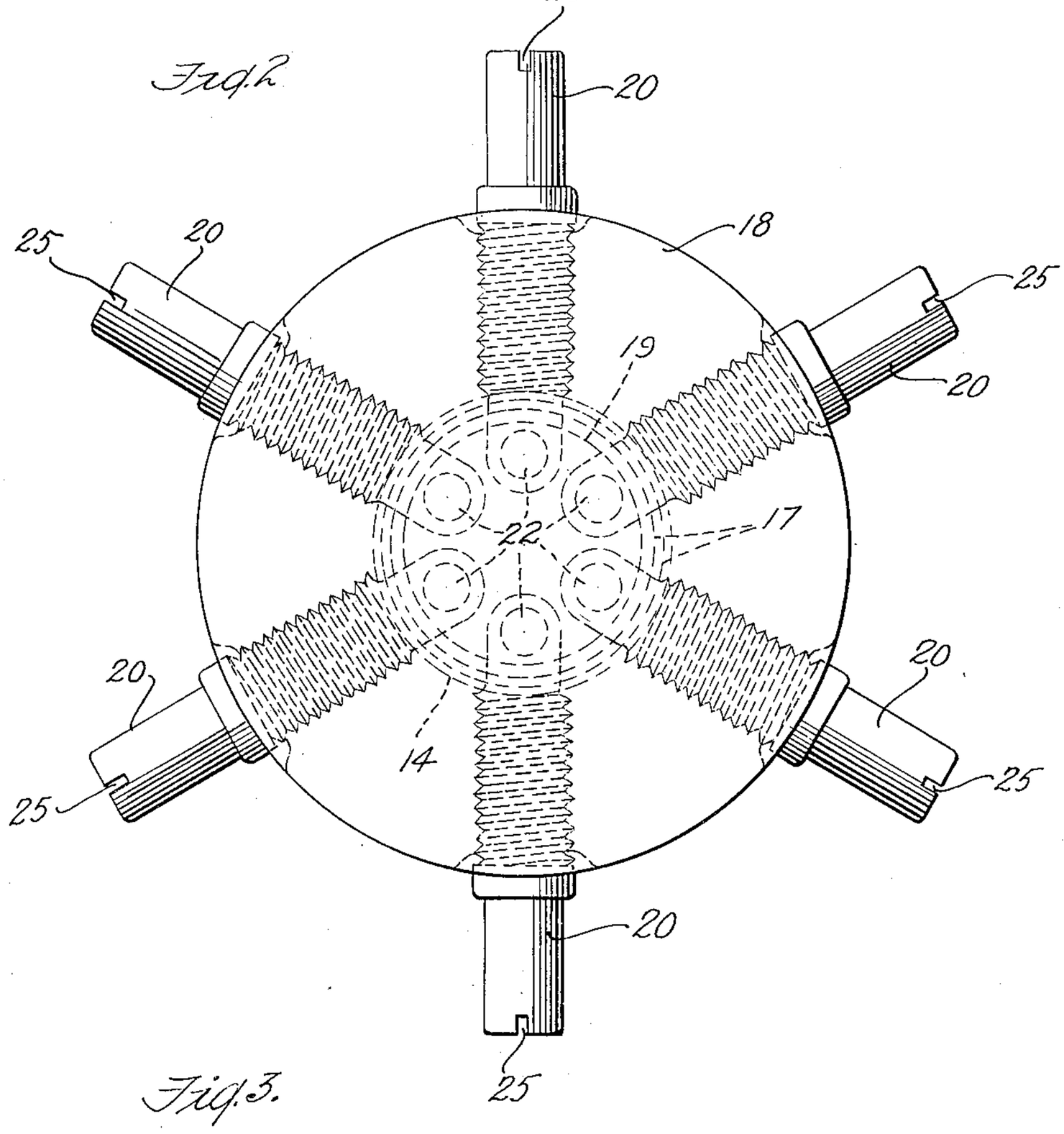
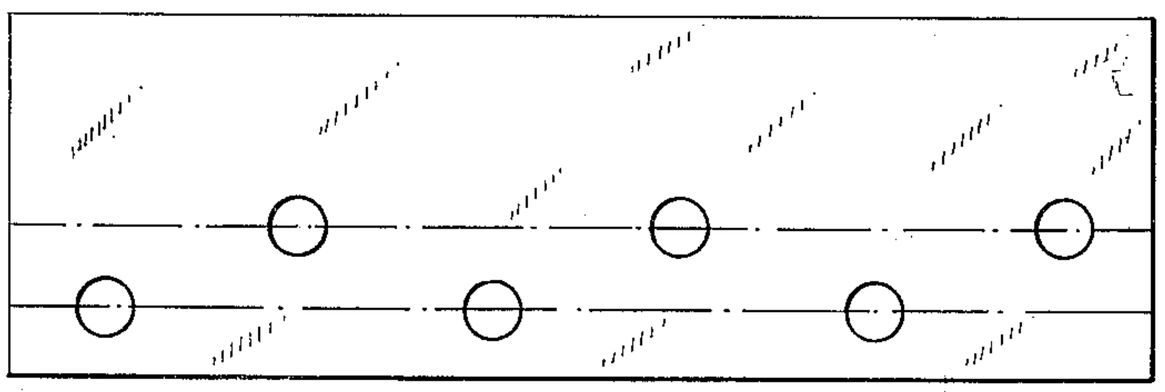


Fig. 3.



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UNITED STATES PATENT OFFICE

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TERMINAL CONSTRUCTION

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This invention relates to terminal construction.

One of the objects of this invention is to provide a simple, practical and thoroughly dependable terminal construction for leading conductors of moderate voltages through a wall member, such as, for example, the wall of a transformer casing. Another object is to provide a terminal construction of the above-mentioned character in which a relatively large number of conductors may be, with complete reliability, carried through a wall member and to provide such a construction that will be inexpensive, capable of rapid assembly, and compact. Another object is to provide a terminal construction in which a plurality of conductors of like or of differing electrical energy characteristics may be, with entire safety, closely compacted for passage through a wall member while providing thoroughly dependable exterior insulation thereof without undue complication or size of parts. Another object is to provide a construction of the above-mentioned character in which a minimum of solid dielectric material is employed, all without detrimentally affecting safety of mechanical construction and electrical action. Another object is to provide a terminal construction of the above-mentioned character in which a very close and compact grouping of the conductors representing the circuits handle by the terminal construction may be dependably achieved without sacrifice of the required insulating properties or characteristics. Another object is to provide a terminal construction in which certain unique advantages of a gaseous dielectric medium under pressure may be fully realized while retaining simplicity and inexpensiveness of construction of entire reliability and safety mechanically even though the pressure employed may be on the order of fifteen atmospheres. Another object is to provide a terminal construction of the above-mentioned character that will be well adapted to meet the varying conditions of hard practical use. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts as will be exemplified in the structure to be hereinafter described and the scope of the application of which will be indicated in the following claims.

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

Figure 1 is a central vertical sectional view of the terminal construction illustratively shown as applied to a transformer, certain parts of the latter being, for the sake of simplicity, shown diagrammatically or broken away;

Figure 2 is a plan view, as seen from above in Figure 1, and

Figure 3 is a development, on a smaller scale, of the outer vertical surface of the solid dielectric member of the terminal construction.

Similar reference characters refer to similar parts throughout the several views in the drawings.

As conducive to a clearer understanding of certain features of my invention, it might at this point be noted that, particularly in transformer and condenser construction, it is desirable to pass through the wall of the transformer or condenser casing a number of conductors, illustratively six, for example, which lead, for example, to the relatively low tension winding or parts thereof of a high tension transformer, or to the high tension winding or parts thereof of a relatively low tension transformer. These conductors may vary in number and they may, for example, number one, two, three, four, five or six. It is a dominant aim of my invention to provide a terminal construction well adapted to meet this requirement of practical use.

In the drawings, referring now to Figure 1, I have diagrammatically indicated a transformer 10—11, one or more windings of which I have indicated as being provided with six taps or points, to which connections are to be made, as illustrative of six different potentials which are to be carried through the casing 12 which encloses the transformer 10—11.

It will be understood that these points, illustratively six in number, to which connections are to be made are illustrative of a typical number of points of connection to the apparatus within the casing 12 which may or may not take the form of a transformer.

The wall of the casing 12 is provided with a suitable opening generally indicated at 13 through which the conductors leading from these different points of connection are to be passed. Secured to the casing 12 and in alinement with the opening 13 is a metal bushing 14 preferably fitted into the opening 13 and provided with a flange 15 at one end thereof, the flange being adapted to abut against the inner face of the wall of the casing 12. The bushing 14 is preferably welded to the casing 12, as is indicated at 16.

The bushing 14 is preferably of circular cross-section. The outer end of the bushing 14 is exteriorly threaded, as is indicated at 17, and in threaded engagement therewith is a member 18 of solid dielectric material, such as phenolic condensation product (known as bakelite). This member 18 is preferably hollow to provide a chamber 19, preferably cylindrical, that forms in effect a closed extension of the opening or passage through the bushing 14.

The member 18 is preferably round, as is clearly shown in Figure 2, and its inside diameter, that is, the diameter of the chamber-forming portion 19, is proportioned with respect to its outside diameter in a manner more clearly described below.

Extending radially (see Figure 2) through the vertical or side walls of the housing member 18 is a plurality of metal studs 20 and they correspond in number with the number of electrical circuits to be passed through the wall 12; illustratively, therefore, they are six in number. Each stud passes through a suitable opening, preferably molded in the member 18, and, moreover, the connection between the studs 20 and the member 18 is fluid-tight.

This fluid-tight connection may be achieved in any suitable manner, but preferably the openings in the solid dielectric member 18 are threaded throughout a suitable portion of their length and the studs 20 are also threaded, as is clearly indicated in Figures 1 and 2, to form a mechanically strong connection between these parts. The coacting threaded surfaces of the member 18 and of the studs 20, as well as of the bushing 14, have interposed therebetween a suitable cement, such as a mixture of shellac and tar, for insuring fluid-tightness at substantial pressures.

The inner end of each stud 20 is provided with a threaded hole 21 extending at right angles to the axis of the stud and into the threaded opening 21 of each stud is threaded a rigid conductor, preferably taking the form of a round bar 22, the bars 22 being of sufficient length to extend through the bushing 14 and into the interior of the casing 12.

The studs 20 are so proportioned as to their length and the threaded holes 21 at their inner ends so located that the conducting bars 22 are substantially equidistantly spaced from each other and from the interior cylindrical wall of the bushing 14. For example, where there are six connecting studs 20, the latter are angularly spaced from each other, as is clear from Figure 2, by preferably 60°, while the threaded holes 21 at the inner ends of the studs 20 preferably fall in substantially a circle, concentric with the cylindrical wall of the bushing 14, and equidistantly spaced about the circumference of this circle. The bars 22, illustratively six in number, are thus rigidly held in the above-mentioned spaced relation and, moreover, also held in substantial alinement with each other and with the axis of the bushing 14.

The inner ends of the conducting rods 22 are provided with suitable connecting devices conveniently taking the form of connecting sleeves 23 to which the conductors 24, leading to the apparatus within the casing 12, may be electrically connected.

The outer ends of the studs 20 are provided with suitable connecting devices generally indicated at 25 for making electrical connection thereto.

The interior of the solid dielectric member 18 and hence the chamber 19 is filled with a gaseous dielectric under pressure, for example, nitrogen, under a pressure on the order of fifteen atmospheres. This gas under pressure also fills the spaces between the conducting bars 22 and the bushing 14 and, where the terminal construction is employed in connection with a casing containing such apparatus as a transformer, for example, the casing 12 may also be filled with this gas under pressure which may serve as the insulating and cooling medium for the apparatus within the casing 12. The bars 22 are preferably bare and may be closely enough spaced, considering the potential difference or differences therebetween, so that the gas under pressure safely withstands these potential differences. The gas under a pressure on the order of fifteen atmospheres has an exceptionally high dielectric strength and permits of a relatively very close grouping of these many conductors and hence a close spacing therebetween and between them and the bushing 14. Thus, these parts may be made relatively small, being capable of being thus closely grouped.

Considering now the proportioning of the diameter of the chamber 19 with respect to the outside diameter of the solid dielectric member 18, hereinabove briefly mentioned, it may first be pointed out that the diameter of the chamber 19 is so chosen that, though the

spacing along the wall or inside surface of the chamber 19 and between adjacent inner ends of studs 20 is relatively small, surface leakage between adjacent inner ends of studs is safely precluded by the action of the gaseous dielectric under pressure. Likewise, the distance of the point or points at which the inner ends of the studs 20 emerge from the walls of the housing 18 from the outer end of the bushing 14 is made sufficient, though relatively exceedingly small (because of the gaseous dielectric under pressure contacting the inner surface of the bushing 18), that surface leakage from any of the studs to the bushing, the latter being generally at ground potential, is safely precluded. And as illustrative of the small magnitude of these possible surface leakage paths, where I use this gaseous dielectric under pressure, I might note that these possible paths may be made even as small a fraction as one-tenth as long as they would have to be in the absence of the gaseous dielectric under pressure, assuming the same potential difference to be effective in tending to produce surface leakage.

The outside diameter of the bushing 18 is made so great with respect to its inside diameter that the housing 18 not only has sufficient wall thickness to safely withstand these high pressures, but also provides exterior leakage paths of such length between adjacent exterior ends of the studs 20 (see Figure 2) that surface leakage, now under atmospheric conditions, is safely precluded, bearing in mind that the studs, as is clearly shown in Figure 2, extend substantially radially through the solid dielectric member. Also, the parts are so proportioned that the surface leakage path along the exposed surface of the housing 18 and between the exterior end of any stud 20 and the bushing 14 is sufficiently long to safely prevent surface leakage at the operating potentials.

Preferably, I stagger the studs 20 with respect to one another in order to achieve certain further advantages, and by way of illustration I have shown alternate studs emerging from the walls of the housing 18 into the chamber 19 at points displaced in an axial direction (that is, along the axis of the cylindrical chamber 19). To achieve this construction the openings for the studs 20 may be molded into the housing 18 in corresponding positions, positions indicated in Figure 3 which is a development of the outer cylindrical surface of the solid dielectric member 18. By this arrangement I am enabled to achieve greater mechanical strength but also I am enabled to make the leakage paths between adjacent studs, both along the interior gas-contacted surface of the housing 18 and the exterior surface thereof exposed to the atmosphere, longer than would be the case if all of the studs were to lie in substantially the same plane. Or, for a given potential difference between studs and a corresponding permissible leakage path, I am enabled to achieve smaller dimensions of the parts or closer grouping of conductive members.

Thus it will be seen that there has been provided in this invention a terminal construction in which the various objects above set forth, together with many thoroughly practical advantages, are successfully achieved. It will be seen that the construction is simple and inexpensive, and makes possible the use of a minimum of material. Also, I am enabled to achieve a compactness of construction heretofore unachievable, all without detracting from the high and dependable character of the insulating properties required by conditions of hard practical use.

As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth, or shown in the accompanying drawings, is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In terminal construction, in combination, a container having therein an electrical apparatus immersed in a dielectric medium comprising a gas under pressure, said container having an opening therein through which the conductors leading to said apparatus are passed, a closure for said opening in the form of a housing of solid dielectric material, secured in air-tight relation to said container, said housing being shaped to encompass therein a chamber the walls of which are contacted by said gas under pressure, and a plurality of conductive members extending in air-tight relation through said housing and into said chamber, said members being angularly related to each other so that the leakage path along the exterior of said housing and between adjacent conductive members is materially greater than the leakage path along the wall of said chamber between the inner ends of adjacent conductive members, the shorter leakage path between said inner ends having, due to the contact with the chamber wall of said gas under pressure, a resistance to surface leakage at least commensurate with that of said greater leakage paths along the exterior of said housing, and the inner end of each of said conductive members having electrically connected thereto a conductor leading to said apparatus and the outer ends of said members being adapted to have an electrical connection made thereto.

2. In terminal construction, in combination, a container having therein an electrical apparatus immersed in a dielectric medium comprising a gas under pressure, said container having an opening therein through

which the conductors leading to said apparatus are passed, a closure for said opening in the form of a housing of solid dielectric material secured in air-tight relation to said container, said housing enclosing a chamber the walls of which are contacted by said gas under pressure and said chamber being substantially circular in cross-section, and a plurality of conductive members extending in air-tight relation and in substantially radial directions from the outside of said housing into said chamber, the inner end of each conductive member having electrically connected thereto a conductor leading to said apparatus and the outer end of each conductive member being adapted to have an electrical connection made thereto, and the inwardly projecting inner ends of said conductive members being insulated by said gas under pressure alone.

3. In terminal construction, in combination, a container having therein an electrical apparatus immersed in a dielectric medium comprising a gas under pressure, said container having an opening therein through which the conductors leading to said apparatus are passed, a closure for said opening in the form of a housing of solid dielectric material secured in air-tight relation to said container, said housing enclosing a chamber the walls of which are contacted by said gas under pressure and said chamber being substantially circular in cross-section, and a plurality of conductive members extending in air-tight relation and in substantially radial directions from the outside of said housing into said chamber, the inner end of each conductive member having electrically connected thereto a conductor leading to said apparatus and the outer end of each conductive member being adapted to have an electrical connection made thereto, certain of said conductive members being staggered in an axial direction relative to certain other of said conductive members.

4. In terminal construction, in combination, a container having therein an electrical apparatus immersed in a dielectric medium comprising a gas under pressure, said container having an opening therein through which the conductors leading to said apparatus are passed, a closure for said opening in the form of a housing of solid dielectric material, a metallic bushing secured in air-tight relation to said container and at said opening therein and extending into said housing and being connected with the latter in air-tight relation, said housing enclosing a chamber beyond the outer end of said bushing, the walls of said chamber being contacted by said gas under pressure, a plurality of conductive members extending from the outside of said housing into said chamber and related to said housing so that the leakage path along the exterior surface of said housing between adjacent conductive members is materially greater than the leakage path along the wall of said chamber between the inner ends of said conductive members, the inner end of each of said conductive members having electrically connected thereto a conductor leading to said apparatus and the outer end of each conductive member being adapted to have an electrical connection made thereto, the inner ends of said conductive members being spaced from the outer end of said bushing by a distance sufficient to prevent leakage along the gas-contacted wall of said chamber at the potential difference existing between any one conductive member and said bushing.

5. In terminal construction, in combination, a wall member having an opening therein through which a plurality of conductors are to be passed, a one-piece housing of solid dielectric material connected in fluid-tight relation to said wall member for substantially closing said opening therein, a gaseous dielectric under pressure within said housing, and a plurality of conductive members extending in fluid-tight relation from the exterior of said housing into the interior thereof, the inner ends of which are connected respectively to said conductors, said housing having such a wall thickness and said conductive members extending at such angles to each other that the distance along the exterior surface of said housing and between adjacent conductive members is sufficiently great to prevent surface leakage therealong to a substantially commensurate extent as the gas under pressure upon the interior surface of said housing prevents surface leakage between the inner ends of said conductive members.

6. In terminal construction, in combination, a wall member having an opening therein through which a plurality of conductors are to be passed, a housing of solid dielectric material connected in fluid-tight relation to said wall member for substantially closing said opening therein, a gaseous dielectric under pressure within said housing, said housing being exteriorly and interiorly substantially circular, and a plurality of conductive members passing in fluid-tight relation and substantially radially through the walls of said housing and having their inner ends electrically connected to said conductors, the inner radius and the outer radius of said housing being so proportioned to each other that the surface leakage path along the exterior of said housing and between adjacent conductive members is sufficiently great to resist surface leakage at the potential difference between adjacent conductive members to a degree substantially commensurate with the resistance to surface leakage along the gas-contacted interior of said housing, and the inner ends of said conductive members, being

those portions of the latter that are in closest proximity to each other, being insulated from each other by said gaseous dielectric under pressure alone.

7. In terminal construction, in combination, a wall member having an opening therein through which a plurality of conductors are to be passed, a housing of solid dielectric material in fluid-tight connection with said wall member, a gaseous dielectric under pressure within said housing, and a plurality of conductive members passing through said housing and having their inner ends respectively connected to said conductors while converging into close proximity to each other, said conductive members and said housing being related to each other to provide a leakage path along the exterior surface of said housing sufficiently long to prevent surface leakage at atmospheric pressures to an extent commensurate with the resistance to surface leakage along the interior of said housing achieved by said gaseous dielectric under pressure, the spaces between approximate ends of said conductive members being filled with said gaseous dielectric under pressure.

8. In terminal construction, in combination, a conductive wall member having an opening therein through which a plurality of conductors are to be passed, a plurality of conductors passing thrugh said opening and spaced from each other and from the walls of said opening, a housing of solid dielectric material in fluid-tight connection with said wall member, a plurality of conductive members passing through said housing and mechanically related at their inner ends to said conductors to independently hold the latter in the above-mentioned spaced relation, and a gaseous dielectric under pressure filling the spaces between said opening and said conductors and contacting with the interior surface of said housing, said conductive members and said housing being related to each other to provide a leakage path along the exterior surface of said housing sufficiently long to prevent surface leakage at atmospheric pressures between adjacent conductive members to an extent commensurate with the resistance to surface leakage along the gas-contacted interior of said housing at the potential differences existing between the conductive parts of the apparatus.

9. In terminal construction, in combination, a wall member having an opening therein a member of solid dielectric material substantially closing said opening, a plurality of threaded studs in threaded engagement with said solid dielectric member and extending from the exterior thereof to the interior but at such angles that the exterior ends of adjacent studs are spaced farther apart than adjacent inner ends of said studs, a plurality of conductors passing through said opening, each connected to the inner end of a stud, and an insulating medium contacting the inner surface of said solid dielectric member for increasing the resistance to surface leakage along the latter between adjacent studs.

10. In terminal construction, in combination, a wall member having an opening therein, a member of solid dielectric material substantially closing said opening, a plurality of threaded studs in threaded engagement with said solid dielectric member and extending from the exterior thereof to the interior but at such angles that the exterior ends of adjacent studs are spaced farther apart than adjacent inner ends of said studs, a plurality of conductors passing through said opening, each connected to the inner end of a stud, said dielectric member being in fluid-tight relation to said wall member and to said studs, and a gaseous dielectric under pressure contacting the inner surface of said solid dielectric member for compensating for the shorter surface leakage path along the interior surface of said solid dielectric member and between studs as compared with the longer leakage path along the outer surface of said member.

11. In terminal construction, in combination, a container having therein a electrical apparatus immersed in a dielectric medium comprising a gas under pressure, said container having an opening therein through which the conductors leading to said apparatus are passed, a closure for said opening in the form of a housing of solid dielectric material, a metallic bushing secured in air-tight relation to said container and at said opening therein and extending into said housing and being connected with the latter in air-tight relation, said housing enclosing a chamber beyond the outer end of said bushing, the walls of said chamber being contacted by said gas under pressure, a plurality of conductive members extending from the outside of said housing into said chamber and related to said housing so that the leakage path along the exterior surface of said housing between adjacent conductive members is materially greater than the leakage path along the wall of said chamber between the inner ends of said conductive members, and a plurality of rigid conductors, one for each of said conductive members and each of sufficient length to extend from the latter through said bushing, the inner end of each of said conductive members having a threaded portion the axis of which extends parallel to the axis of said bushing and each of said conductors having a threaded portion adapted to be received into the threaded portion of a conductive member whereby said conductors are electrically connected to said conductive members and are mechanically held parallel to each other and parallel to the axis of said bushing through which they extend.

12. In terminal construction, in combina-

tion, a container having therein an electrical apparatus immersed in a dielectric medium comprising a gas under pressure, said container having an opening therein through which the conductors leading to said apparatus are passed, a closure for said opening in the form of a housing of solid dielectric material, a metallic bushing secured in air-tight relation to said container and at said opening therein and extending into said housing and being connected with the latter in air-tight relation, said housing enclosing a chamber beyond the outer end of said bushing, the walls of said chamber being contacted by said gas under pressure, a plurality of conductive members extending from the outside of said housing into said chamber and related to said housing so that the leakage path along the exterior surface of said housing between adjacent conductive members is materially greater than the leakage path along the wall of said chamber between the inner ends of said conductive members, a plurality of rigid conductors, one for each of said conductive members and each of sufficient length to extend from the latter through said bushing, and means forming detachable connections between each conductive member and its related rigid conductor adapted to hold each rigid conductor substantially parallel to the axis of said bushing and against movement out of said parallelism.

In testimony whereof, I have signed my name to this specification this 22nd day of January, 1931.

FRANKLIN S. SMITH.