C. LE G. FORTESCUE.

TRANSFORMER TERMINAL.

APPLICATION FILED AUG. 7, 1911.

1,129,466. Patented Feb. 23, 1915.

Fig. 1.

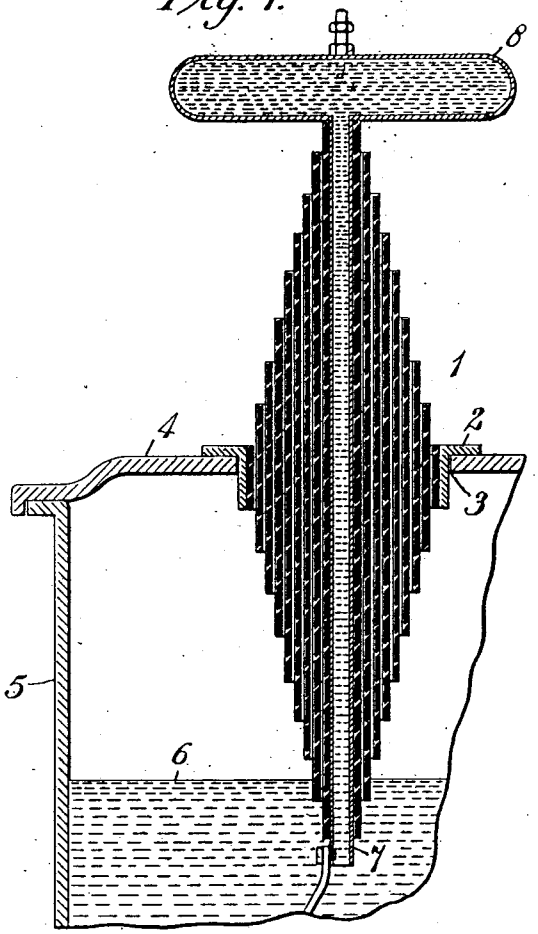
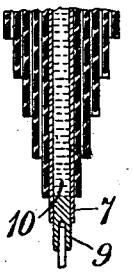


Fig. 2.



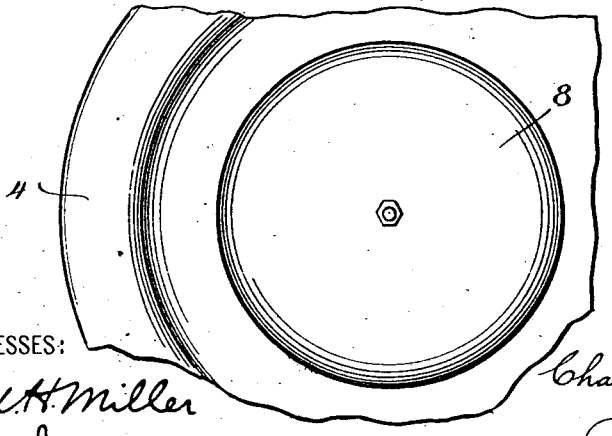


Fig. 3.

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TRANSFORMER-TERMINAL.

1,129,466. Specification of Letters Patent. Patented Feb. 23, 1915.

Application filed August 7, 1911. Serial No. 642,877.

To all whom it may concern:

Be it known that I, CHARLES LE G. FORTESCUE, a subject of the King of Great Britain, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Transformer-Terminals, of which the following is a specification.

My invention relates to outlet terminals or bushings for electrical apparatus and particularly to terminals of transformers and such other electric devices as are adapted to operate on high voltage systems.

The object of my invention is to provide a terminal or high potential outlet structure which shall be adequately insulated for very high voltage service, and, at the same time, substantially preclude the concentration of electric stresses upon certain portions thereof.

Another object of my invention is to provide a terminal structure of the character above indicated which also embodies a specially cooled conducting lead.

Insulating bushings for the terminal connections of a high voltage transformer, circuit breaker and other similar electrical apparatus, are usually supported in the cover or top of the tank or casing in which the apparatus is located. An electric device located in a tank or casing is usually immersed in an insulating fluid, such as oil, which, at the same time, may be utilized for cooling purposes. It will be apparent, however, that my invention may be applied to electrical devices other than those immersed in an insulating fluid. Heretofore, insulating bushings were designed so as to have a sufficient thickness of di-electric material to resist the stresses imposed thereupon by the radial electrostatic lines emanating from the high potential conductors projecting through the bushings. Again, the lengths of bushings were usually proportioned to exceed the discharge distances between needle points which were subjected to potential differences equal to the maximum potential impressed upon the conductors to be insulated. Of course, the requisite safety factors were applied in proportioning the thickness and the length of each bushing in order to conform to all operating conditions. Bushings designed in accordance with the above outline usually broke down by reason of the concentration of electrostatic lines upon the insulator surfaces which resulted in the insulator being subjected to concentrated and consequent abnormal electrostatic stresses.

I have discovered that, if the electrostatic flow lines in the field external to the bushing are precluded from concentrating upon surfaces of the bushing, the bushing is capable of insulating conductors of potentials higher than heretofore utilized. I believe that the efficiency in design of a terminal must be considered both from the point of view of the effectiveness of application of the insulating material around the lead, and also of the uniformity of stress in the region external to the terminal. Accordingly, the maximum insulating strength of the bushing may be obtained if the external electrostatic field is so distributed as to create a uniform surface stress upon the bushing. To attain this result with the usual bushing, the space external to the bushing must be bounded by two infinite parallel conducting planes perpendicular to the axis of the bushing. Inasmuch as such a structure is impracticable, I provide means whereby the electrostatic field is sufficiently distributed in order to secure a substantially uniform surface distribution of the electrostatic stresses upon the bushing. Although an entirely uniform surface stress is not obtained by means of my invention, it will be understood that undue concentrations of electrostatic lines are precluded from forming upon the surfaces of insulating bushings, thereby admitting such bushings to be used in insulating extremely high voltage conductors.

Figure 1 of the accompanying drawings is a sectional elevation of a terminal structure embodying my invention. Fig. 2 is a sectional view of a part of a modified form of the structure of Fig. 1, and Fig. 3 is a plan view of the terminal.

While I have shown a bushing of the condenser type of construction, it is not intended that my invention be limited to terminals or outlet structures embodying condenser bushings only. Porcelain bushings, the well known "oil filled type" bushings, etc., may be effectively used in my terminal structure. However, I have found that the condenser type bushing is particularly adapted for use in my structure because of its high insulating property, its light weight,

and simplicity in construction. According to my present invention, I make the conducting lead of tubing and provide a hollow disk shape or substantially ellipsoidal body at its upper end which communicates with the tube. The lower end of the tube may be either open or closed as hereinafter pointed out, and the discoidal body is preferably sealed except for its opening into the tube.

Referring to Fig. 1, a terminal bushing 1 of insulating material is supported by a ring 2 in an aperture 3 which is provided in a top or cover 4 in a tank or casing 5. The tank or casing is adapted to receive electrical apparatus such as a transformer, and is partially filled with oil 6, or other insulating fluid, into which the lower end of the terminal bushing 1 extends. A tube 7 of conducting material extends through the bushing 1 and is sealed into a hollow ellipsoidal body 8 at its upper end. The central conducting lead 7 is provided with a discoidal body 8 of conducting material at its outer end for the purpose of distributing the electrostatic field and preventing concentration of stresses at any point on the surface of the terminal bushing 1. The lower end of the tube extends into the oil 6 and is open so that if the air is once exhausted or excluded from the tube and the terminal 8, the oil will be maintained therein. As before mentioned, it would be most desirable to bound the space external to the bushing 1 with two infinite parallel conducting planes perpendicular to the axis of the bushing. However, this is impracticable, but the result obtained by that disposition of conducting planes may be sufficiently approximated for commercial conditions by disposing the conducting disk 8 and the substantially flat conducting cover 4 of the case 5, as shown in the drawing. It is desirable that the cover 4 be so constructed as to have a minimum number of projecting surfaces or sharp edges. The surfaces of the member 8 are so shaped as to relieve the electrostatic stresses that would otherwise exist in the air at the top end of the terminal, and also to redirect the electrostatic field that would otherwise exist adjacent to the surface of the bushing, so that the stresses imposed upon the bushing are substantially evenly distributed. To this end, the member 8 is extended laterally from the conductor 7 a distance that is large relative to the diameter of the conductor, and its edges are curved to present convex surfaces to the static field existing between it and the cover 4. The member 8 also has thin walls and a large major diameter relative to its thickness or depth, thereby providing a large radiating surface. Consequently, if the oil in the lower end of the tube becomes heated, it will rise and replace the much cooler oil contained in the closed member 8. By this means, a circulation is automatically maintained, the heat being conducted rapidly away through the relatively thin walls of the hollow member 8.

In Fig. 2, the tube 7, instead of being open at its lower end, is sealed by a plug 9, and the tube is filled with a fluid 10 which may be either insulating or conducting, its sole purpose being to transfer the heat from the conducting tube to the walls of the member 8 from which it may be readily radiated.

Although I have shown and described a device of specific structural detail, many modifications may be effected therein within the spirit and scope of my invention, and I desire that only such limitations shall be imposed as are indicated in the appended claims.

I claim as my invention:

1. The combination with a conductor, an insulating bushing surrounding the conductor, and a conducting member surrounding the bushing intermediate its ends, of a laterally extending flattened body upon the conductor that is convexly curved adjacent to its edges with respect to the said member.

2. The combination with a conductor, an insulating bushing surrounding the conductor, and a conducting member surrounding the bushing intermediate its ends, of a substantially disk shaped body extending laterally from the conductor and having its edges curved convexly with respect to the said member.

3. The combination with a conductor, an insulating bushing surrounding the conductor, and a conducting member surrounding the bushing intermediate its ends, of a conducting body extending laterally from the conductor and substantially parallel to the opposing surface of the said conducting member, the edges of the conducting body being curved convexly with respect to the said member.

4. The combination with a conductor, an insulating bushing surrounding the conductor, and a conducting member surrounding the bushing intermediate its ends, of a substantially disk shaped body extending laterally from one end of the conductor, said body having rounded edges.

5. The combination with a conducting tube, an insulating bushing therefor composed of alternate layers of insulating and conducting materials, a conducting member embracing the bushing, of a closed hollow conducting body extending laterally from the conducting tube and being convexly curved adjacent to its edges with respect to said member, said conducting tube being sealed into said conducting body at its upper end, and a cooling liquid disposed within the tube and hollow body.

6. The combination with a conducting tube, an insulating bushing therefor com-

posed of alternate layers of insulating and conducting materials, and a conducting member embracing the bushing, of a closed hollow discoidal shaped conducting body into which the conducting tube is sealed at its upper end, the lower end of the tube extending into a body of liquid with which the tube and hollow member are filled.

7. The combination with a conductor, and an insulating bushing surrounding the conductor comprising alternate layers of insulating and conducting materials, of a substantially discoidal shaped conducting body extending laterally from the conductor, said body being convexly curved adjacent to its edges with respect to the exposed surfaces of the bushing.

8. The combination with a conductor, and an insulating bushing surrounding the conductor comprising alternate layers of insulating and conducting materials, of a substantially discoidal shaped conducting body on one end of the bushing, said conducting body having its edges convexly curved with respect to the exposed surfaces of the bushing.

9. The combination with a conductor, and an insulating bushing surrounding the conductor comprising alternate layers of insulating and conducting materials and having one of its end portions stepped and in substantially the form of a truncated cone, of a substantially discoidal shaped conducting body extending laterally from the conductor, said body being convexly curved adjacent to its edges with respect to the exposed surfaces of the bushing.

10. The combination with a conductor, and an insulating bushing surrounding the conductor comprising alternate layers of insulating and conducting materials and having one of its end portions shaped in substantially the form of a truncated cone, of a substantially discoidal shaped conducting body extending laterally from the conductor and disposed adjacent to one end of said bushing, the conducting body being convexly curved adjacent to its edges with respect to the exposed surfaces of the bushing.

11. The combination with a conductor, an insulating bushing surrounding the conductor comprising alternate layers of insulating and conducting materials and having one of its end portions shaped in substantially the form of a truncated cone, of a substantially discoidal shaped conducting body extending laterally from the conductor and disposed adjacent to the smaller end of said truncated-cone portion of the bushing.

12. The combination with a conductor, and an insulating bushing surrounding the conductor comprising alternate layers of insulating and conducting materials, of a conducting body extending transversely of the conductor and so shaped as to insure a substantially uniform distribution of electrostatic stresses upon the surfaces of the bushing.

13. The combination with a conductor, an insulating bushing surrounding said conductor and having embedded cylindrical conducting layers, and a conducting member surrounding said bushing intermediate its ends, of a flattened conducting body mounted upon said conductor and having plane portions extending laterally therefrom at one end of the bushing and also having its edges rounded.

In testimony whereof, I have hereunto subscribed my name this 31st day of July, 1911.

CHARLES LE G. FORTESCUE.

Witnesses:
R. J. DEARBORN,
B. B. HINES.