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## UNITED STATES PATENT OFFICE

## GUSTAY JANSSON, OF WOLLASTON, MASSACHUSETTS, ASSIGNOR TO CONDIT ELEC-TRICAL MANUFACTURING CORPORATION, OF SOUTH BOSTON, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS

## INSULATOR

Application filed April 14, 1926. Serial No. 102,027.

This invention relates to insulating bushings which are used in high tension electrical apparatus, as an electric switch or transformer, having a metal casing to pro-

- 5 tect incoming and outgoing leads, and has particular reference to that type of bushing which is built up of paper or other fibrous material to form a solid insulating unit.
- A bushing made up of such material, as 10 paper or other fibrous material, bakelite, and the like has numerous advantages over the usual porcelain bushing. The manufacture of such a bushing is not attended with any particular difficulties. It may be built of
- 15 inexpensive material and can be readily produced in any desired shape or size. Moreover, the fibrous bushing possesses certain structural advantages over those of the usual ceramic materials in that it is much less
- 20 fragile. Consequently by the use of such fibrous material it is possible to build an insulator which is much cheaper and which is more serviceable than the porcelain bushings in present use.
- 25 It has been found in practice, however, that insulating bushings made up of fibrous or similar carbonizable materials are subject to slow deterioration on account of the di-electric losses therein. Since these losses
- are directly proportional to the field strength, the heaviest loss takes place in the vicinity of maximum field density, or the interior of the bushing, adjacent to the stud. From the inner surface of the tube there is
  a uniform decrease in field strength through-
- a uniform decrease in field strength throughout the tube wall, so that at the outer wall the field strength is greatly reduced. Consequently the inner parts of the tube are subjected to the greatest stress and suffer
  40 the most rapid deterioration. That part
- 40 the most rapid deterioration. That part of the tube adjacent to the stud is further subject to the deleterious action of corona, which is set up due to imperfect contact between the stud and the tube.
- It is an object of this invention to provide an essentially fibrous insulating bushing of the solid tube type which will be able to withstand corona and which will not be subject to any serious deterioration due to dielectric losses; and more specifically to lower end of said sleeve is provided a simi- 100

provide a fibrous, as a paper, bushing having a lining of some suitable ceramic material adjacent to the conducting stud to protect the fibre tube from carbonization and subsequent failure.

A further object is generally to improve <sup>55</sup> the construction of electric insulators.

The figure shows an elevation, partly in section, of an insulating bushing embodying the invention.

Certain features of this invention are disclosed in my co-pending applications Serial No. 89,888, filed February 23, 1926; and Serial No. 89,889, filed February 23, 1926.

As here shown, the insulator embodying 65 my invention includes two concentric tubes of substantial length, an inner tube 10 of any ceramic material, as porcelain, and an outer tube 12 of some fibrous material, such as paper. Said inner tube extends somewhat 70 beyond said outer tube at both its ends and has a uniform tubular wall portion 14 coextensive with the length of the outer tube and the enlarged end-portion 16 below the end of said outer tube. A series of annular 75 corrugations 18 are formed on said enlarged end-portion to increase the surface leakage path around the lower end of the insulator.

Said outer tube 12 may be built up to the desired shape and thickness from strips of 80 bakelized paper or the like, which material is adapted to be wound tightly upon the straight tubular wall 14 of said inner tube, and preferably is so applied as to form the tapered upper end 20 to conform to the de- 85 creased strength of the electric field at the upper end. A layer 22 of wire is wound tightly around said outer tube beginning at a point approximately intermediate its ends and preferably extending downward to a  $_{90}$  point well below the oil level a in the casing 23 of the electrical apparatus, whereby to form a ground sleeve and also to provide a strong mechanical bond between the fibre tube and the supporting means for the insu- 95 lator. At the top of said sleeve 22, a series of spaced, superimposed convolutions 24 of wire are provided which are soldered securely in place on said sleeve, and at the extreme

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lar convolution 25 of wire, whereby to lessen the intensity of the static field at this point.

A supporting flange 26 is disposed about

- said outer tube at a point intermediate the s ends thereof, and said flange is secured fixedly to the wire sleeve 22 of said tube by any suitable means as a body of cement 28. The effectiveness of the mechanical connection between said flange and said sleeve is fur-10 ther enhanced by the provision of the annu-
- lar grooves 30 in the inner vertical face of said flange and the wire-formed projections 24 which are aligned with said grooves. Said flange is secured removably to the 15 casing 20 by any suitable means as bolts 32.
- The inner tube 10 has at its lower end an enlarged annular recess 34 adapted to receive the metal bushing 35, and a body of cement 36 between the bushing and said 20 inner tube secures said bushing fixedly in position in said tube so that the inner pas-
- sage of the bushing is aligned with the axial passage in the tube 10. Said bushing is provided with an integral outstanding annu-25 lar flange 37 which is adapted to bear against the end of said tube, through the
  - medium of said cement 36, and receive any pressure exerted against the bushing.
- A conductor, or stud, 38 is disposed with-30 in the axial passage of said tube and is screw-threaded at its lower end into the bushing 35 and is arranged to extend a substantial distance below the bushing to provide the screw-threaded terminal-portion 40 35 for suitable connection to any electrical ap-
- paratus within the casing.

For outdoor service the insulator is further provided with a protective porcelain covering disposed above the supporting 40 flange  $\underline{26}$  to protect the outer fibre tube  $\underline{12}$ from moisture, and as here shown said protection comprises a porcelain shell 42 extending above said supporting flange to the top of said inner tube and having a tapered 45 upper portion 44 to conform to the tapered end 20 of the outer fibre tube 12. Said shell may fit snugly over the upper portion of the paper tube or there may be a small clearance space therebetween. Said support-50 ing flange is provided with an annular groove 48 in which the lower end of said shell is received and supported. The vertical face 50 of said flange 26 is adapted to extend upwardly within the internal recess. 55 51 in the end of said shell, whereby to provide a barrier against entrance of water. A body of cement 52 is provided within said groove 48 to further seal the joint thereat 60 and to unite said shell and flange.

A body of compound 54 may fill the space between the shell and the paper tube 12 and also the space 58 above said tube and is preferably of such nature that it may be 65 poured therein while hot, and subsequently

solidify, whereby any moisture present in the insulator will be driven out.

Said protective shell 42 is further provided with a series of petticoat structures or capes 60 as is customary in outdoor insu- 70 lators to prevent the possibility of flashovers in wet weather.

A metal ferrule 61 is fixed to the upper end of said protecting shell by a body of cement 62 or other suitable means and ex- 75 tends over and provides a cover for the top openings of said shell and the inner and outer tubes 10 and 12. Said ferrule is also provided with the integral upstanding neck 63 which is arranged to receive said con- 80 ductor 38 in the central opening 64 thereof. An axially extended slot 65 provided in said conductor 38 and a corresponding slot 66 in the adjacent neck 63 are adapted to receive a spline 67 whereby to prevent rotation of 85 said conductor within said neck. One of said slots, as the slot 65 is arranged to be sufficiently longer than said spline to permit free vertical movement of said conductor.

A yielding packing 70 of some suitable 90 insulating material may be interposed between the ferrule 61 and the top of the tube 10 and the shell 42 to provide a yielding cushion against which said tube and shell 95 may expand.

The conductor 38 extends through and beyond the neck 63 of said ferrule 61 and is screw-threaded into the metal terminal connector 72. Said connector is provided with an externally screw-threaded stud 73 to 100 which a line conductor is adapted to be attached, and said connector is also provided with a depending annular apron, or flange, 74 which surrounds the neck 63 of said ferrule and is arranged in covering relation 105 with the conductor-passage in said neck. Said apron is free to move axially under the expansion and contraction of the conductor, while maintaining the aforesaid relation.

The paper tube, or one made of materials 110 having similar characteristics when subjected to a severe electric stress, is subject to a slow deterioration, which shows up usually as a carbonization of the material and a gradual reduction of its insulating 115 property. By placing the tube remote from the stud or high-tension conductor, it is in a region having a relatively weak field and so is protected from any material and rapid deterioration. The porcelain tube, or 120 one composed of a substance which does not carbonize or eventually lose its high insulating properties permanently under heavy electric stresses, is located in the region of greatest electric field. The composite insulator thus provided may be very effective, and have a long useful life, and can be constructed at a relatively low cost.

I claim:

1. An electric insulator having two solid 130

insulating bodies composed of dissimilar insulating materials, one of which is composed of paper and is more deleteriously affected by a long continued high electric stress 5 than the other and is located in that portion of the insulator in which the electric field is least.

2. An electric insulator having a stud, a porcelain tube surrounding said stud, a

10 paper tube surrounding and in intimate contact with said porcelain tube, and a ground sleeve surrounding and having a large area in intimate contact with said paper tube.

3. An electric insulator comprising an 15 inner porcelain tube, an outer fibrous tube carried by said porcelain tube, and a sleeve of closely wound wire carried by said outer tube, and a metal filler for the spaces between the convolutions of said sleeve.

4. An electric insulator having an inner 20 porcelain tube, an outer concentric fibrous tube surrounding and in intimate contact with said inner tube, a metal ground sleeve surrounding and having a large area in inti-25 mate contact with the lower end of said outer tube, and a supporting flange for said

insulator secured to the upper end of said ground sleeve. 5. An electric insulator of the bushing-

30 type comprising an inner porcelain tube, an outer paper tube wound upon said porcelain tube, an attaching flange secured to said paper tube intermediate its ends, and a porcelain shell disposed over the upper 35 ends of said tubes and having its lower end closed by said flange.

6. An electric insulator having a fibrous tube, an internal integral porcelain lining for said tube, an axial stud disposed within 40 said lining, a metal sleeve disposed on the outer surface of said fibrous tube intermediate its ends comprising adjacent turns of wire wound tightly on said tube and soldered together, a series of spaced groups of wire-45 convolutions carried by said sleeve at its upper end, and an annular metal flange having grooves in its inner face opposed to said wire-groups, and a body of cement in said grooves and the space between said

50 sleeve and flange. 7. A high tension insulating bushing consisting of a high tension conductor, a porcelain insulating tube surrounding said conductor, and a paper insulating tube sur-55 rounding said porcelain tube.

8. A high tension insulating bushing consisting of a high tension conductor, a porcelain insulating tube surrounding said conductor, and a paper insulating tube sur-60 rounding and carried by said porcelain tube. In testimony whereof, I have signed my name to this specification.

GUSTAV JANSSON.

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