April 28, 1925. 1,535,094

R. V. BINGAY

TRANSFORMER

Filed Sept. 29. 1920

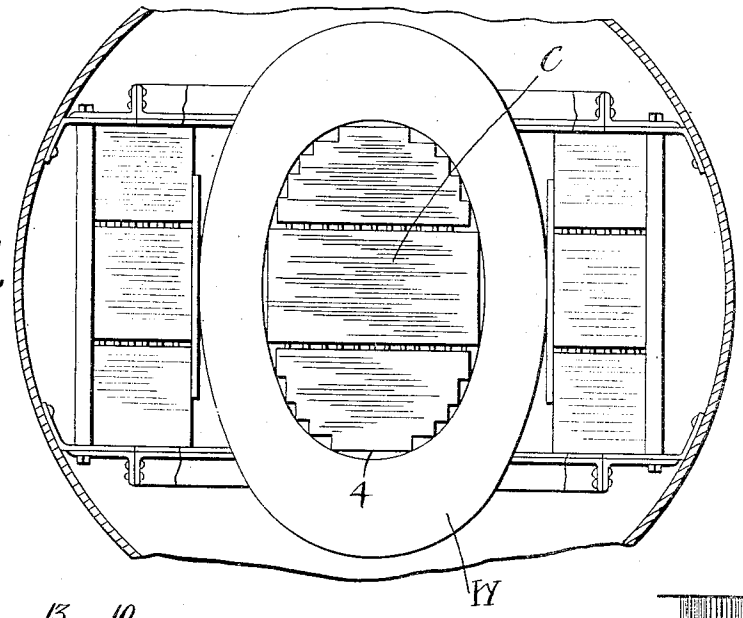


Fig: 1.

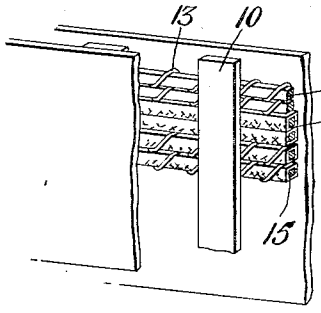
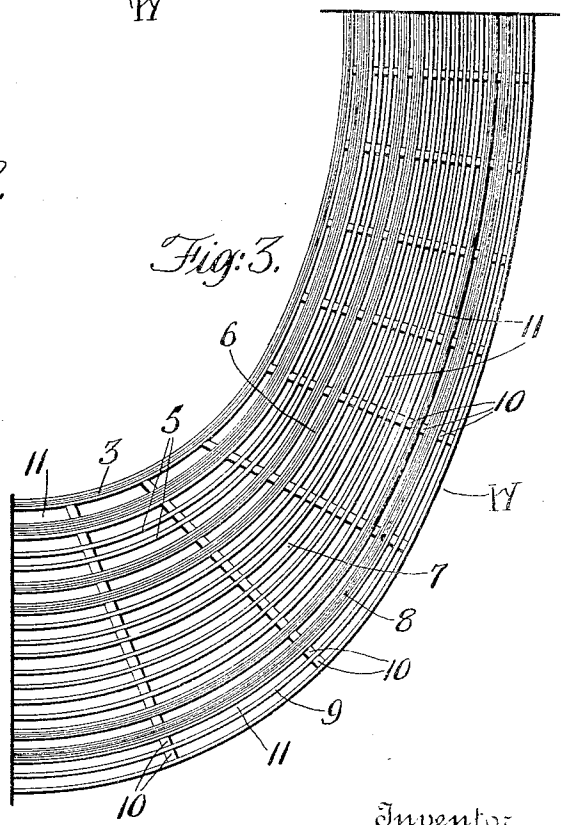


Fig: 2.

Fig: 3.



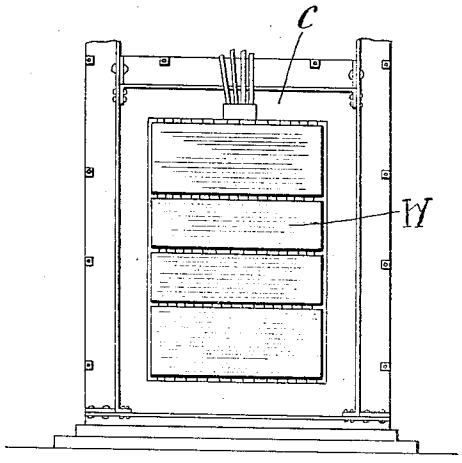


Fig: 4.

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UNITED STATES PATENT OFFICE.

ROBERT V. BINGAY, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO PITTSBURGH TRANSFORMER COMPANY, A CORPORATION OF PENNSYLVANIA.

TRANSFORMER.

Application filed September 29, 1920. Serial No. 413,613.

To all whom it may concern:

Be it known that I, ROBERT V. BINGAY, a citizen of the United States, residing at Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Transformers, of which the following is a specification.

This invention relates to electrical transformers and particularly to transformers cooled by a circulating fluid. The object of the invention is to provide a transformer in which the insulation between the conductors or windings is impregnated with a varnish-like compound hardened to impart great mechanical and dielectric strength and durability to the coil structure.

In the accompanying drawings illustrating the invention—

Fig. 1 is a plan view of a transformer structure.

Fig. 2 is an elevational view thereof.

Fig. 3 is a plan view on enlarged scale of the transformer coil of Fig. 1, and

Fig. 4 is a diagrammatic view in perspective of the coil formation of this invention.

In the transformer of this invention the windings preferably have vertical axes and the primary and secondary windings are wound as layers of a unitary structure having the cross section of a circle or oval. Starting at the innermost insulating barrier 3 of the windings W which will be adjacent the core leg 4 of the core C there is wound one section 5 of the low tension winding then a barrier 6 of insulating material then a section 7 of the high tension winding, another barrier 8 and another section 9 of the low tension winding, each section being of any desired number of layers. Adjacent layers are separated by strips 10 of insulating material so as to provide ducts 11 giving access to and through the interior of the windings for the varnish and air during the process of this invention and for the cooling and insulating oil when the transformer is in service.

The insulation around the conductors or wires is preferably of absorbent material such as cotton and similarly the barriers may be of fuller board or other material also absorbent. As illustrated in Fig. 4 the conductors will preferably be wound in open coils and with the insulation permitting the varnish to permeate the innermost portions around the wire. For instance the conductors as at 12 may be wound with string 13 leaving spaces between the wires for the varnish, or the wires may be wound with fabric, as at 14, adapted to absorb the varnish or both string and a covering may be used as indicated at 15 and the string or fabric or both may be of asbestos. When the windings are completed they are heated below the charring or singeing point of the insulating or binding material. The effect of this heating is to drive off moisture and it is continued until the entire windings are thoroughly heated to the innermost recesses which, for instance, may be in good practice 100° to 120° C. for twenty-four hours. The hot windings are then subjected to a high vacuum and this together with the heat supplied by the hot material rids the winding entirely of moisture and leaves it thoroughly dry.

The winding is then treated with liquid varnish for instance by admitting the varnish to the vacuum chamber to submerge the coil before relieving the vacuum. Air and moisture are thus entirely excluded and the varnish is drawn in and penetrates into the innermost recesses of the coil structure soaking into all the porous insulation, and pressure may be added to aid this impregnation. The coils are then again heated to a safe temperature in the presence of air to finally drive off the varnish diluents and to thoroughly oxidize the varnish and permanently harden it. This hardening is usually slow and the length of time it takes depends upon the particular type of coil and varnish used, the usual time required being, for instance, from several days to two weeks. The open ventilated character of the windings also permits the excess varnish to drain off and the diluent vapors to pass off from the interior and the air to gain access to all the surfaces so that the varnish hardens in all parts binding the windings into a strong permanently rigid unit. The varnish used is preferably of the type hardening by evaporation of a diluent and by oxidation; it may for instance be composed of linseed or chinawood oils with a gum, such as rosin or copal and with gasoline or naphtha as a diluent. To hasten the fixing and hardening of the varnish a partial vacuum may also be applied to the impregnated coil.

Each wire is surrounded by a layer of the

hardened varnish impregnating the fabric cover or coating the bare wire and virtually results in a continuous tube, the hardened varnish being itself a high insulation. The barriers and spacers are also impregnated and covered with the hardened varnish rendering them stiff and strong and greatly improving their insulating properties. The hardened varnish also connects and binds all the parts together against relative shifting and this varnish hardened by this process does not soften or weaken when the transformer becomes heated in service but remains as a permanent rigid binder and insulator in all the parts.

After the hardening of the varnish of the first treatment further coatings may be applied for instance by dipping and hardening to form protective, strengthening layers of varnish over the parts already impregnated by the first treatment.

The hardened varnish produces smooth walled ducts and ventilating spaces in the windings for the free flow of the cooling fluid, and being a better heat conductor than the oil aids in the transfer of heat from the conductors to the cooling oil. The hardened varnish is moisture proof and oil-proof and serves as a protective, insulating covering, permanently separating the conductors and preserving the cotton or other material and greatly adding to its dielectric strength.

Prior attempts to varnish coils have been impracticable and unsuccessful in that particularly when carried within the inner deeper parts the varnish would remain in fluid form and before it could harden it would attack the copper wire "greening" it and weakening the insulation so as to ultimately cause a breakdown instead of preventing it. It has therefore been the common practice to impregnate the coils with a melted composition which would harden by cooling. Such compositions however invariably show a tendency to weaken when the coils heat up in service and these compositions also become soluble in the transformer oil so as to be dissolved out, further weakening the coil insulation and causing a deposit of sludge on the transformer parts. The structure and method of this invention overcome the objections of this prior practice and provide a permanently insulated and durable coil structure.

While this invention has been illustrated in connection with a specific embodiment and process it is not confined thereto but is intended to cover such variations therefrom as fall within the scope of the appended claims.

I claim:—

1. In a transformer the combination with a core leg, of a transformer coil surrounding said leg and extending lengthwise thereof and comprising a plurality of successive conductor windings one within the other, insulation comprising strips spacing successive windings apart to provide ventilating ducts between said windings said ducts extending from end to end of the coil, and a layer of hardened varnish forming a binding and insulating film over the conductors and insulation throughout the coil.

2. In a transformer the combination with a core leg, of a transformer coil surrounding said leg and extending lengthwise thereof and comprising a plurality of successive conductor windings one within the other, insulation comprising strips spacing successive windings apart to provide ventilating ducts between said windings and extending from end to end of the coil and communicating with at least one side of each conductor, and a layer of hardened varnish forming a binding and insulating film over the conductors and insulation throughout the coil.

ROBERT V. BINGAY.