Dec. 22, 1953 R. M. BAKER 2,663,827

RADIO FREQUENCY CURRENT TRANSFORMER

Filed Oct. 18, 1950

Fig. 1.

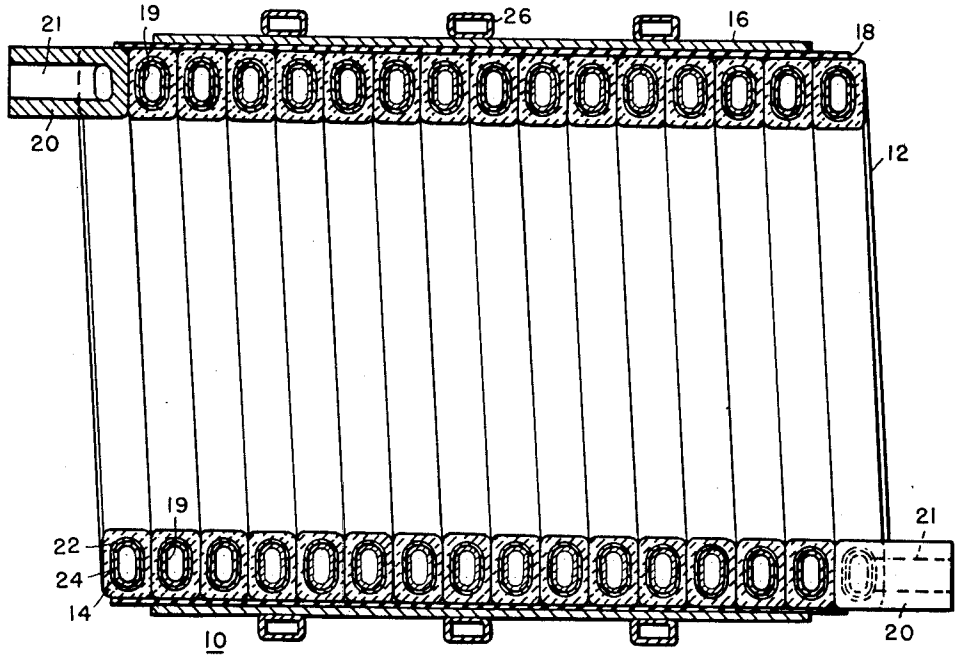
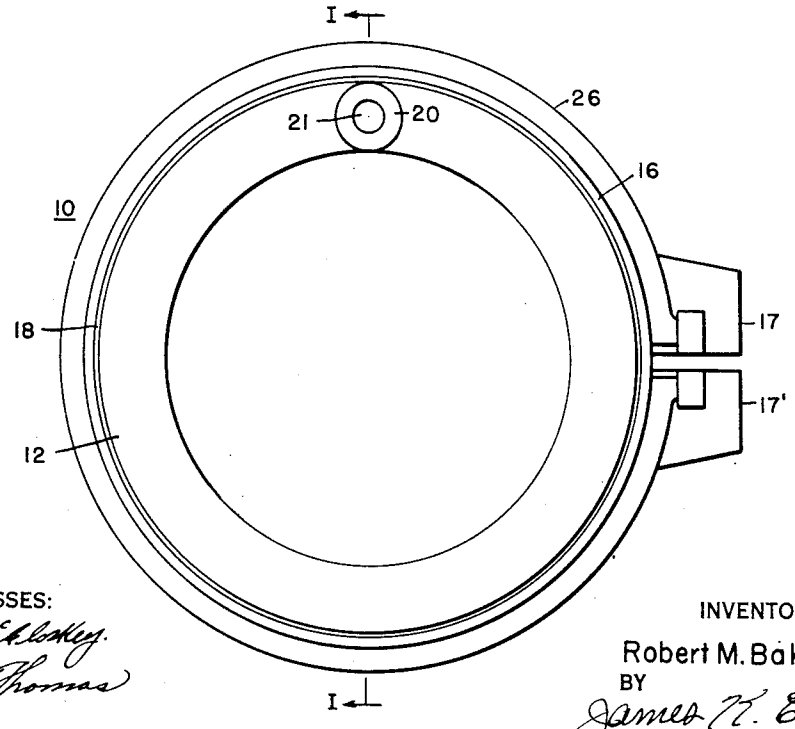


Fig. 2.



WITNESSES:

E. A. McKinley.

K. H. Thomas

INVENTOR

Robert M. Baker.

BY

James M. Ely

ATTORNEY

Patented Dec. 22, 1953

2,663,827

UNITED STATES PATENT OFFICE

2,663,827

RADIO FREQUENCY CURRENT TRANSFORMER

Robert M. Baker, Catonsville, Md., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application October 18, 1950, Serial No. 190,743

7 Claims. (Cl. 317—213)

1

This invention relates to current transformers and particularly to current transformers suitable for use at radio frequencies.

Radio-frequency current transformers having a helically wound copper tube primary winding that may be utilized for cooling purposes and a single-turn secondary have been employed heretofore in the electrical industry. However, one of the problems in manufacturing such a radio-frequency current transformer has been to obtain sufficient insulation between the primary and secondary winding so as to withstand the high radio-frequency voltages present.

An object of this invention is the provision of primary and secondary windings for radio-frequency current transformers which are so insulated from each other that they function properly when subjected to the radio-frequency voltages impressed on such transformers.

Another object of this invention is the utilization of an inorganic refractory tubing having conductive coatings on the inside as the primary winding of a current transformer suitable for radio frequencies, the refractory material utilized in the primary winding serving as insulation between the windings.

Other objects of the invention will appear from reading the specification and claims in connection with the accompanying drawing, in which:

Figure 1 is a view in section taken along the line I—I of Figure 2 of the radio-frequency current transformer embodying the features of this invention, and

Figure 2 is a plan view of the radio-frequency current transformer embodying the features of this invention.

Referring to the drawing, the modification of a radio-frequency current transformer shown generally at 10 embodies the features of this invention. As illustrated, the radio-frequency current transformer 10 comprises a primary winding 12 formed from an inorganic refractory tube 14 and on which coatings of conducting material have been applied over the inner surface of the tube 14, which will be described in detail hereinafter. A single-turn secondary winding 16 having terminals 17 and 17' surrounds and conforms to the circular configuration of the primary winding 12, and an insulating material 18 is disposed between the primary winding 12 and the secondary winding 16, which insulating material 18 will be described hereinafter in detail.

In production, the tube 14 of the primary winding 12 is formed from an inorganic refractory material, such as zircon porcelain, electrical porcelain, steatite, or the like, in a plastic unfired state. The first step in forming the primary winding 12 is to extrude the plastic in-

2

organic refractory material into a long hollow tube 14, which in this embodiment is of rectangular cross section and has a bore 19 for the passage of a cooling fluid. The tube 14 having been extruded, the inner surfaces at the two ends of the tube 14 are then fashioned to facilitate the attachment of a metal water fitting 20 having a passage 21 in continuation of bore 19. The fitting 20 also constitutes a portion of a terminal for connecting the transformer 10 to a power source (not shown). The tube 14 while still in its plastic state is wound into a helical coil with the adjacent turns touching. It is then dried and fired in the conventional manner.

In order to improve the mechanical and physical properties, particularly the strength and surface smoothness of the ceramic tube 14, both its inner and outer surfaces are glazed in any well-known manner. Two metallic coatings 22 and 24 of electrical conducting material are then applied to the inner surface of the tube 14.

The metallic coating 22 is applied by chemically depositing a layer or film of platinum, gold, or silver on the inner surface of the tube 14. This metallic coating 22 facilitates the bonding of additional metal to the inner surface of the ceramic tube 14. As shown, the coating 22 extends over the entire inner surface of the tube 14 so as to cover that portion of the surface to which water fittings 20 are attached and makes electrical contact with the fittings 20. A satisfactory method of producing and applying the coating 22 of platinum to a ceramic, such as porcelain, so as to enable the bonding of a metal to porcelain is described in Patent No. 1,852,093.

Once the platinum has been chemically deposited on the inner surface of the tube 14, the second coating 24 of copper or silver is electrically deposited on the first coating 22. In practice, it has been found satisfactory to electrically deposit the copper or silver until a coating 0.005 inch thick is obtained.

In order to electrically deposit the copper or silver on the fist coating 22, a copper or silver wire (not shown), which acts as a plating anode, is threaded through the bore 19. The first coating 22 is utilized as the plating cathode. Glass beads (not shown) are threaded onto the wire anode at intervals, thus acting as an insulator between the plating anode and the first coating 22. When the plating anode has been properly positioned in the spiral passage, plating solution (not shown) is then continuously pumped through the bore 19. Passing an electrical current between the plating cathode and anode results in the electrical depositing of the coating 24 of either copper or silver on the first coating 22 depending on whether a copper or

silver electrolyte is used. The plating process having been completed, the wire anode is removed from the tube 14 and the pumping of the plating solution is discontinued. The coatings 22 and 24 having been applied, the metal water fittings 20 are attached in any suitable manner, as by brazing or soldering, to the ends of the tube 14. When the transformer 10 is in use, the coatings 22 and 24 serve as an electrical conductor.

In order to cool the primary winding 12 when the transformer 10 is in service, water is continuously pumped through the bore 19, the water being obtained from any suitable source (not shown). The procelain tube 14 serves as a support for the applied coatings 22 and 24 and also functions as an insulator between the conducting metallic coatings 22 and 24 and the secondary winding 16. This added insulation is necessary in order for the transformer 10 to withstand for a sufficient length of time the high radio-frequency voltages present in radio-frequency current transformers.

The secondary winding 16 is superimposed on and conforms to the configuration of the primary winding 12. For the purpose of cooling, a tube 26 is either brazed or welded to the secondary winding 16. It is to be understood, however, that other cooling means than that shown could be used for cooling the secondary winding 16.

In order to provide additional insulation, a layer 18 of insulating material is so applied as to surround the outer surface of the primary winding 12 and conform to its configuration. This layer 18 of insulating material may be a resilient, low-loss, resinous composition. Exapmles of suitable insulating material for this purpose are polyethylene of a molecular weight of 10,000 to 40,000 and higher, polyisobutylene of a molecular weight of up to 150,000 and higher, interpolymers and mixtures of polyethylene and isobutylene, organopolysiloxanes and particularly elastomeric dimethylsiloxanes, polytetrafluoroethylene, polytrifluorochloroethylene, ethyl cellulose, polyvinyl carbazole, polystyrene, chlorinated rubber, and silicone-rubber as described in Patents 2,472,629 and 2,480,620.

The radio-frequency current transformer 10 shown and described herein has many advantages over other such transformers. As hereinbefore mentioned, the radio-frequency current transformer embodying the teachings of this invention stands up under the high radio-frequency voltages impressed on the transformer, and as a result, the life of the transformer is long.

The tube 14 is formed from a porcelain coil, such as zircon porcelain, electrical porcelain, steatite or the like, and can usually be obtained as a stock item from most suppliers, which is an important factor when it is necessary to repair the transformer on short notice. And except for the plating operation, the construction and assembly of the radio-frequency current transformer 10 embodying the teachings of this invention is simple and straight-forward since the workmen do not require special training in applying insulations.

I claim as my invention:

1. In a transformer, in combination, a primary winding comprising an inorganic refractory tubing, a coating of conducting material chemically deposited over the inner surface of the inorganic refractory tubing so as to obtain a continuous adherent contact, a coating of conducting material electrically deposited on the

said chemically deposited conducting material, and a secondary winding inductively associated with the primary winding.

2. In a transformer, in combination, a primary winding comprising an inorganic refractory tubing, a continuous coating of conducting material chimically deposited over the inner surface of the inorganic refractory tubing so as to obtain a continuous adherent contact, a coating of conducting material about 0.005 inch thick electrically deposited on the said chemically deposited coating, and a secondary winding inductively associated with the primary winding.

3. In a transformer, in combination, a primary winding comprising an inorganic refractory tubing, a coating of platinum glaze chemically deposited over the inner surface of the inorganic refractory tubing so as to obtain a continuous adherent contact and another coating comprising a conducting material electrically deposited on the coating of platinum glaze, and a secondary winding inductively associated with the primary winding.

4. In a transformer, in combination, a primary winding comprising an inorganic refractory tubing, a coating of silver chemically deposited over the inner surface of the tubing so as to obtain a continuous adherent contact and another coating comprising a conducting material electrically deposited on the silver coating, and a secondary winding inductively associated with the primary winding.

5. In a transformer, in combination, a primary winding comprising an inorganic refractory tubing wound into a helical coil, a coating of platinum glaze chemically deposited over the inner surface of the tubing so as to obtain a continuous adherent contact and a coating of copper electrically deposited on the coating of platinum glaze, and a secondary winding superimposed on the primary winding and being inductively associated therewith.

6. In a transformer, in combination, a cooled primary winding comprising an inorganic refractory tubing, a coating of platinum glaze chemically deposited over the inner surface of the inorganic refractory tubing so as to obtain a continuous adherent contact and a coating of silver electrically deposited on the coating of platinum glaze, and a cooled secondary winding superimposed on the primary winding and inductively associated therewith.

7. In a transformer, in combination, a water-cooled primary winding comprising an inorganic refractory tubing wound into a helical coil, a coating of platinum glaze chemically deposited over the inner surface of the tubing so as to obtain a continuous adherent contact and a coating of copper electrically deposited on the coating of platinum glaze, and a single-turn, water-cooled secondary winding superimposed on the water-cooled primary winding and inductively associated therewith.

ROBERT M. BAKER.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,273,135	Ohnesorge et al.	Feb. 17, 1942
2,366,290	Rudd	Jan. 2, 1945

FOREIGN PATENTS

Number	Country	Date
498,116	Great Britain	Jan. 3, 1939