H. B. SMITH.

TRANSFORMER.

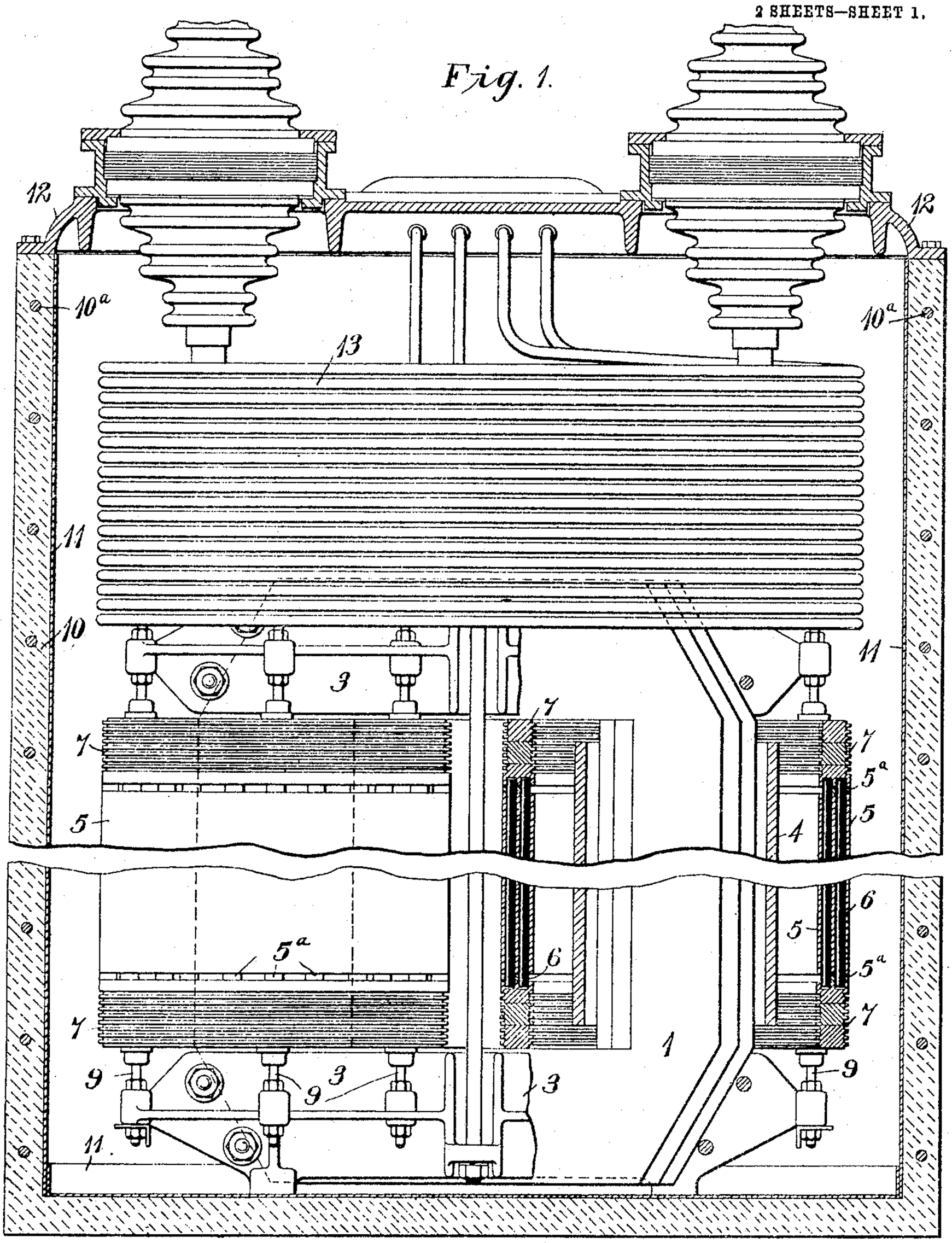
APPLICATION FILED SEPT. 4, 1906.

914,981.

Patented Mar. 9, 1909.

2 SHEETS—SHEET 1.

*Fig. 1.*




WITNESSES:

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2 SHEETS—SHEET 2.

*Fig. 2.*

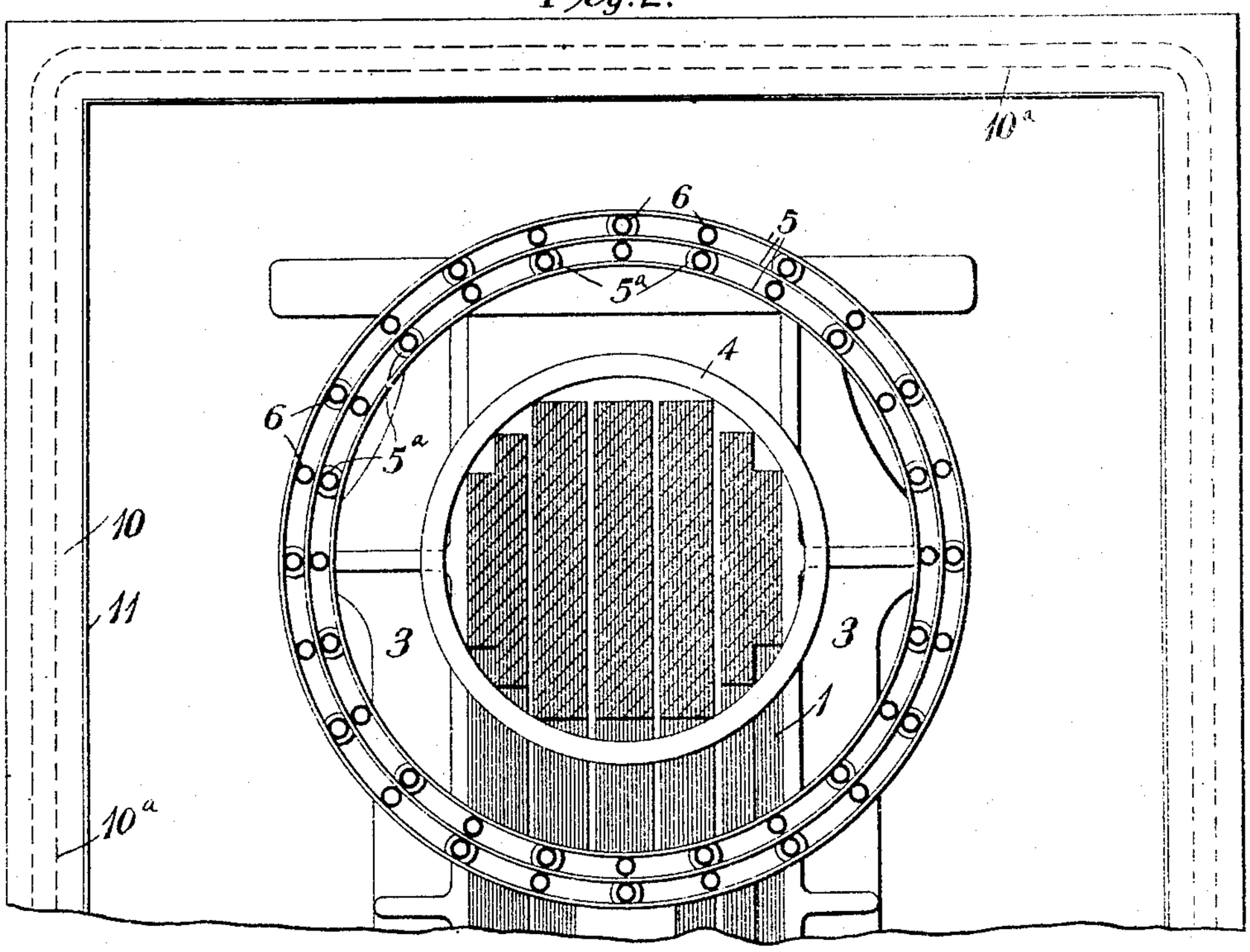



*Fig. 3.*

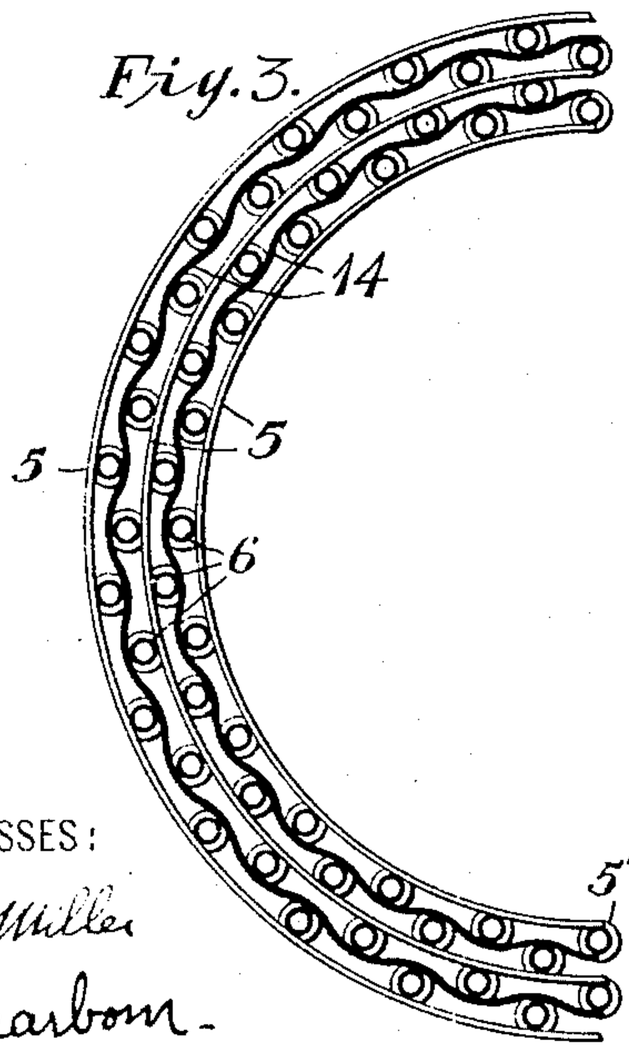
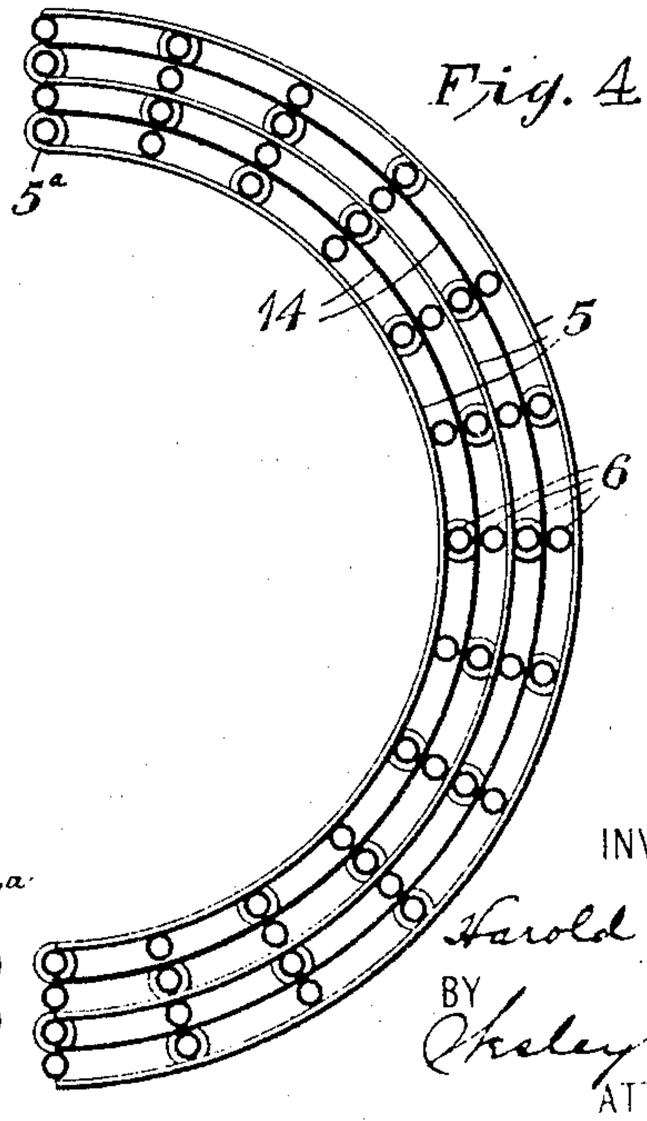



*Fig. 4.*

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# UNITED STATES PATENT OFFICE.

HAROLD B. SMITH, OF WORCESTER, MASSACHUSETTS, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

## TRANSFORMER.

No. 914,981. Specification of Letters Patent. Patented March 9, 1909.

Application filed September 4, 1906. Serial No. 333,115.

*To all whom it may concern:*

Be it known that I, HAROLD B. SMITH, a citizen of the United States, and a resident of Worcester, in the county of Worcester and State of Massachusetts, have invented a new and useful Improvement in Transformers, of which the following is a specification.

My invention relates to electrical apparatus, and has special reference to the windings for high voltage alternating current transformers.

The object of my invention is to provide means for effectively insulating and mounting windings for devices of the class above indicated that shall be simple, durable and relatively inexpensive, and that shall insure a maximum heat radiation.

The convolutions of conducting material of which the windings of my transformer are composed are all exposed to contact with the insulating fluid in which the transformer is immersed. The space occupied by the windings is relatively small and although the number of convolutions may be very great, adequate heat radiation is provided for every turn.

The windings comprise, in general, a plurality of concentrically mounted substantially cylindrical coils of materially different diameters which are constructed by winding a single layer of strap conductor on edge.

Figure 1 of the accompanying drawing is a view, partially in elevation and partially in section, of a transformer constructed in accordance with my invention. Fig. 2 is a view, partially in section and partially in plan, of a portion of the transformer shown in Fig. 1, and Figs. 3 and 4 are plan views of portions of coil groups similar to those shown in Fig. 2, but having insulating barrier plates.

Referring to Figs. 1 and 2 of the drawings, the transformer illustrated therein comprises a laminated core member 1 which is substantially rectangular in form and constitutes a single continuous magnetic circuit.

The core structure is bound together by clamping plates 3, which are arranged in pairs and are located on opposite sides of the two short legs of the core member. Upon the two longer legs of the core member, primary coils 4 and similar groups of concentric secondary coils 5 are disposed. As illustrated, the primary winding 4 comprises a single coil of strap conductor on each leg of the core that is substantially cylindrical in form and is of suitable diameter to fit easily onto the core member. The secondary winding 5 comprises two groups of three cylindrical coils each, the diameters of which vary progressively and are materially greater than the diameter of the primary coils 4 so that they may be concentrically mounted and at the same time be sufficiently separated from each other to permit of the free circulation of oil or other suitable insulating fluid between the several coils. The primary coils may, of course, be subdivided and the size and arrangement of both primary and secondary coils and the numbers of each may be varied to suit the conditions for which the transformer is designed.

The relative positions of the coils 5 are maintained by means of a series of insulating tubes or rods 6 which are somewhat longer than the coils and are of suitable size to fit between the concentrically mounted coils. These rods or tubes are supported at their ends by rings 7 of wood or other suitable insulating material, the inner surfaces of which are provided with a series of cavities so that the tubes may be spaced about the surface of the coils and retained in such a position. The rings 7 are themselves supported by projections which extend from the clamping plates 3 and to which they are connected by adjustable clamping bolts 9. The tubes 6 are longer than the coils 5, and collars $5^a$ are provided at the lower ends of the tubes so that the rings 7 do not seal the ends of the coils and consequently the insulating fluid may circulate between them.

The core and the windings are located in a tank 10 which, as illustrated, is rectangular, but which may be of any suitable size and shape and which may be constructed of concrete or similar substance. The interior of the concrete tank is provided with a lining 11 of sheet metal, so that it is capable of retaining oil or other insulating fluid in which it is desirable to immerse the transformer coils. The tank 10 is provided with a cover 12 which may be of similar construction to the tank or may be made of cast iron according to the usual practice. The concrete tank may preferably be reinforced by girders or rods $10^a$ of iron, which are built into its structure in the usual manner.

The sheet metal lining may be replaced by

a coating of a suitable fluid-resisting substance.

The insulating fluid in the tank may be kept cool by any convenient means, such as a coil of pipe 13, which is supported from the cover and through which water or other cooling fluid may be circulated.

The core section of the magnetizable core 1 may be modified by providing notches or steps in the corners, as shown in Fig. 2, so that the coils 4 may be fitted more closely to the core section.

Referring to Figs. 3 and 4 of the drawings, the concentric coils 5 are separated, not only by the spacing tubes 6 but also by insulating barrier plates 14, the use of which is well known for insulating high voltages in connection with fluid insulation. The barrier plate may be of any convenient shape, corrugated or cylindrical, and in some instances it may be desirable to provide several barrier plates in the form of concentric cylindrical shells which may be separated by insulating tubes or rods as the coils 5 are separated in Figs. 1, 2, 3 and 4. For use with very high voltages, the barrier plates are of considerable advantage since they materially reduce the aggregate oil distances which are capable of sustaining such voltages and consequently improve the transformer regulation by reducing the reactance.

I make no claim herein to the tank or casing, but have made that the subject-matter of a divisional application, Serial No. 350,952, filed January 5, 1907.

The improvements of my invention are not restricted to the transformer illustrated and may be readily applied to various other devices, and I desire that only such limitations be imposed as are indicated in the appended claims.

I claim as my invention:

1. A winding for electrical apparatus comprising a plurality of substantially cylindrical coils of materially different diameters, and spacing means between the coils.

2. A winding for electrical apparatus comprising a plurality of concentrically mounted cylindrical coils of materially different diameters, each of which is composed of a single layer of convolutions of a strap conductor wound on edge.

3. In a transformer, the combination with a magnetizable core member, of a winding therefor comprising a plurality of substantially cylindrical coils of materially different diameters, and spacing tubes of insulating material between the coils.

4. In a transformer, the combination with a laminated core member, of a winding comprising concentric cylindrical coils formed of strap conductors, and spacing tubes and barrier plates of insulating material serving to separate said coils.

5. In a transformer, the combination with a magnetizable core member, of a winding comprising a plurality of concentric and substantially cylindrical coils of materially different diameters constructed of insulated strap conductor wound on edge, and barriers of insulating material between adjacent coils.

6. In an oil-immersed transformer, the combination with a magnetizable core member, of a winding comprising substantially concentric and cylindrical coils and corrugated barriers of insulating material between adjacent coils.

7. The combination with a plurality of substantially concentric cylindrical coils for electrical apparatus, and barrier plates of insulating material between the coils, of an inclosing and fluid-containing casing therefor.

8. The combination with a plurality of substantially concentric cylindrical coils for electrical apparatus, and barrier plates of insulating material between the coils, of a fluid-containing tank constructed of concrete or similar substance.

9. The combination with a plurality of substantially concentric cylindrical coils for electrical apparatus, and corrugated barrier plates of insulating material between the coils, of an inclosing tank constructed of concrete or similar substance and having a fluid-resisting lining.

10. The combination with a plurality of substantially concentric cylindrical coils for electrical apparatus, and barrier plates of insulating material between the coils, of an inclosing tank or casing constructed of concrete or similar substance and having a sheet metal lining.

11. The combination with a substantially rectangular core member, and a plurality of concentric cylindrical coils mounted on two opposite legs of the core member, of corrugated barrier plates of insulating material between adjacent coils, and means for immersing the core and the windings in insulating fluid.

12. The combination with a substantially rectangular core member, and a plurality of concentric cylindrical coils each comprising a single layer of convolutions of edgewise wound conductor, of barriers between the adjacent coils, and a fluid-containing tank in which the core and windings are disposed.

13. The combination with a substantially rectangular core member, and a plurality of concentric cylindrical coils each comprising a single layer of convolutions of edgewise wound conductor, of corrugated barrier plates between adjacent coils, and a fluid-containing tank constructed of concrete or similar material and inclosing the core and windings.

14. In a transformer, the combination with a plurality of concentric and substantially cylindrical coils, of spacing means between the adjacent coils comprising a series

of insulating tubes, and means for supporting the tubes and for maintaining the concentric relation between the coils.

15. In a transformer, the combination with a plurality of concentric and substantially cylindrical coils, and a series of insulating spacing tubes disposed between adjacent coils, and end rings which support the spacing tubes.

16. In a transformer, the combination with a plurality of concentric and substantially cylindrical coils, of a series of insulating spacing tubes, and barrier plates between adjacent coils, and rings of insulating material which engage and support the ends of the spacing tubes.

In testimony whereof, I have hereunto subscribed my name this 17th day of August, 1906.

HAROLD B. SMITH.

Witnesses:
R. J. DEARBORN,
BIRNEY HINES.