EXAMINER.

Aug. 25, 1925. 1,550,889

J. A. DORAN

INDUCTION DEVICE AND MAGNETIC CIRCUITS FOR THE SAME

Filed Sept. 15, 1924 2 Sheets-Sheet 1

Fig. 1.

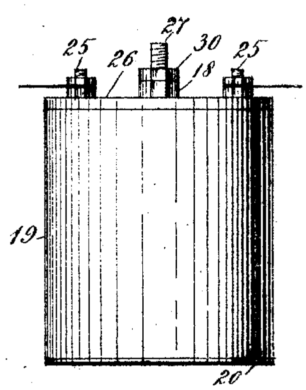


Fig. 2.

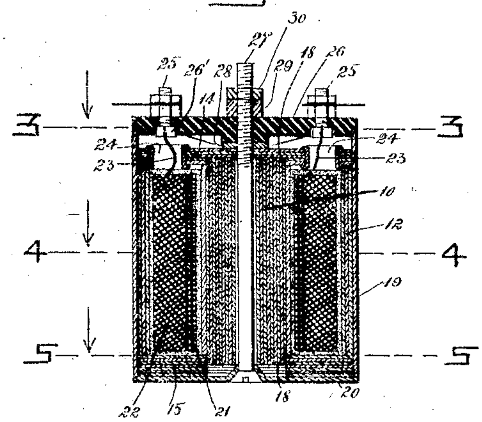


Fig. 3.

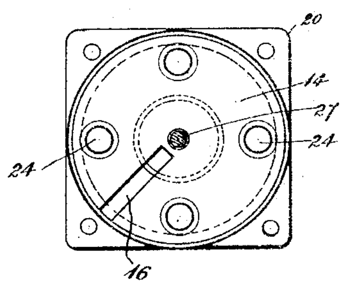


Fig. 4.

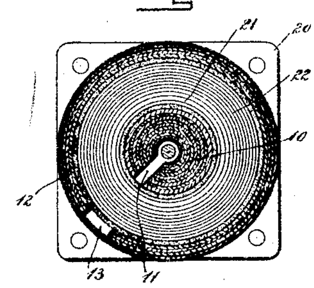


Fig. 9.

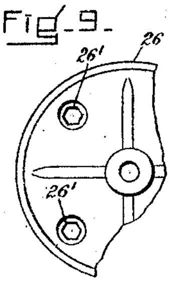
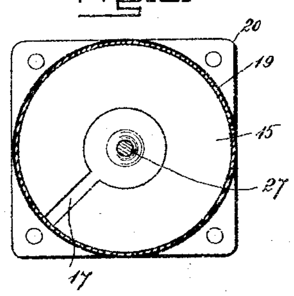


Fig. 5.



INVENTOR:
James A. Doran

By Geo. K. Woodworth.
ATTORNEY

EXAMINER.

Aug. 25, 1925.

J. A. DORAN

1,550,889

INDUCTION DEVICE AND MAGNETIC CIRCUITS FOR THE SAME

Filed Sept. 15, 1924 2 Sheets-Sheet 2

Fig. 6.

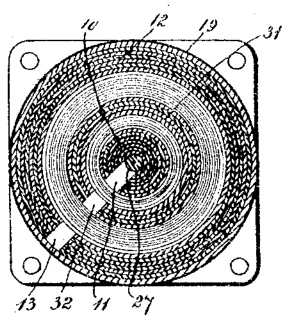


Fig. 7.

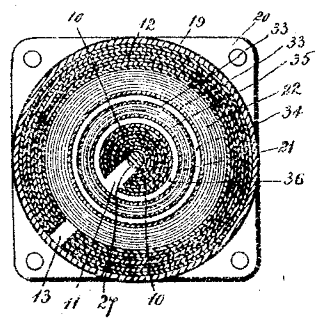
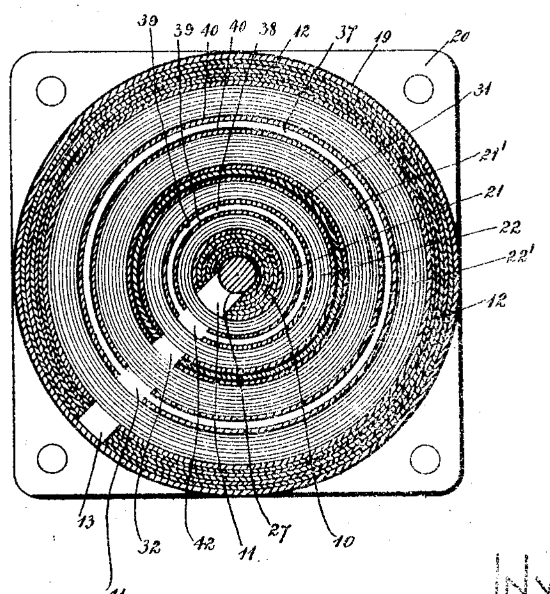


Fig. 8.



INVENTOR:
James A. Doran
By Geo. K. Woodworth
ATTORNEY:

EXAMINER

Patented Aug. 25, 1925. **1,550,889**

UNITED STATES PATENT OFFICE.

JAMES A. DORAN, OF PROVIDENCE, RHODE ISLAND.

INDUCTION DEVICE AND MAGNETIC CIRCUITS FOR THE SAME.

Application filed September 15, 1924. Serial No. 737,774.

To all whom it may concern:

Be it known that I, James A. Doran, citizen of the United States, and a resident of Providence, in the county of Providence and State of Rhode Island, have invented a new and useful Improvement in Induction Devices and Magnetic Circuits for the Same, of which the following is a specification.

My invention relates to induction devices such as induction coils, spark coils, transformers for electric distribution, telephony, radio communication, et cetera, solenoids and the like, and to magnetic circuits for the same; and the object of said invention is to provide a device of the character specified which shall have practically no external field, which may be readily ventilated or cooled by oil and the magnetic circuit of which shall have minimum reluctance, and otherwise to improve and simplify the construction of the same and increase the efficiency thereof in the manner hereinafter more fully set forth.

In the drawings which accompany and form a part of this specification—

Figure 1 is an elevation of a transformer embodying my invention which is particularly adapted for use in radio receiving systems;

Fig. 2 is a central longitudinal section of said transformer;

Figs. 3, 4 and 5 are transverse sections taken respectively on the lines 3—3, 4—4, 5—5 of Fig. 2;

Fig. 6 is a transverse section of a modification in which an auxiliary field is employed;

Fig. 7 is a transverse section of another modification in which the transformer windings are separated from each other and from the core to provide cooling passages;

Fig. 8 is a transverse section of a further modification in which a plurality of primary and secondary windings are employed, each primary being spaced apart from its secondary to provide a cooling passage.

Fig. 9 is a fragmentary plan view of the underside of the insulation cap.

In the particular drawings selected for more fully disclosing my invention 10 represents an axially-laminated core herein shown as consisting of a number of tubes each provided with a longitudinal slot 11. Preferably the core is formed by winding an iron ribbon on a mandrel and sawing said slot therethrough. It is to be understood however that said core is not necessarily tubular and may be formed of wire or plates of varying widths.

An axially-laminated field 12, herein shown as tubular and as slotted longitudinally at 13, encloses the core and is spaced therefrom.

The magnetic circuit is completed by the field caps 14, 15 which are laminated and slotted radially as shown at 16, 17, said caps magnetically connecting the ends of the field and core. In the present instance the inner faces of each of said field caps are cupped as indicated at 18, 18 for receiving the ends of the core. A casing 19 preferably of magnetic material encloses the field and rests on the base-plate 20, which likewise is of magnetic material. Disposed concentrically with the core and field are the primary and secondary windings 21, 22, respectively, the terminals 23, 23 of said windings passing through holes 24, 24 which preferably are eyeleted, in the upper field cap 14 and being connected to the bindingpost screws 25, 25 which pass through the insulation cap 26.

In order to prevent the turning of said screws and the twisting of the transformer lead-wires, the heads of said screws are poly-angular and the apertures in the insulation cap through which said screws pass, are countersunk poly-angularly to receive said heads, as indicated at 26′ (Fig. 9). The several parts may conveniently be assembled and held in position by the bolt 27 which passes through the base-plate, the core and the field caps, a nut 28 being threaded to said bolt to clamp the several parts of the magnetic circuit together, and then after the bindingpost screws have been soldered to the lead-wires and inserted through the insulation cap 26, the latter is clamped to the casing 19 by the nut 29 which is threaded to said bolt.

A lock-nut 30 may be employed and affords a convenient means for attaching a conductor for grounding the core as is sometimes desirable when the transformer is used as an audio-frequency amplifier in a radio-receiving set.

Preferably the outer tube of the field should be slightly longer than the core in order to provide a clearance space for the coil and prevent the crushing of the same when the nut 28 is tightened.

It will be understood that the slots 11, 13, 16 and 17 are not absolutely essential, but they are desirable for minimizing eddy currents.

The proportions of the magnetic circuit should be such that the cross-sectional area of the core 10 is substantially equal to the cross-sectional area of the field 12 and to the central cross-sectional area of each of the field caps 14, 15.

The magnetic circuit above described will prevent leakage of magnetic flux into the space surrounding the inductance device with which it is used,—in other words, the external field is practically nil which increases the efficiency of the device and prevents disturbances in adjacent instruments and circuits, a feature which is especially important in radio apparatus.

Heretofore it has been customary to provide a laminated magnetic circuit consisting of flat plates of the shape required to complete the circuit around the coils, and this results in producing a magnetic path in one plane only. When the primary is energized the resulting flux passes through the core and the tendency is to return by a radial path to the opposite end of the core. The reluctance of the iron field being of course very much less than that of the air, a single-plane core and field provides an unnatural path for the flux with consequent leakage into the space surrounding the transformer.

It is in part due to this fact that in radio-receiving apparatus only two stages of audio-frequency amplification can with advantage be used, and it is well known that the amplification obtained by audio-frequency transformers of the prior art varies materially with the frequencies of the currents employed. I have found, however, that by means of my improved construction the amplification obtained is much higher over a wider frequency band than with transformers having single-plane fields and cores, and furthermore that the almost entire absence of external field permits the use of four or even more stages of audio-frequency amplification without distortion.

I have discovered also that my improved magnetic circuit permits the use of a much higher ratio of transformation than heretofore found possible which augments the work done by each amplification stage.

Another advantage of my improved magnetic circuit is that the amplification obtained by means of the high ratio of transformation aforesaid is effective over a frequency band almost as wide as in the case of transformers having a much lower transformation ratio.

A further advantage of my construction is the reduced cost of the device resulting from the fact that the core of circular cross-section may be smaller in diameter than a square core, this resulting in coils of smaller diameter and less wire for a given effect.

The several parts of the magnetic circuit are clamped tightly together, thus eliminating mechanical vibration which in radio work causes undesirable noises, and is otherwise deleterious.

The fact that the surface of the round core 10 is close against the primary coil results in higher efficiency than where flat-plate lamination is used and the section of the core is rectangular, for such rectangular-sectioned core is commonly employed with a coil having a round central hole which results in energy losses.

In Fig. 6 an auxiliary axially-laminated tubular field 31 is interposed between the primary 21 and the secondary 22, said field preferably being slotted longitudinally as indicated at 32. In Fig. 8 the primary and secondary windings are each made in two sections, 21, 21′ being the sections of the primary, and 22, 22′ those of the secondary, and the auxiliary field 31 is interposed between two of the coils, herein shown as the secondary 22 and the primary 21′. In both cases the advantage is obtained that the magnetic flux is kept nearer the center and passes more uniformly through the secondaries.

In Fig. 7 the primary and secondary coils 21, 22 are spaced from each other, preferably by the tubes 33, 33 to provide the cooling passage 34 for ventilation or oil cooling, and the primary is spaced away from the core by the tube 35 to provide the cooling space 36. Obviously the core 10 may have one or more tubes omitted for the same purpose.

Ventilating passages 37, 38 are formed in the arrangement shown in Fig. 8 by spacing each primary from its secondary by means of the iron tubes 39, 39, 40, 40 which are longitudinally slotted at 41, 42, respectively. The constructions shown in Figs. 6, 7 and 8 are especially applicable to the distribution of power where iron losses are serious and exist constantly while the primaries are energized, even although there is no load on the secondary.

My improved magnetic circuit results in a smaller iron loss than the usual flat-plate circuit, as a much greater surface of iron can be placed in equivalent space. In large transformers used in electric distribution flux leakage causes variable voltage, and inasmuch as my improved magnetic circuit has practically no flux leakage even in large power or lighting transformers under all conditions of variable load, I am enabled to eliminate this difficulty.

Having thus described illustrative embodiments of my invention without however limiting the same thereto, what I claim and desire to secure by Letters Patent is:—

1. A magnetic circuit for an induction device comprising an axially-laminated tubular core, an axially-laminated tubular field enclosing said core and spaced therefrom, and laminated field caps magnetically connecting the ends of said core and field.

2. A magnetic circuit for an induction device comprising an axially-laminated longitudinally-slotted tubular core, an axially-laminated tubular field enclosing said core and spaced therefrom, and laminated field caps magnetically connecting the ends of said core and field.

3. A magnetic circuit for an induction device comprising an axially-laminated tubular core, an axially-laminated longitudinally-slotted tubular field enclosing said core and spaced therefrom, and laminated filed caps magnetically connecting the ends of said core and field.

4. A magnetic circuit for an induction device comprising an axially-laminated tubular core, an axially-laminated tubular field enclosing said core and spaced therefrom, and laminated radially-slotted field caps magnetically connecting the ends of said core and field.

5. A magnetic circuit for an induction device comprising an axially-laminated tubular core, an axially-laminated tubular field enclosing said core and spaced therefrom, an axially-laminated auxiliary tubular field concentric with and spaced from said core and field, and laminated field caps magnetically connecting the ends of said core, field and auxiliary field.

6. A magnetic circuit for an induction device comprising an axially-laminated tubular core, an axially-laminated tubular field enclosing said core and spaced therefrom, and axially-laminated longitudinally-slotted auxiliary tubular field concentric with and spaced from said core and field, and laminated field caps magnetically connecting the ends of said core, field and auxiliary field.

7. A transformer comprising an axially-laminated core, an axially-laminated field enclosing said core and spaced therefrom, laminated field caps magnetically connecting the ends of said core and field, and windings disposed concentrically with said core and field, said windings being spaced from each other to provide cooling passages.

8. A transformer comprising an axially-laminated core, an axially-laminated field enclosing said core and spaced therefrom, laminated field caps magnetically connecting the ends of said core and field, and windings disposed concentrically with said core and field, one of said windings being spaced from said core to provide cooling passages.

9. A transformer comprising an axially-laminated core, an axially-laminated field enclosing said core and spaced therefrom, laminated field caps magnetically connecting the ends of said core and field, a plurality of primary windings disposed concentrically with said core and field, a plurality of secondary windings disposed concentrically with said core and field, and an axially-laminated auxiliary field magnetically connected to said caps and interposed between two of said windings.

10. A transformer comprising an axially-laminated core, an axially-laminated field enclosing said core and spaced therefrom, laminated field caps magnetically connecting the ends of said core and field, and a plurality of pairs of primary and secondary windings disposed concentrically with said core and field, each primary winding being spaced from its secondary to provide a cooling passage.

11. A magnetic circuit for an induction device comprising an axially-laminated core, an axially-laminated field enclosing said core and spaced therefrom, and laminated field caps magnetically connecting the ends of said core and field, the cross-sectional area of said core being substantially equal to the cross-sectional area of said field and to the central cross-sectional area of each of said caps.

12. A magnetic circuit for an induction device comprising an axially-laminated tubular core, and laminated field caps magnetically connected to the ends of said core, the inner faces of each of said caps being cupped to receive the ends of said core.

13. A transformer comprising an axially-laminated core, an axially-laminated field enclosing said core and spaced therefrom, laminated field caps magnetically connecting the ends of said core and field, said core and caps each being provided with a central bore, a base-plate disposed on one of said caps, a bolt passing through said base-plate, core and caps, a nut threaded to the end of said bolt for binding the several parts together, a casing having one end resting on said base-plate and concentric with said field, an insulation cap resting on the other end of said casing, said cap being provided with a central bore for receiving said bolt, a nut threaded to the end of said bolt projecting through said insulation cap for binding said cap to said casing, windings disposed concentrically with said field and core, the terminals of said windings passing through apertures in the field cap adjacent to said insulation cap, and bindingposts passing through said insulation cap, the terminals of said windings being connected respectively to said bindingposts.

14. A transformer comprising a core, primary and secondary windings disposed concentrically with said core, a casing enclosing

said windings and core, an insulation cap disposed on one end of said casing, said insulation cap being provided with apertures countersunk poly-angularly for receiving bindingpost screws provided with polyangular heads conforming to the countersunk portions of said apertures, means connecting said screws respectively to the terminals of said windings, and bindingposts secured to the ends of said screws projecting beyond said insulation cap.

In testimony whereof, I have hereunto subscribed my name this 12th day of September, 1924.

JAMES A. DORAN.