

March 30 , 1926.

1,578,307

M. K. ZINN

INDUCTANCE COIL

Filed August 8, 1925

3 Sheets-Sheet 1

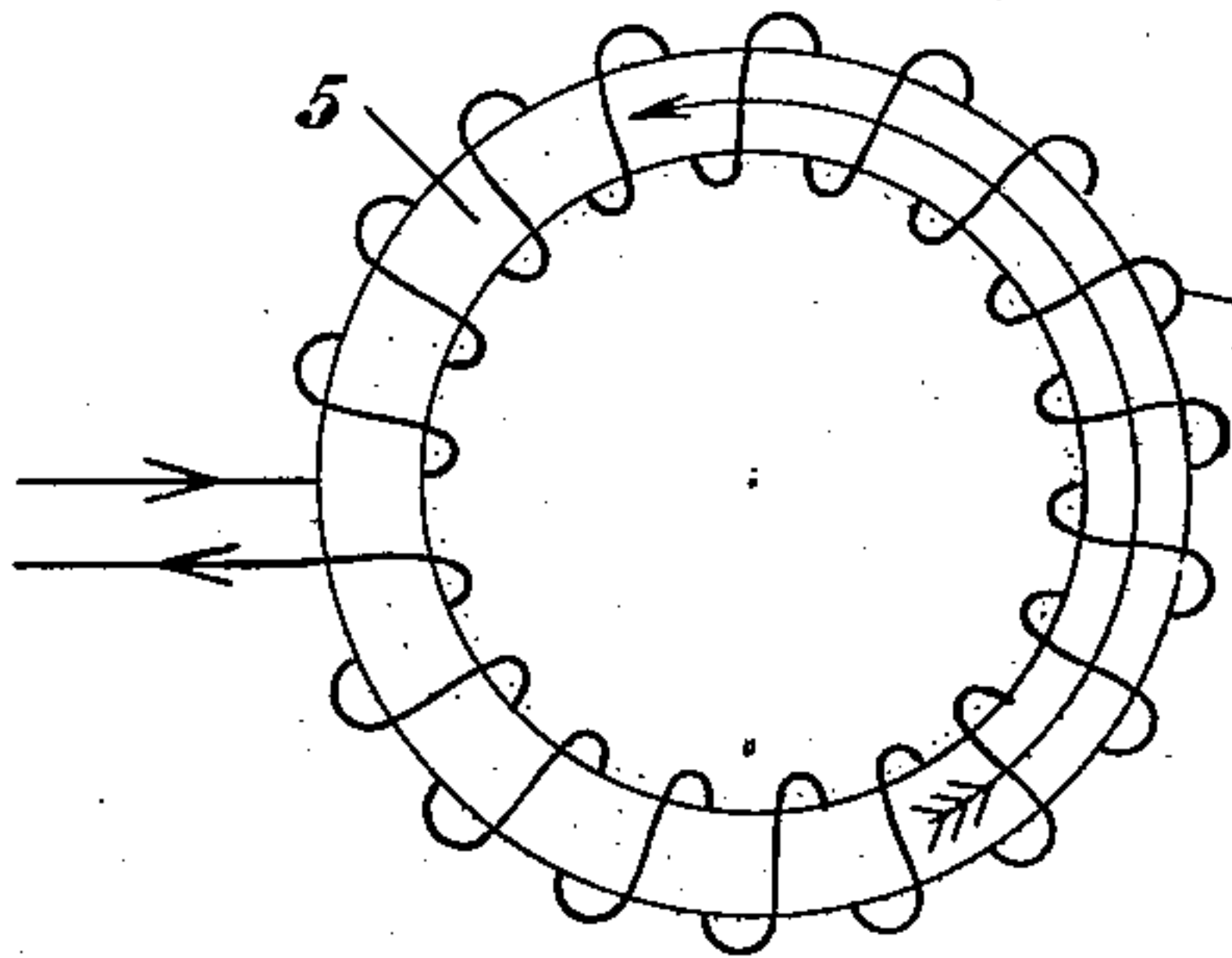


Fig. 1

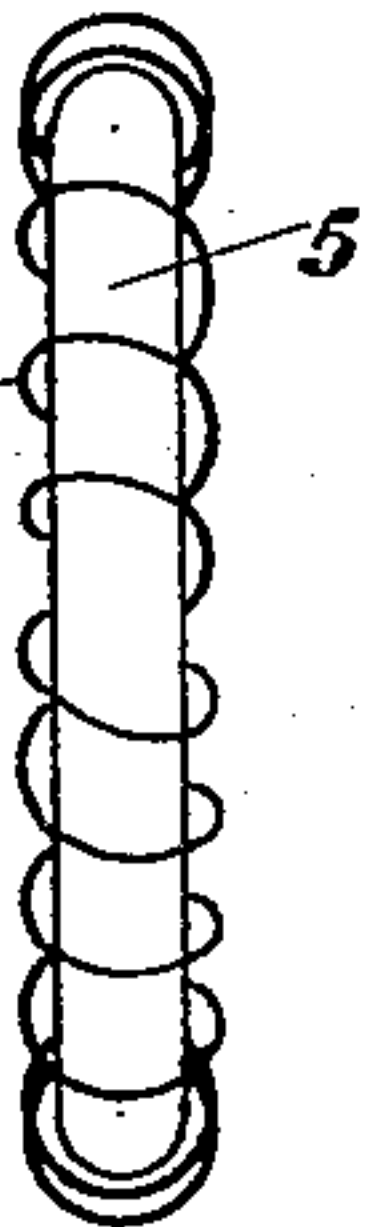


Fig. 2

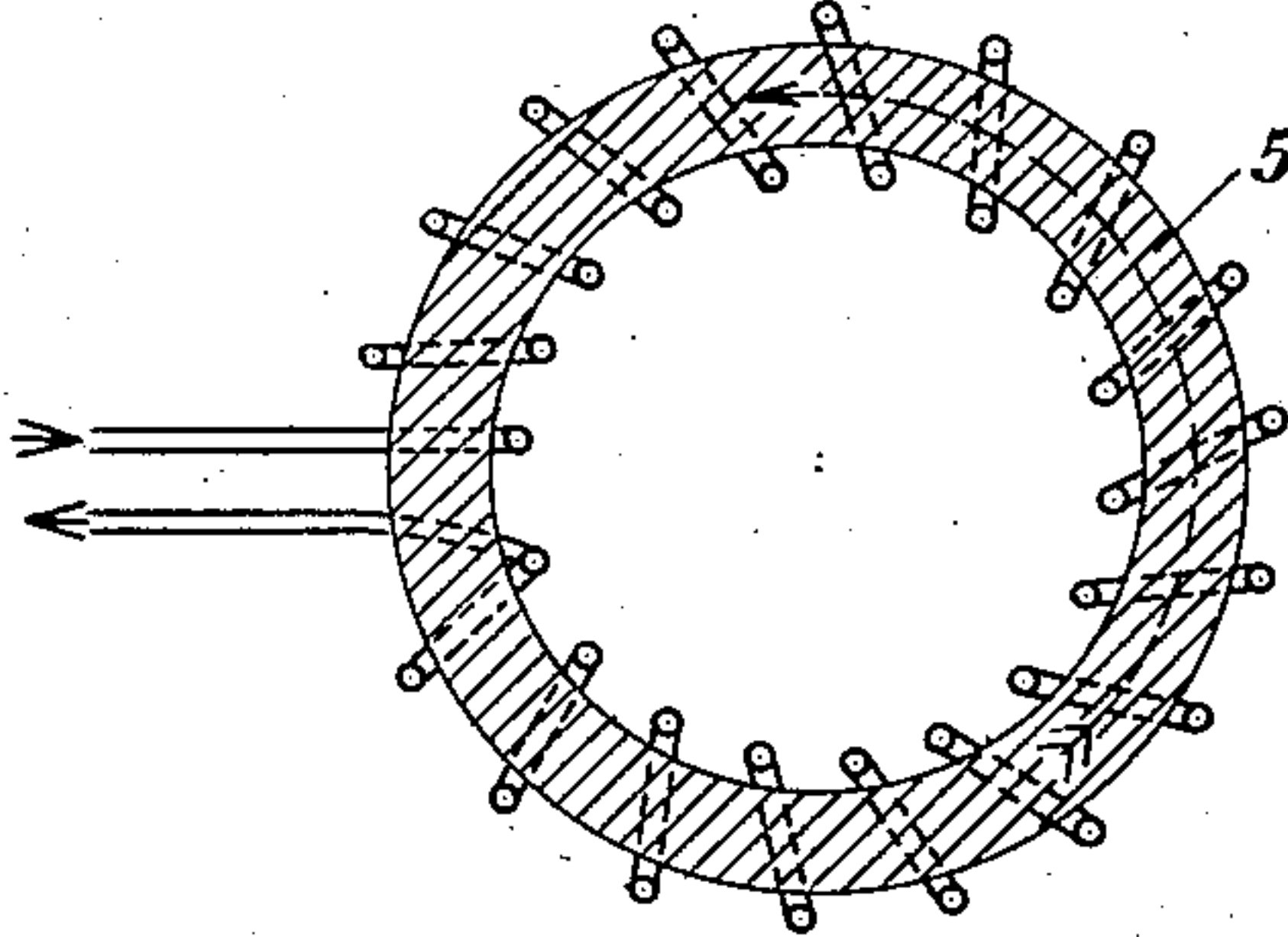


Fig. 3

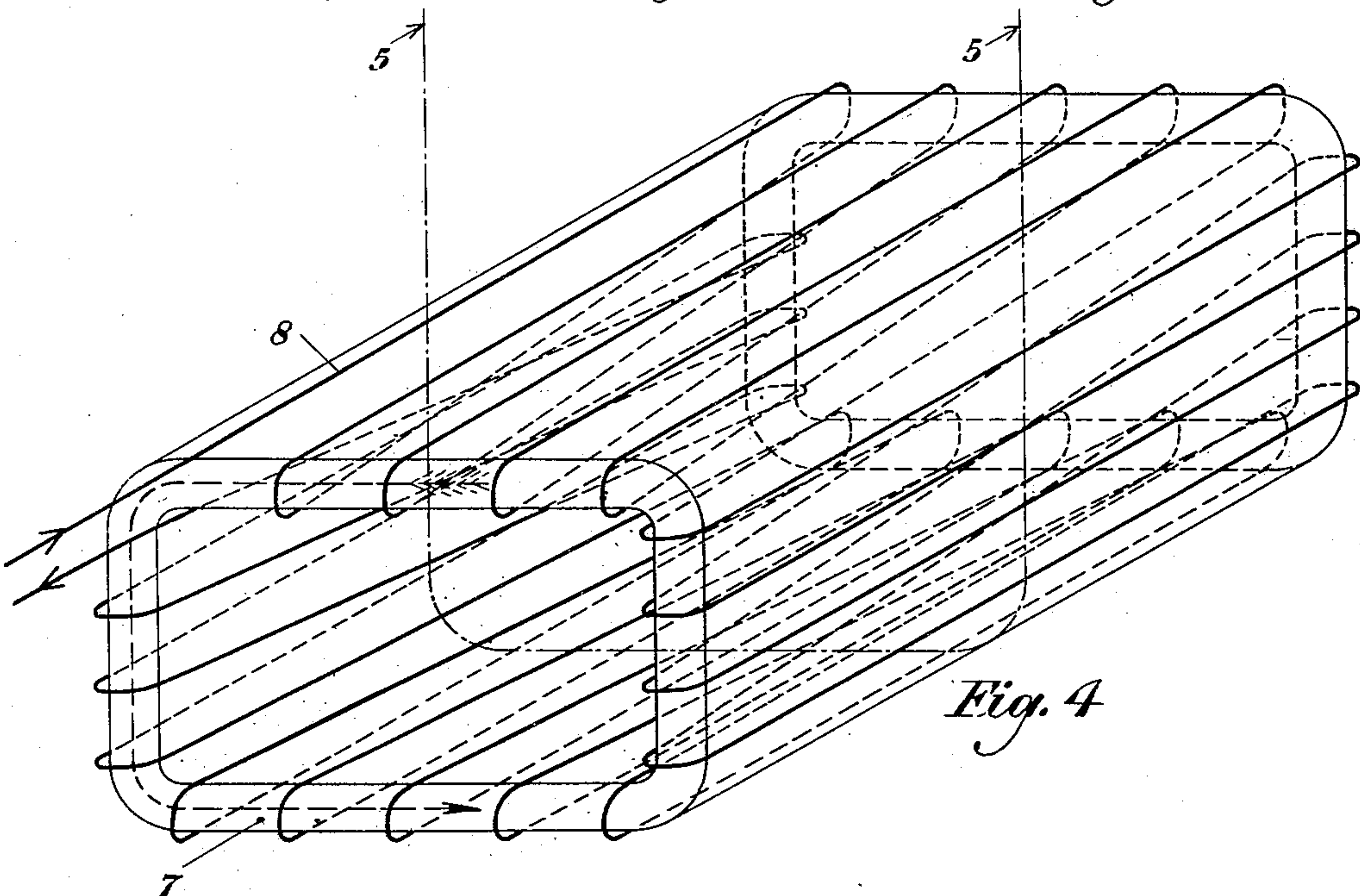


Fig. 4

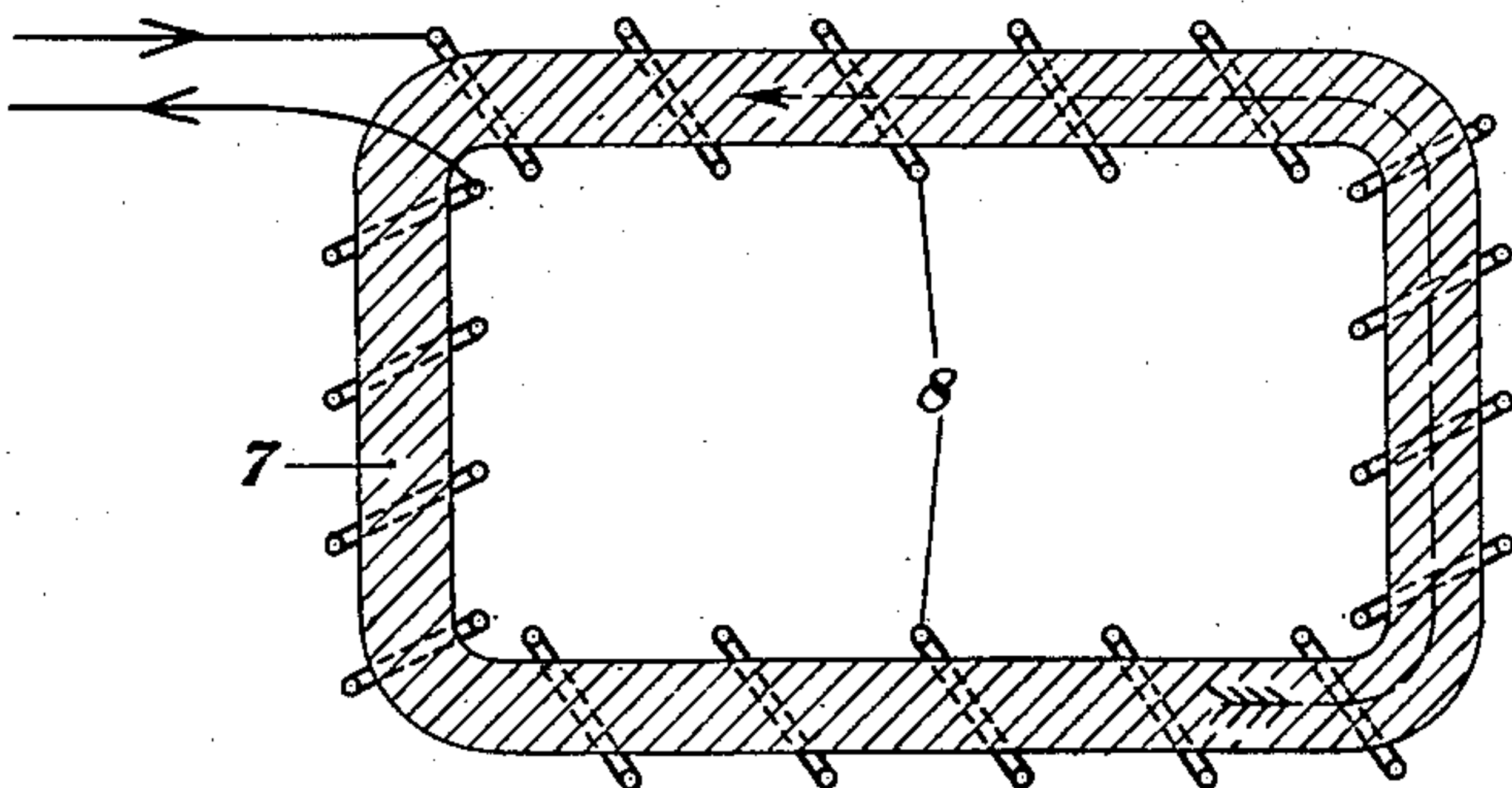


Fig. 5

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3 Sheets-Sheet 2

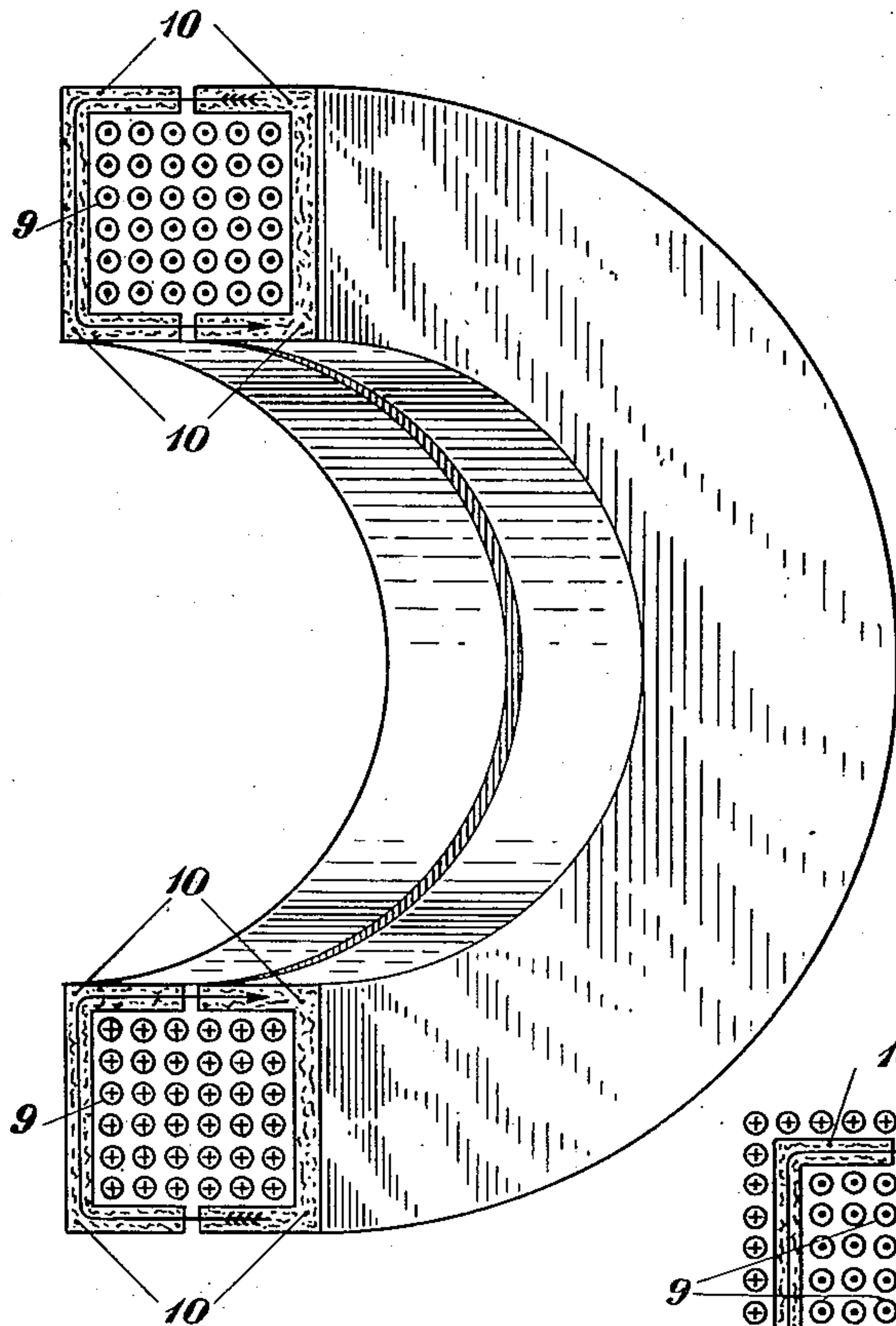


Fig. 6

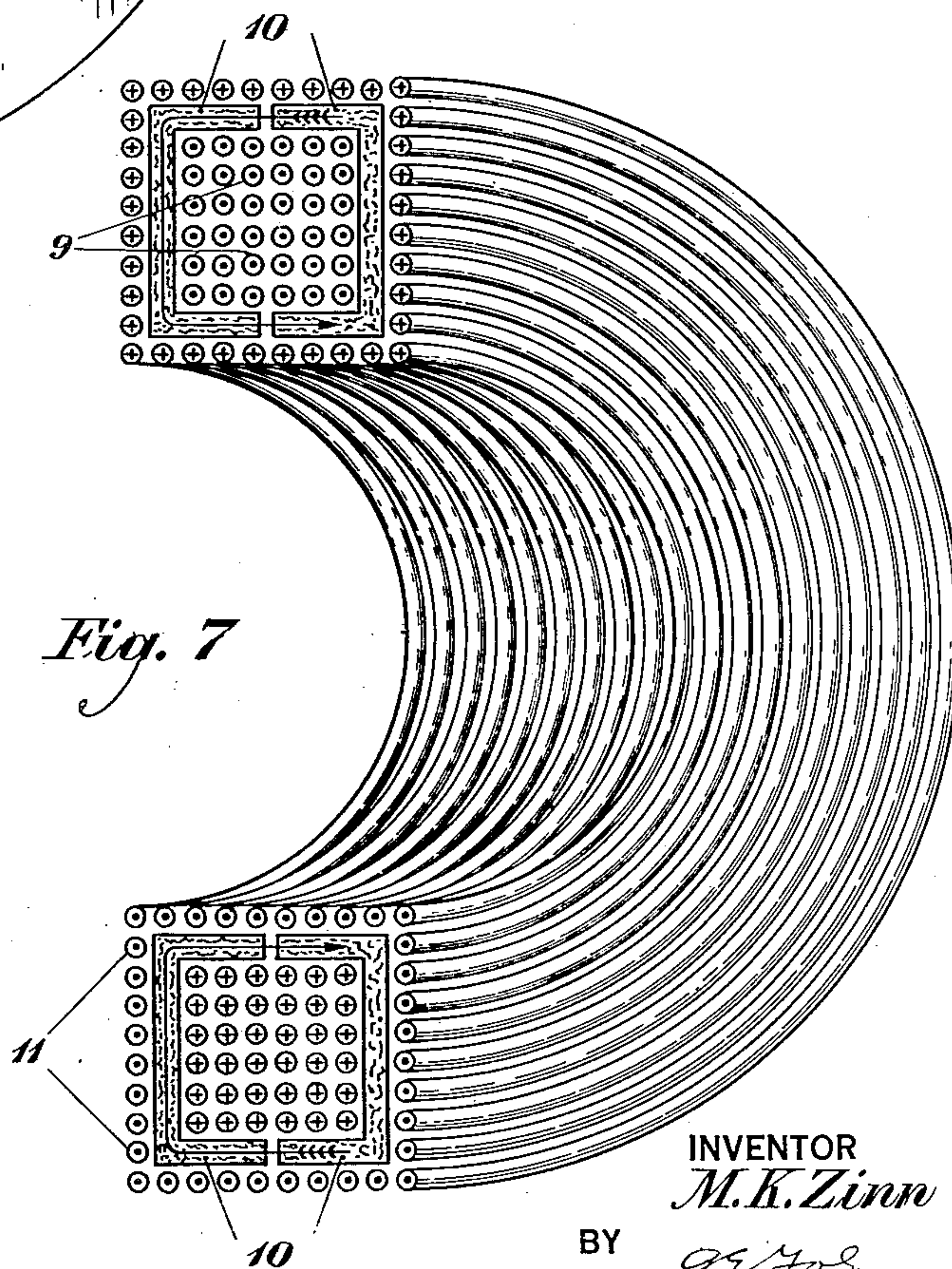


Fig. 7

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3 Sheets-Sheet 3

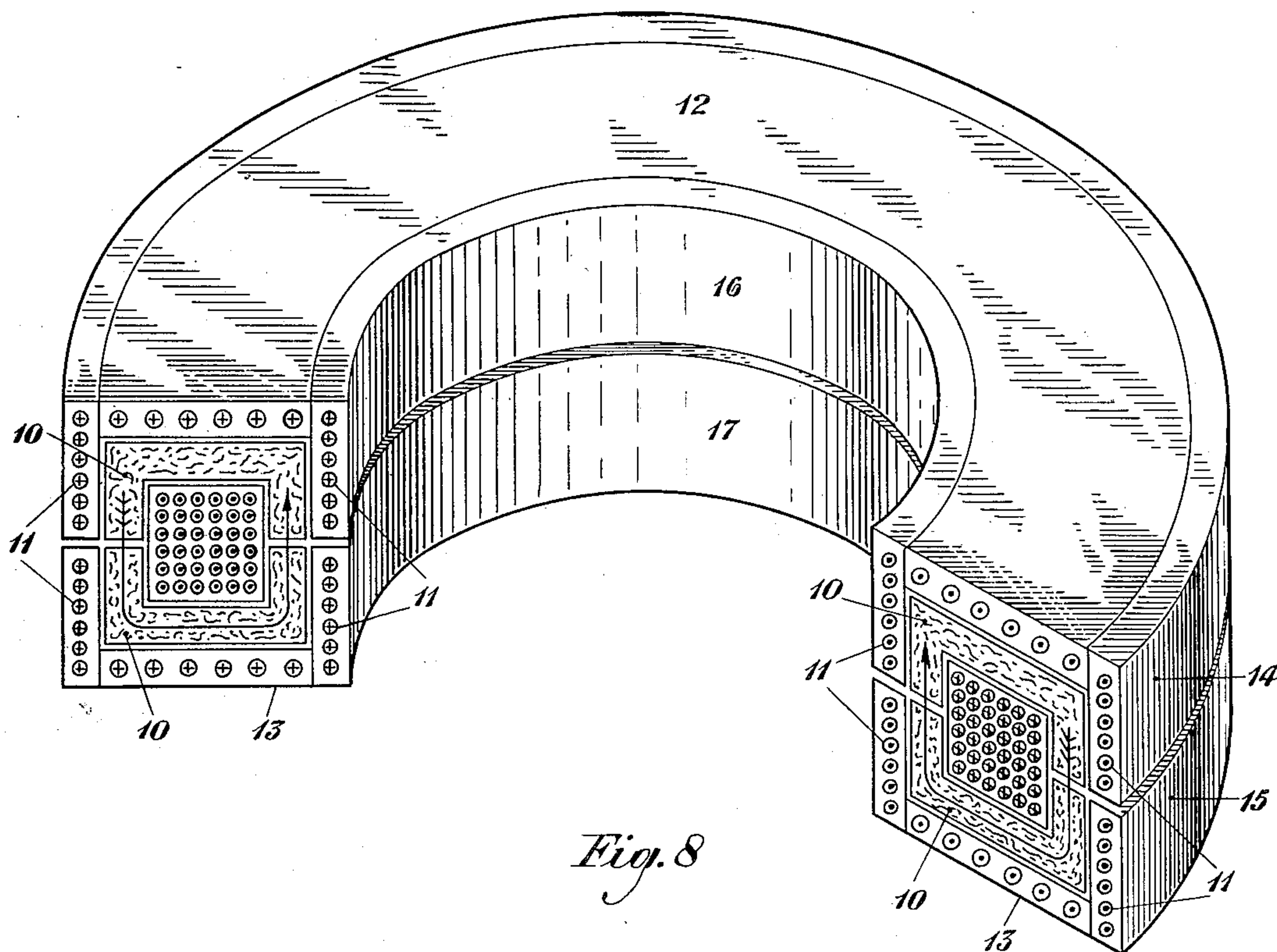


Fig. 8

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UNITED STATES PATENT OFFICE.

MANVEL K. ZINN, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

INDUCTANCE COIL.

Application filed August 8, 1925. Serial No. 49,127.

To all whom it may concern:

Be it known that I, MANVEL K. ZINN, a citizen of the United States, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Inductance Coils, of which the following is a specification.

This invention relates to inductance coils, and more particularly to inductance coils of a type adapted to be used as transformers, loading coils, or the like.

An object of the invention is to provide an inductance coil with a self-contained magnetic circuit so that the magnetic field created by the passage of electric current through the windings is entirely confined to the core and windings of the coil.

Another object consists in the provision of such a coil in an efficient and comparatively inexpensive manner.

These and further objects of the invention will be apparent from the following description, when considered in connection with the accompanying drawings.

Referring to the drawings, Figure 1 illustrates a schematic side view of a form of toroidal coil; Fig. 2 is an end view thereof; Fig. 3 is a sectional view of Fig. 1; Fig. 4 is a perspective view of a coil having its windings arranged longitudinally of the core; Fig. 5 is a sectional view of Fig. 4; Fig. 6 is a schematic view of a coil having its windings included within the core; Fig. 7 is a view similar to Fig. 6, showing windings inside and outside the core in accordance with the present invention; and Fig. 8 is a perspective view of a coil of the present invention with a cutaway portion illustrating the relation of the windings with respect to the core.

In Figs. 1, 2 and 3 of the drawings, the numeral 5 designates a toroidal core having windings 6 wound about it as illustrated. Current flowing through the windings in the manner indicated causes a magnetic field to be set up in the core in a direction indicated by the arrows, according to the usual convention.

If the winding is applied uniformly around the toroidal core, the magnetic field will be confined entirely within the core. This type of coil has been very extensively used for this reason, because it is in general important to eliminate stray magnetic fields,

which tend to have an objectionable influence upon neighboring coils and circuits.

From the standpoint of manufacturing convenience and economy, however, it is desirable to employ a coil structure such that it is not necessary to wrap the wire directly on to the core. It is preferable to be able to make up the windings separately, which is obviously impossible with the toroidal form of coil. To accomplish this end, it has been proposed to reverse the structural arrangement, so that the relative positions of the windings and the core are interchanged, the windings being then enclosed within the core. Such an arrangement is shown in Fig. 6. In Fig. 6, as well as in Figs. 7 and 8, which will be referred to later, the circles representing sections of the coils of wire have dots applied to them to indicate currents leaving the wire at the section points, and have plus marks applied to them for currents entering the wire at the section points.

In Fig. 6 the coil is shown as having inside windings 9 forming an annulus, about which a core 10 is provided. This structure is sometimes known as an ironclad coil. The mechanical structure of the core is not of material consequence, as far as the principle of electromagnetic structure is concerned, although it should be in the general form of a hollow annulus surrounding the toroidal coil of wire. Practically it may be made up of two mating annular members which are hollowed or grooved at their mating faces as indicated in Fig. 6, so that when juxtaposed the two parts of the annular core entirely surround the coil of wire.

In such a structure as this the current which flows circumferentially through the individual turns of the coil of wire produces a flux in the external magnetic material which passes through the annulus in the direction indicated by the arrow. It should be noted that the closed magnetic path for the lines of force is in a plane at right angles to the toroid instead of in the plane of the toroid. In the case of the ordinary toroidal coil the current flows in the plane at right angles to the toroid and the magnetic field is in the plane of the toroid.

In order that we may better understand the relation between a coil of the type of Fig. 6 and the ordinary toroidal coil, let us

assume that a coil is constructed as shown in Fig. 4. Here the core material is in a form equivalent to the toroidal form, but the toroid is, in effect, extended laterally so that the core is very wide as compared with the narrow core of Fig. 2. The wires if wrapped around the core of Fig. 4, in the same manner as they are wrapped around the core in Fig. 1, would produce a field passing in the direction indicated by the dotted arrow. In other words, if we take a section of Fig. 4, as indicated in Fig. 5, it will be seen that the field is completed in a plane at right angles to the long axis of the core. It is also apparent that this arises from the current flowing in a direction along the axis of the core.

If now we assume that the hollow core of Fig. 4 is extended, and the two ends are then brought together, we will have an arrangement which, so far as the direction of flow of current and the direction of the magnetic flux is concerned, is similar to that of Fig. 7. From this analogy, it will be apparent that the current flowing circumferentially of the windings in Fig. 7 will produce a flux in a plane at right angles thereto. This being especially clear when the condition at a section of the coil of Fig. 7 is compared with the section of Fig. 4 shown in Fig. 5.

In a coil such as shown in Fig. 6 is considerable leakage flux which would render it objectionable in many ways, chiefly because of its effect on adjacent coils in causing cross-talk. In order to obviate these difficulties, it is proposed in accordance with the present invention to construct the coil as shown in Fig. 7, in which the outside windings 11 are wound circumferentially about the core 10, and are conductively connected to the internal windings 9 in such relation as to annul the leakage field outside the core. The outer windings 11 in Fig. 8 may be made up in sections, in the present instance being shown as six in number so that they may be conveniently wound and mounted upon the external surface of the core material. The windings 11 surround and enclose the core 10, which comprises a pair of approximately U-shaped members oppositely positioned with respect to each other. Within the core 10 the individual coils of wire 9 are wound to form an annulus. The sections outside the core each contain a certain number of turns of wire, the aggregate number of turns of wire in all the sections corresponding to the number of turns of the individual coils 9 forming the annulus within the core 10. As illustrated, the top and bottom sections 12 and 13, respectively, of Fig. 8 are in the forms of pancakes or flat disks of wire, with the turns of wire arranged in the manner indicated, while in the side sections 14 and 15, and the inner sections 16 and 17 the wires are arranged in the

form of helical coils. When the sections are arranged in position it will be obvious that the outer layers of wire surrounding the core are so wrapped with respect thereto that the currents flowing in the individual turns of the wire flow circumferentially with respect to the annulus, and flow in the opposite direction to the currents in the turns of wire forming the inner annulus, so that the magnetic field produced by the currents forms a complete path about a transverse cross-section of the core.

With the present improved structure, it will be noted that the windings may be made up separately on forms, and assembled on the core, and the placing of the wires outside the core as illustrated and described will eliminate stray magnetic fields and prevent injurious effects, such as cross-talk, in adjacent coils. That the use of the outer layers of wire as in Figs. 7 and 8, will have the result of confining the flux within the toroid itself will be evident when a cross section of Fig. 7 is compared with the cross section of Fig. 4, illustrated in Fig. 5. It will be seen at once that the inner and outer turns of wire are disposed about a cross section of the core material in the same way in both cases, and in both cases the current on the outside of the core material flows in one direction, while that in the inside of the core material flows in the opposite direction.

What is claimed is:

1. A coiled bundle of wire forming an annulus in which electric currents in individual coils of wire flow circumferentially with respect to the annulus, a core comprising a casing of magnetic material in the general form of a hollow ring surrounding and enclosing the annular bundle of wire, and an outer layer of wires surrounding the core and so wrapped with respect thereto that the current flowing in the individual turns of the wire flows circumferentially with respect to the annulus.

2. A coiled bundle of wire forming an annulus in which electric currents in individual coils of wire flow circumferentially with respect to the annulus, a core comprising a casing of magnetic material in the general form of a hollow ring surrounding and enclosing the annular bundle of wire, and an outer layer of wires surrounding the core and so wrapped with respect thereto that the current flowing in the individual turns of the wire flows circumferentially with respect to the annulus, and flows in the opposite direction with respect to the current in the turns of wire forming the inner annulus.

3. A coiled bundle of wire forming an annulus in which electric currents in individual coils of wire flow circumferentially with respect to the annulus, a core comprising a casing of magnetic material in the gen-

eral form of a hollow ring surrounding and enclosing the annular bundle of wire, and an outer layer of wires surrounding the core and so wrapped with respect thereto that the current flowing in the individual turns of the wire flows circumferentially with respect to the annulus, whereby the magnetic field produced by the current forms a complete path about a transverse cross-section of the core.

4. A coiled bundle of wire forming an annulus in which electric currents in individual coils of wire flow circumferentially with respect to the annulus, a core comprising a casing of magnetic material in the general form of a hollow ring surrounding and enclosing the annular bundle of wire, and an outer layer of wires surrounding the core and so wrapped with respect thereto that the current flowing in the individual turns of the wire flows circumferentially with respect to the annulus, and flows in the opposite direction with respect to the turns of wire forming the inner annulus, whereby the magnetic field produced by the current forms a complete path about a transverse cross-section of the core.

5. A coiled bundle of wire forming an annulus in which electric currents in individual coils of wire flow circumferentially with respect to the annulus, a core comprising a casing of magnetic material surrounding and enclosing the annular bundle of wire, and an outer layer of wires surrounding the core and so wrapped with respect to the core that the current flowing in the individual turns of the wire flows circumferentially with respect to the annulus, said outer layer of wires having a number of turns about said core substantially equal to the number of said individual coils forming the annulus.

6. A coiled bundle of wire forming an annulus in which electric currents in individual coils of wire flow circumferentially with respect to the annulus, a core comprising a casing of magnetic material in the general form of a hollow ring surrounding and enclosing the annular bundle of wire, and an outer layer of wires surrounding the core with turns corresponding in number to the individual coils of wire about said annulus and being so wrapped with respect to the core that the current flowing in the individual turns of the wire flows circumferentially with respect to the annulus, and flows in the opposite direction with respect to the turns of wire forming the inner annulus.

7. A coiled bundle of wire forming an annulus in which electric currents in individual coils of wire flow circumferentially with respect to the annulus, a casing of magnetic material in the general form of a hol-

low ring surrounding and enclosing the annular bundle of wire, and an outer layer of wires surrounding the core with turns corresponding in number to the individual coils of wire about said annulus and being so wrapped in parallel relation with respect to the core that the current flowing in the individual turns of the wire flows circumferentially with respect to the annulus, whereby the magnetic field produced by the current forms a complete path about a transverse cross-section of the core.

8. A coiled bundle of wire forming an annulus in which electric currents in individual coils of wire flow circumferentially with respect to the annulus, a casing of magnetic material in the general form of a hollow ring surrounding and enclosing the annular bundle of wire, and an outer layer of wires divided into a plurality of sections surrounding the core with the total number of turns in all sections corresponding to the number of individual coils in said annulus and so wrapped with respect to the core that the current flowing in the individual turns of the wire flows circumferentially with respect to the annulus, and flows in the opposite direction with respect to the turns of wire forming the inner annulus, whereby the magnetic field produced by the current forms a complete path about a transverse cross-section of the core.

9. A coiled bundle of wire forming an annulus in which electric currents in individual coils of wire flow circumferentially with respect to the annulus, a core comprising a casing of magnetic material in the general form of a hollow ring surrounding and enclosing the annular bundle of wire, and an outer layer of wires surrounding the core and so wrapped with respect thereto that the current flowing in the individual turns by virtue of a conductive and inductive connection between the outer layer of wires and the inner coil of wires flows circumferentially with respect to the annulus.

10. An inductance coil having a closed core forming a chamber and two sets of copper windings, one set of said copper windings being placed in the chamber within the core and the other set being applied on the outside of the core in a direction parallel to the inner winding, said sets of windings being so proportioned and disposed in their electromagnetic relations to one another and to the common core to prevent an external magnetic field.

In testimony whereof, I have signed my name to this specification this 7th day of August, 1925.

MANVEL K. ZINN.