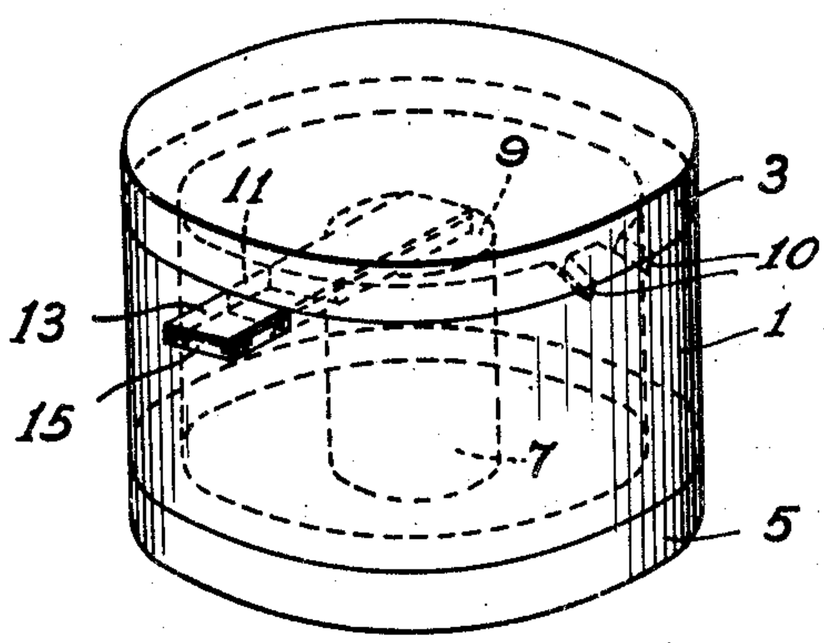
Oct. 4, 1949. J. J. C. HARDENBERG ET AL 2,483,900

COIL HAVING A FERRITE CORE

Filed March 25, 1947




Inventors
JAN JESAYAS CHRISTIAAN HARDENBERG
AND WILLEM SIX.

By Ellis B. Lemon
Attorney.

Patented Oct. 4, 1949

2,483,900

# UNITED STATES PATENT OFFICE

2,483,900

## COIL HAVING A FERRITE CORE

Jan Jesayas Christiaan Hardenberg and Willem Six, Eindhoven, Netherlands, assignors to Hartford National Bank and Trust Company, Hartford, Conn., as trustee

Application March 25, 1947, Serial No. 737,128
In the Netherlands April 13, 1946

3 Claims. (Cl. 171—242)

1

The invention relates to coils comprising a core with an air gap. The core consists of sintered ceramic ferro-magnetic material, for example of the kind known under the name "ferrite," one example thereof being described in French Patent 887,083. For the sake of simplicity the sintered ceramic ferromagnetic material constituting the core of a coil according to the invention will hereinafter always be referred to as "ferrite."

The core has the shape of a closed pot with a central rod, which pot consists of at least two portions. The term "coil" also includes a transformer.

A coil of the described type is particularly suitable for use in a filter. Owing to the presence of a ferrite core we obtain a quite satisfactory quality of the coil together with small dimensions. The closed construction is necessary in order to avoid leakage fields and coupling with other coils.

It is frequently necessary to adjust the self-induction exactly. In the case of cores in the shape of a closed pot this may generally be effected in various ways. For example, in the cover or in the core may be provided an auxiliary core adapted to be screwed-in from the outside. It has proved to be difficult to carry out this method in the case of ferrite since this material is unsuitable for being moulded with fine profiles, for example, a screw thread. The same disadvantage exists with another known method of adjustment wherein the cover of the pot is adapted to be screwed-in and out. A further method wherein the air gap is inclined or is suitably profiled so that upon rotation or displacement of the cover the air-gap is altered, has the disadvantage that after adjustment the cover still has to be immobilized. It has been found that in this case the inductance, especially when the coil is compounded, changes to such an extent that exact adjustment is not possible.

Furthermore, the possibility is imaginable that the pot-shaped core has the shape of the magnet pot of an electro-dynamic loudspeaker and that the (annular) air-gap is varied by sliding a ferromagnetic plate across it. This method has the disadvantage that the flux emerges to the outside so that undesired couplings may occur.

Various other methods may be imagined (copper in the air-gap; bending the cover) but they all have been found to cause unsurmountable disadvantages.

According to the invention the self-induction is varied by inserting iron into the air-gap. It is true that this method, which is known already for cores having not the shape of a pot, also

2

causes disadvantages in the case of coils of the type to which the invention relates, but it has been found that these disadvantages are not insurmountable. For example, one of these disadvantages is the inaccessibility of the air-gap. According to the invention, in the side-wall of the pot, about at the height of the air-gap formed by an interruption of the central rod, there is provided at least one aperture through which a regulating member constituted by an elongated and, at least partially, ferromagnetic body is passed as far as into the air-gap. Owing to this step not only access to the air-gap is obtained but also the great advantage that the coil portions can be definitely secured to one another and then, in the desired position of insertion, the regulating member can very easily be immobilized in the aperture, for example with the aid of lacquer, and subsequently any projecting part may be cut off. At the same time the problem of immobilizing the regulating member in such manner that no trouble is experienced from projecting parts is thus solved in a very simple manner. Since the magnetic main circuit is left unaffected, the immobilizing and cutting-off operations cause only negligible variations of the self-induction.

The presence of an aperture in the wall of the core is insofar disadvantageous that again some leakage may occur, but, owing to the absence of field concentration at the place of the aperture, this leakage has been found to be so small as to cause no disturbances.

In order to avoid technical difficulties in connection with the provision of the aperture, the core of the coil is preferably composed of a ring, two covers fitting thereon and a rod the length of which is smaller than that of the ring whilst in one of the edges of the ring at least one radial groove is provided. In general it will be possible to provide such a simple profile in the ferrite during the moulding of a ring; otherwise the aperture may be provided in a very simple manner by grinding.

The invention will be explained more fully with reference to the accompanying drawing which represents in perspective, by way of example, one embodiment thereof.

The coil shown in the drawing comprises a pot-shaped and practically completely closed core of ferrite which consists of an annular sheath having surface-ground edges, two likewise ground covers **3** and **5** fitting on the edges of the sheath and a central rod **7** coaxially arranged in the interior of the pot thus formed. The length of this rod is slightly smaller than the axial length of the ring

1 so that an air gap 9 is left between the rod 7 and the cover 3. For the sake of clearness, the winding of the coil which coaxially surrounds the rod in the usual manner is not shown.

The components 1 to 7 of the core are manufactured by pressing powdered ferrite in moulds and by sintering the parts thus formed. During the latter operation the various parts mostly curve slightly. This circumstance and the fact that the powder to be sintered does not "flow" when being moulded, render it almost impossible to produce fine and exact profiles such, for example, as a screw thread. This curving tendency makes it necessary to grind the faces to be applied to one another, during which operation at the same time a rough adjustment of the self-induction may be obtained by grinding-off the rod 7 to a greater or smaller extent. In addition to one or more small grooves 10 for the passage of connecting wires, a radial groove 11 is provided, during the moulding operation or by grinding, in the upper end of the ring 3 for the purpose of fine adjustment. A flat rod or strip 13 of ferromagnetic material, for example ferrite powder and a binder agent, which is preferably provided on a support of card-board 15 is passed through the said groove 11 as far as into the air gap 9. By inserting the rod or strip to a greater or smaller length it is possible to vary the self-induction. It is already sufficient if ferromagnetic material is provided on that end of the support 15 which is inserted in the gap.

After being assembled the coil is compounded, for example by immersion, with insulating material, the adjusting member 13—15 being previously replaced by a dummy of the same shape but of slightly larger dimensions. Then the coil is immobilised mechanically and electromagnetically, apart from the possibility of adjustment by means of the member 13, 15 which, after removal of the dummy is inserted into the air gap and is set tightly in the desired position of insertion, for example by means of lacquer provided in the aperture 11. Then any projecting part may be cut off without appreciable variation of the self-induction. Subsequently the whole of the coil may be compounded, for example in a container of tin plate, with insulating material having a melting point which is lower than that of the insulating material present in the interior of the pot-shaped core.

Different from the drawing it is possible to provide instead of one aperture 11 two diametrically opposite apertures 11, in which event the insulating rod 15 protrudes at both ends from the coil, the adjustment and the immobilisation of the adjusting member being thus slightly facilitated.

What we claim is:

1. In an inductance coil, a core having an air-gap therein comprising a hollow cylindrical body



enclosed at both ends and consisting of a sintered ceramic ferromagnetic material, a central member of sintered ceramic ferromagnetic material between the ends of said body and being provided with an air-gap therein, said body being provided with an aperture in the peripheral wall thereof which is aligned with said air-gap, and an adjustable member of ferromagnetic material extending through said aperture into said air-gap for altering the width thereof and thereby altering the self-induction of the coil.

2. In an inductance coil, a core having an air-gap therein comprising a hollow cylindrical body enclosed at both ends and consisting of sintered ceramic ferromagnetic material, a central cylindrical member of sintered ceramic ferromagnetic material supported by one end of said body and separated from the other end thereof by an air-gap, said body being provided with an aperture in the peripheral wall thereof which is aligned with said air-gap, and an adjustable member of insulating material provided with a layer of pulverulent ferromagnetic material extending through said aperture into said air-gap for altering the width thereof and thereby altering the self-induction of the coil.

3. In an inductance coil, a core having an air-gap therein comprising a tubular cylindrical body consisting of sintered ceramic ferromagnetic material, cover portions of sintered ceramic ferromagnetic material closing both ends of said tubular member, a central cylindrical member of sintered ceramic ferromagnetic material supported by one of said cover portions and spaced from said other cover portion by an air-gap, said tubular body having an aperture in the peripheral wall thereof aligned with said air-gap, and an adjustable ferromagnetic member extending through said aperture and extending into said air-gap for varying the width thereof and thereby altering the self-induction of said coil.

JAN JESAYAS CHRISTIAAN HARDENBERG.
WILLEM SIX.

**REFERENCES CITED**

The following references are of record in the file of this patent:

UNITED STATES PATENTS

| Number | Name | Date |
|---|---|---|
| 2,064,772 | Vogt | Dec. 15, 1936 |
| 2,220,126 | Six et al. | Nov. 5, 1940 |
| 2,317,724 | Bergtold | Apr. 27, 1943 |

FOREIGN PATENTS

| Number | Country | Date |
|---|---|---|
| 559,018 | Great Britain | Feb. 1, 1944 |