Aug. 7, 1945. H. J. McCREARY 2,381,763

INDUCTIVE DEVICE

Original Filed Dec. 31, 1940

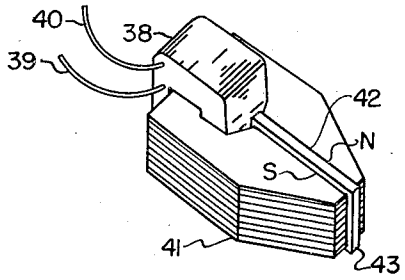

FIG. 1

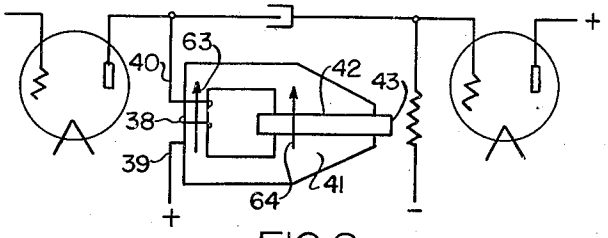

FIG. 2

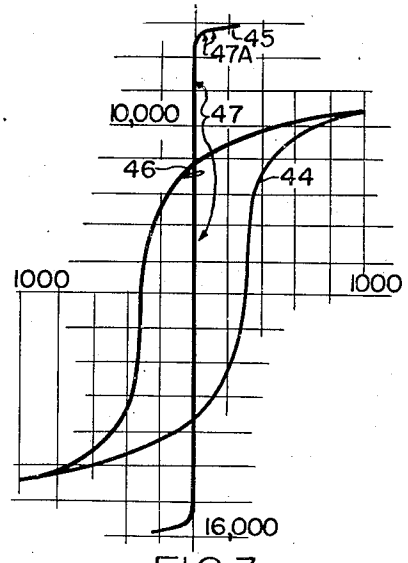

FIG. 3

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INDUCTIVE DEVICE

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Original application December 31, 1940, Serial No. 372,484. Divided and this application April 25, 1942, Serial No. 440,427

1 Claim. (Cl. 171—242)

This invention relates in general to an inductive device and more specifically to an inductance or transformer having a permanent magnet introduced into the fixed magnetic circuit thereof.

The primary object is to provide an inductive device having very low hysteresis loss by cutting down or practically eliminating the direct current magnetic flux in the magnetic core of the device. This is accomplished by introducing an inverse steady magneto motive force into the core comprising a properly poled permanent magnet.

Further features will be apparent from the follwing description and the accompanying drawing.

This application is a division of my prior application Serial No. 372,484, filed December 31, 1940, Patent Number 2,324,634.

Fig. 1 shows one embodiment of my invention consisting of a choke coil in which the constant flux caused in the core by the direct current flowing in the coil is not only reduced by means of an air gap in the core in the usual manner, but is further reduced and practically eliminated by the use of a permanent magnet consisting of a thin slice of "Alnico" or equivalent high coercive forc material in the air gap to provide an inverse magneto motive force.

Fig. 2 is a diagrammatic circuit showing one manner in which the device of Fig. 1 may be connected in circuit as an audio choke in an amplifier circuit.

Fig. 3 is a hysteresis curve of a material used in alternating magnetic fields and to the same scale, that of a permanent magnet material (40% cobalt).

Referring to Fig. 1, the audio choke shown comprises the choke coil **38**, having a large number of turns of wire through which the plate current may be supplied to a vacuum tube of an amplifier (see Fig. 2). The coil **38** has leads **39** and **40** and is mounted on a laminated core **41** of special design. The core as shown is widened in cross section at the air gap **42** so that the flux density and magneto motive force is correspondingly increased. In the gap **42** is placed a flat, solid or laminated "Alnico" magnet **43** which is permanently magnetized in a direction opposing the magneto motive force produced in the core **41** by the constant direct current flowing through the coil **38** to the plate of the tube. The reason for the shape of this design is shown by the curves of Fig. 3, in which **45** is the hysteresis curve for Alleghany electric metal and **44** is the hysteresis curve for 40% cobalt magnet steel. The loss in the silicon steel is very small as shown by the area of the curve **45**, likewise, due to the low alternating flux density and magneto motive force in the cobalt magnet steel the hysteresis loss is small as shown by the small loop **46**.

The principal gain of this device is the compensation for the D. C. flux as otherwise the operation of the choke would be over the small loop **47A** of a low apparent permeability whereas it now operates over a loop of apparently high permeability, as shown by **47** in Fig. 3.

Referring to Fig. 2 the choke coil **38** is shown connected in the plate battery feed of an amplifier circuit. The flux **63**, generated by the plate current flowing in coil **38**, is indicated by the arrow and is neutralized by the magneto motive force **64** which is generated by the permanent magnet **43** as shown by the arrow. Thus the direct current steady flux normally produced in core **41** is practically eliminated and the losses reduced to zero.

The hysteresis curve **44** of Fig. 3 for 40% cobalt magnet steel, is on the same scale as the curve **45** for Alleghany metal. It will be noted that curve **45** has practically zero area when compared to curved **44**. In all the embodiments of my invention, however, it will be noted that alternating magneto motive forces of very small values are used in the permanent magnet materials so that the permanent magnet materials are operated over very small loops such as **46** of Fig. 3 in all cases and the losses are therefore small.

I claim:

An inductive device, for use in an electrical circuit in which a direct current and a relatively small superimposed alternating current flows, comprising a laminated core of magnetic material having a high initial permeability and a low hysteresis loss, a winding on said core, the direct current component of a composite current flowing in said winding normally magnetizing said core to an extent such that its incremental permeability is low compared to its initial permeability, a narrow air gap in said core, said core having a much greater cross sectional area at said air gap than at all other points, a thin permanently magnetized element having a high coercive force, an inherently high hysteresis loss, and a higher reluctivity than the core material, inserted in and having substantially the same cross sectional area as said air gap, said element producing a magneto-motive force substantially equal and opposite to that produced in the core by the direct current component of the composite

current flowing in said winding to thereby bias said core into the region where its incremental permeability is high, the increased cross sectional area of said element and the adjacent portions of the core reducing the density of the alternating magnetic flux produced therein, by the relatively small alternating current component of the composite current flowing in said winding, as compared to the remainder of the core to thereby overcome the increased reluctance and the increased hysteresis loss of the composite core structure occasioned by the insertion of said element.

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