Aug. 15, 1961 G. S. DICKINSON 2,996,695

CONTROLLABLE INDUCTOR

Filed Dec. 6, 1955

FIG. 1.

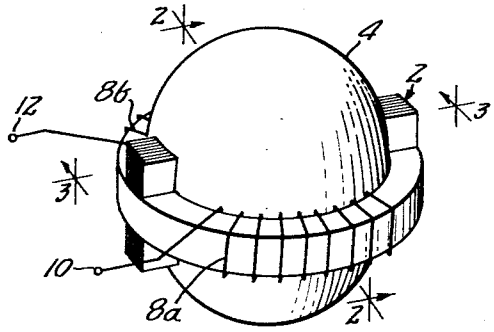


FIG. 2.

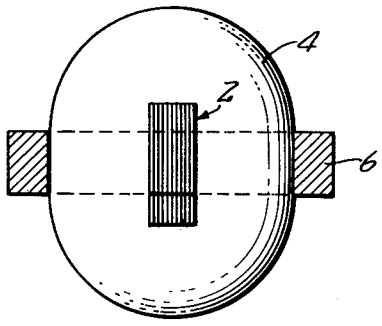


FIG. 3.

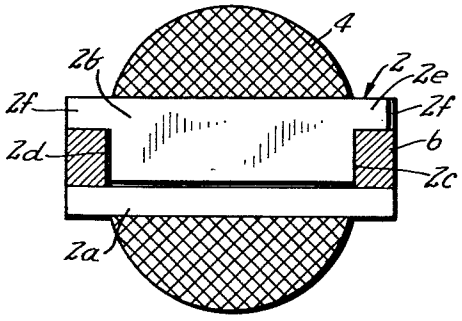


FIG. 4. FIG. 5.

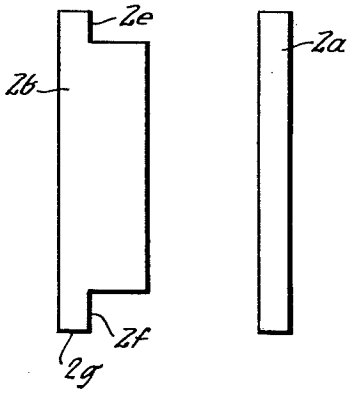
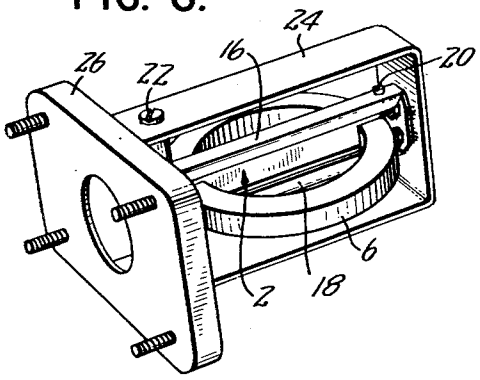


FIG. 6.



INVENTOR.
GEORGE S. DICKINSON

BY

Curtis, Morris & Safford

ATTORNEY

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CONTROLLABLE INDUCTOR

George S. Dickinson, Fairfield, Conn., assignor to C.G.S. Laboratories, Inc., Stamford, Conn., a corporation of Connecticut

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This invention relates to controllable inductors in which the inductance of a signal winding is varied by changing the degree of magnetic saturation of ferromagnetic cores by changing the magnitude of a direct current through a separate control winding.

The invention relates particularly to the configuration and arrangement of the various parts of the core structure by which an inductor is provided capable of controlling audio and radio frequency signals. The resulting unit is particularly advantageous in that it has low distributed capacity in the signal winding, minimum hysteresis characteristics, and low residual magnetism. The various features of the invention will be apparent from the following description of a controllable inductor embodying the invention considered in conjunction with the accompanying drawings, in which:

FIGURE 1 is a diagrammatic perspective view of a controllable inductor embodying the invention;

FIGURE 2 is a sectional view taken along line 2—2 of FIGURE 1;

FIGURE 3 is a sectional view taken along line 3—3 of FIGURE 1;

FIGURE 4 is a plan view of part of the laminated core;

FIGURE 5 is a plan view of the other part of the laminated core; and

FIGURE 6 is a perspective view of the inductor mounting bracket, the windings being omitted to simplify the illustration.

As shown in the drawing, the controllable inductor includes an H-shaped yoke generally indicated at 2, formed of soft iron laminations. A control winding 4 is positioned around this yoke 2 and is more or less in the shape of a ball so that the maximum number of turns can be positioned within a ring 6 formed of ferrite material. The winding 4 need not fill all of the space within the ring 6 and usually it is preferred to leave substantial space between the winding 4 and the ring 6. The ring 6 extends through the opposite end portions of the H-shaped yoke and carries a signal winding 8 which is wound in two parts, indicated respectively at 8*a* and 8*b*, and which are connected in series.

In use, the circuit to be controlled is connected to the leads 10 and 12 of the signal winding 8. A source of variable D.-C. current is connected to the control winding 4. With zero control current in the winding 4, the signal winding has maximum inductance. As the control current is increased, the ferrite core ring 6 becomes partially saturated with a corresponding decrease in the inductance of the signal winding 8. With complete saturation of the core ring 6, the signal winding reaches its minimum value of inductance.

The yoke 2 is formed of a first set of rectangular laminations indicated at 2*a*, and a second set of laminations indicated at 2*b*, which are provided with a step at each end. The shorter length dimension of these laminations 2*b* is arranged to be slightly less in length than the inside diameter of the core ring 6, and the longer dimension of the laminations 2*b* is equal to the length of the laminations 2*a*, which is in turn approximately equal to the outside diameter of the ring core 6.

In assembly of the unit, the control winding 4 is most conveniently wound on a conventional rectangular bobbin with the center portion of the winding bellied out so

as to fit nicely within the core ring 6. The laminations 2*b* are then placed within the bobbin of the control winding which is then positioned within the ring 6. The other set of laminations 2*a* is then pushed longitudinally through the remainder of the opening in the control winding bobbin to form the H-shaped yoke as illustrated in the drawing.

After assembly, the yoke 2 may be held in place merely by frictional contact with the inside of the control winding 4, but it is better to clamp it in place mechanically by any suitable means or by cementing it. In order to insure that firm contact is made between the yoke 2 and the inner surface of the ring 6, every other lamination of the set 2*b* is forced longitudinally in one direction and the intervening laminations are forced in the opposite direction. This is most readily accomplished by the unsymmetrical structure of the core laminations 2*b*. Thus, as indicated on a magnified scale in FIGURE 4, the dimension indicated at 2*e* is shorter than the dimension indicated at 2*f*. When the laminations are stacked, they are stacked in alternate direction; that is, with one of the extensions 2*e* adjacent the extension 2*f* of the next lamination. Therefore, when the unit is finally constructed, it is only necessary to apply compression to the end surfaces 2*g* of the laminations 2*b* to force them into engagement with the inner surface of the ferrite ring core 6. Thus, as shown in FIGURE 3, the right end 2*c* of each alternate lamination 2*b* is forced against the inner surface of the ring 6 and the opposite end 2*d* has a slight air gap, and, conversely, the left end 2*d* of each intervening lamination 2*b* is forced in the opposite direction against the inner surface of the ring 6.

FIGURE 6 shows one form of structure which can be used to support the inductor. Two channel members 16 and 18 of brass or other suitable material are positioned along opposite edges of the core 2 inside the control winding 4. These members are clamped together at one end by a screw 20 and at the other end by a screw 22 which extends also through the lower portion of a U-shaped bracket 24. The lower ends of the bracket 24 are soldered to a base 26. The upper ends of the channel members 16 and 18 are secured to the bracket 24 by soldering or other means.

It will be seen that in accordance with the invention, there is provided a controllable inductor that is small in size, and which can be fabricated economically, and which is well adapted to meet the ends and objectives hereinbefore set forth, and which can be modified in a variety of ways within the scope of the following claims.

What is claimed is:

1. A controllable inductor including a ring core of magnetically permeable and saturable material, and a generally H-shaped yoke of magnetically permeable material extending diametrically across from a first side of the ring core to a second side of the ring core opposite to said first side, the plane of the axes of the two parallel legs of the H-shaped yoke being generally perpendicular to the plane of the ring core and with the inner surface of said first side of the ring core lying within one of the recesses of said H-shaped yoke and with the inner surface of said second side of the ring core lying within the other recess of the H-shaped yoke, a control winding around both of said legs of said H-shaped yoke and being encompassed by said ring core, and a signal winding in two parts connected in series and wound around portions of said ring core which are on opposite sides of said H-shaped yoke.

2. A controllable inductor as claimed in claim 1 and wherein said generally H-shaped yoke is laminated, each lamination including a T-shaped part having a shank and two arms of unequal length extending from opposite sides of the shank near one end, said arms being aligned

one with the other and forming one leg of the generally H-shaped yoke and a straight part extending across the opposite end of the shank and parallel with the arms of the T-shaped part and forming the other leg of the yoke, the respective arms of the T-shaped part of at least one lamination being reversed in position with respect to the arms of the T-shaped part of another lamination, with opposite sides of the shanks of the respective reversed T-shaped parts being displaced towards the inner surface of the ring core at the respective first and second sides thereof.

3. A controllable inductor comprising a continuous ring of ferrite material forming a ring core, a yoke formed predominately of magnetically soft laminated material extending diametrically across the middle of said ring core from one side to the other, said yoke being generally H-shaped as seen looking parallel with the plane of said ring core, with the central body portion of said H-shaped yoke extending diametrically across within the interior of said ring core and with the legs of said H-shaped yoke overlapping opposite sides of the said ring core in straddling relationship, a control winding around said yoke and encompassed by said ring core, and a signal winding around said ring core outside of said control winding.

4. A controllable inductor comprising a closed loop of ferrite material forming a closed core, a laminated H-shaped yoke extending across the middle of said closed loop core from one side to the other thereof, the plane of said H-shaped yoke being perpendicular with the plane of said closed loop core, opposite sides of said closed loop core extending through the recesses at opposite ends of said H-shaped yoke and being straddled by the legs at opposite ends of said H-shaped yoke, said laminated H-shaped yoke including a plurality of laminations, each lamination of said plurality being formed in two parts, one of which is generally rectangular and forming one leg of the H-shaped yoke, and the other part being T-shaped, with the shank thereof forming the central body portion of the H-shaped yoke and with the two arms thereof forming the other leg of the H-shaped yoke.

5. A controllable inductor as claimed in claim 4 and wherein one arm extending from one side of each of said T-shaped lamination parts is longer than the opposite arm.

6. A controllable inductor as claimed in claim 5 and wherein certain of said T-shaped lamination parts are stacked in alternate directions and the respective edges of the shanks thereof adjacent to the shorter arms are pressed firmly against the interior surface of the closed core.

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