Oct. 23, 1962 C. G. SONTHEIMER 3,060,393

CONTROLLABLE INDUCTOR

Original Filed July 22, 1954

Fig. 1.

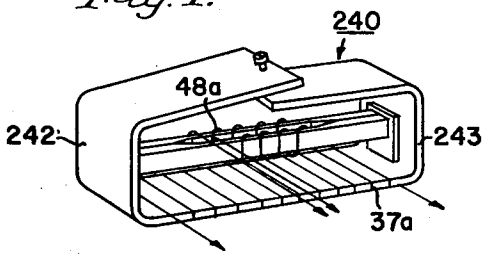
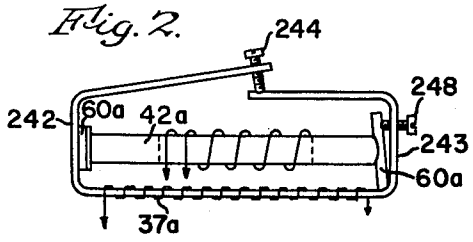


Fig. 2.



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3,060,393
CONTROLLABLE INDUCTOR

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Original application July 22, 1954, Ser. No. 445,146, now Patent No. 2,973,431, dated Feb. 28, 1961. Divided and this application Oct. 16, 1958, Ser. No. 771,935
6 Claims. (Cl. 336—20)

The present invention relates to controllable inductors including magnetically saturable material and in which the effective inductance of a signal winding is controlled by varying the relative magnetic saturation of the saturable material. In particular, this invention relates to controllable inductors including adjustment mechanism for adjusting their operating characteristics. This application is a division of application Serial No. 445,146, which issued as Patent No. 2,973,431.

The various aspects and advantages of the present invention will be apparent from the following description of a controllable inductor incorporating the invention considered in conjunction with the accompanying drawings, in which:

FIGURE 1 is a perspective view of an adjustable controllable inductor embodying the present invention, the control winding being indicated diagrammatically; and

FIGURE 2 is an elevational view of the inductor of FIGURE 1.

In FIGURES 1 and 2 an embodiment of a variable inductor **240** is shown. This variable inductor **240** may be used for various inductance control applications, for example, it may be used with two other similar controllable inductors (not shown) to provide the control circuits in a radio receiver, for example, as shown in U.S. Patent No. 2,973,431. The controllable inductor **240** has a control winding **37***a* which in operation is supplied with an electrical current which is controlled so as to provide the desired inductance control action, for example, the control winding **37***a* may be connected in series with the corresponding control windings (not shown) of the other two similar controllable inductors, mentioned above, as will be understood. This inductor **240** includes a signal core portion **42***a* comprising two elongated bars of ferrite or ferromagnetic ceramic placed longitudinally adjacent one another. This ferrite material may be similar to that disclosed by Snock in U.S. Patents Nos. 2,452,529; 2,452,530; and 2,452,531. A generally elongated hexagonal signal winding opening is formed by trapezoidal recesses in the adjoining sides of the two bars. The signal core portion **42***a* carries a signal winding **48***a* which is in two halves extending through the hexagonal opening and connected in series, so that their magnetic fields are in aiding relationship around the opening to induce flux flowing around this opening. Core **42***a* is bridged across between a pair of copper shimes **60***a* resting against the side legs **242–1** and **242–2** of a control core portion **52***a*. The control winding **37***a* is wound on the back part of the core **52***a*. The core **52***a* is made of a flexible magnetizable material, for example a strap of soft iron bent into a U shape to form the two side legs **242** and **243**, with the ends of the side legs being bent over again toward one another in a spaced overlapping relationship to form a magnetic path for the control flux between legs **242** and **243** in shunt with the path through the core **42***a*. An adjustment of the effective reluctance of this shunt path is provided by a large-headed machine screw **244** of non-magnetic material threaded through a hole in the outer end of the leg **242** and resting against the inner end of the leg **243**. By tightening it, this shunt reluctance is increased, so that for any given value of

the current in the control winding **37***a* the degree of magnetic saturation of the signal core portion **42***a* is increased lowering the effective inductance of the winding **48***a* thereon. In overall effect tightening the screw **244** is equivalent to adding some turns in the winding **37***a*.

When the three inductors similar to inductor **240** have their control windings connected in series there may be deviations of the controlled inductance values in the respective circuits being controlled thereby, so that due to individual differences they do not "track" properly. The shunt control flux path adjustment by the screw **244** enables compensations to be made for the individual deviations so that the inductance values are caused to "track" one another.

Another adjustment for tracking characteristics is provided by changing the reluctance in series with the control flux path through the core **42***a* with a non-magnetic machine screw **248** which serves to skew the right shim **60***a* to change the effective length of the reluctance region between the right end of the core **42***a* and the leg **243**. To facilitate the tilting of this shim, the end of the screw may be rounded to fit it into a socket in the shim. By adjusting the screws **244** and **248** all of the controllable inductors **240** used can be adjusted to "track" one another as desired.

Among the advantages of using separate controllable inductors instead of having them ganged upon a single control yoke is that each of them may then be located closely adjacent the portion of the receiver circuit desired, thus advantageously enabling the use of shorter interconnecting wires within the receiver.

The advantage of such arrangements will be understood both from the standpoint of convenience and utility as well as from the standpoint of ease of service and maintenance.

From the foregoing description it will be understood that the present invention provides an adjustable controllable inductor having many advantages as discussed above, and it is understood that the apparatus described can be adapted to a wide variety of different applications and that various changes or modifications may be made therein, each as may be best suited to the particular application desired and that the scope of the present invention is intended to include such modifications or adaptations, as defined by the following claims limited only by the prior art.

What is claimed is:

1. A controllable inductor comprising a U-shaped yoke of magnetically permeable material having two legs with a back portion therebetween, a magnetically saturable core portion bridged across from one leg of said yoke to the other leg, said magnetically saturable core portion having an opening therein, a pair of adjustable permeable elements spaced from each other and extending from the ends of the two legs of said yoke toward each other, a control winding on the back of said yoke, a signal winding on said magnetically saturable core portion, said signal winding being divided into two halves connected in series aiding relationship, each of said halves passing through said opening and around opposite sides of said magnetically saturable core portion, first adjustment means for regulating the spacing between said elements, and second adjustment means for changing the spacing between one of said legs and the magnetically saturable core portion.

2. A controllable inductor comprising a length of magnetically permeable material bent into a substantially closed loop with its ends closely spaced, a control winding on said loop at a position remote from said ends, a magnetically saturable core portion extending across said loop between regions on said loop spaced from said ends,

said magnetically saturable core portion having an elongated opening therein, a signal winding on said magnetically saturable core portion, said signal winding including two connected parts, each part passing through said elongated opening and surrounding the respective areas of said magnetically saturable core portion on opposite sides of said opening, a first adjustment screw of non-magnetic material extending between said ends for adjusting their spacing, and a second adjustment screw for changing the spacing between one of said regions on said loop and said magnetically saturable core portion.

3. A controllable inductor comprising a flexible C-shaped control yoke of magnetically permeable material having a pair of end portions in closely adjacent relationship, a control winding on said yoke, a signal core portion of magnetically saturable material having two ends, one of said ends being adjacent to one side of said C-shaped control yoke with the other end being adjacent to the other side of said C-shaped control yoke and said signal core portion being bridged across from said one side of the C-shaped yoke to the other, said signal core portion having an opening therein, a signal winding on said signal core portion, said signal winding including two winding parts each passing through said opening and around opposite edges of said signal core portion, said two winding parts being connected in series aiding relationship with respect to magnetic flux in said signal core portion and surrounding said opening, and adjustment means for adjusting the spacing between the end portions of said yoke.

4. A controllable inductor comprising a flexible control yoke of magnetically permeable material having a pair of end portions in overlapping adjacent relationship, a control winding on said yoke, a signal core portion of magnetically saturable material having two ends, one of said ends being adjacent to one side of said control yoke with the other end being adjacent to the other side of said control yoke with the body of said signal core portion being bridged across from said one side of the yoke to the other, said signal core portion having an opening therein, a signal winding on said signal core portion, said signal winding including two winding parts each

passing through said opening and around opposite edges of said signal core portion, said two winding parts being connected in series aiding relationship with respect to magnetic flux in said signal core portion and surrounding said opening, and adjustment means for adjusting the spacing between the overlapping end portions of said yoke by deflecting the end portions of said control yoke apart.

5. A controllable inductor comprising a control yoke of magnetically permeable material, a control winding on said yoke, a signal core portion of magnetically saturable material having two ends, one of said ends being adjacent to one area of said control yoke with the other end being adjacent to another area of said control yoke with said signal core portion extending between said areas of the yoke, said signal core portion having an opening therein, a signal winding on said signal core portion, said signal winding including two winding parts each passing through said opening and around opposite edges of said signal core portion, said two winding parts being connected in series aiding relationship with respect to magnetic flux in said signal core portion and surrounding said opening, a non-magnetic spacing element between one end of said signal core portion and the adjacent area of the control yoke, and an adjusting mechanism for skewing said spacing element, thereby to change the effective length of the reluctance region between said end of the signal core portion and the control yoke.

6. A controllable inductor as claimed in claim 5 and wherein said adjusting mechanism is an adjusting screw which tilts said non-magnetic spacing element.

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