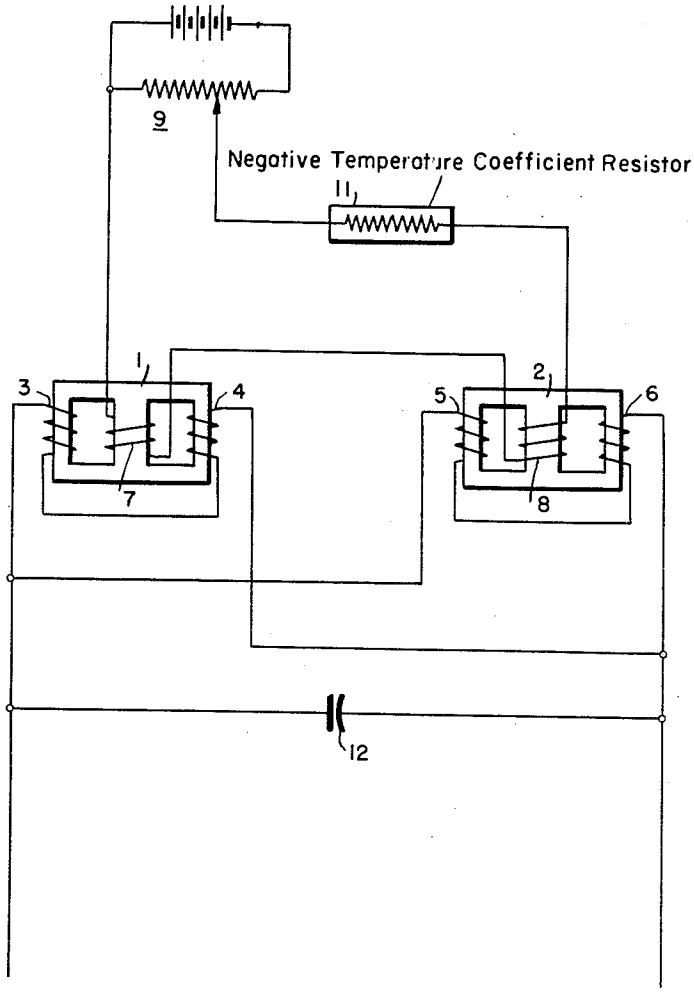
Oct. 30, 1956 A. F. PRUITT 2,769,092

TEMPERATURE-COMPENSATED INDUCTOR

Filed Oct. 28, 1952



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United States Patent Office 2,769,092 Patented Oct. 30, 1956

2,769,092

TEMPERATURE-COMPENSATED INDUCTOR

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Application October 28, 1952, Serial No. 317,186

4 Claims. (Cl. 250—40)

My invention relates to inductors and in particular relates to arrangements for imparting to inductors a desired characteristic relating their inductance to temperature. An important particular case of such relationship is the maintenance of substantial constancy of the natural period of vibration of an oscillatory circuit in the face of variations in its ambient or operating temperature.

For a number of uses, of which the frequency-fixing circuit of an electronic oscillator may be cited as typical, it is desirable to have resonant circuits made up of a capacitor and an inductor of such types that the product of their capacitance C and inductance is invariable with temperature. However, in capacitors and inductors of the commonly used types, both C and L increase with temperature. In the case of circuits operating at frequencies of the broadcast order or higher, it has usually been considered more desirable to provide automatic means which decrease C with temperature rise in the proper degree to keep the product LC constant. However, in the case of low frequency circuits, the product LC must be large, and it would be uneconomical to compensate for temperature changes by means of a temperature-variable capacitor.

One object of my invention is accordingly to provide a temperature-variable inductor of a new and improved type.

Another object is to provide an inductor having a negative temperature coefficient of inductance.

Another object is to prvoide an arrangement particularly applicable to inductors of relatively large size for causing the inductance to vary with temperature in a predetermined way.

Still another object is to provide an inductor arrangement in which the net inductance can be given either a positive or negative temperature coefficient as desired by placing an auxiliary resistor of proper characteristics in a portion of the circuit.

Other objects of my invention will become apparent on reading the following description taken in connection with the drawings, in which the single figure is a schematic diagram of an inductor arrangement embodying the principles of my invention.

Referring in detail to the drawings, my inductor arrangement comprises two shell-type magnetic cores **1** and **2**, having series-connected alternating current windings **3**, **4** and **5**, **6** on their outside legs, and having direct current windings **7**, **8** on their middle legs. The respective inductors are preferably each as symmetrical as possible about a central axis, and are also preferably as nearly identical as possible.

The windings **3** and **4** are connected with their magnetomotive forces aiding each other to cause magnetic flux to flow in opposite directions through the middle leg of the core; and the windings **5** and **6** are similarly poled on their core **2**. If the core **1** and windings **3**, **4** were absolutely symmetrical about the central axis of core **1**, the magnetic potential difference between the ends of its middle leg would be zero, and no flux would flow through that leg. However, since such absolute symmetry is, of course, impossible, a slight remnant flux will flow in the mid-leg and will induce an A. C. voltage in winding **7**. Similarly, a small voltage will be induced in winding **8** on core **2**. The windings **7** and **8** are accordingly connected so that these A. C. voltages oppose each other.

The windings **7** and **8** are connected to a variable source of direct current voltage **9** through a resistor **11**. By varying the value of the direct current flowing through windings **7** and **8**, the magnetic saturation and mean permeability of the cores **1** and **2** may be varied at will over a wide range, thereby controlling the inductance of the A. C. windings **3**, **4** and **5**, **6**. A capacitor **12** connected across the terminals of these windings forms with them a resonant circuit which may be used for any of a number of well-known purposes, for instance, as the tank circuit of an oscillator.

The windings **3**, **4**, **5**, **6** would, in themselves, have a positive temperature-coefficient. To eliminate this temperature coefficient the resistor **11** may have a negative temperature-coefficient, such resistors being readily purchasable on the market; for example the Thermistor sold by the Western Electric Co. In many cases, it will be desirable to position the resistor **11** in good thermal contact with one of the inductors. Any rise in temperature of the inductors will then cause a decrease in resistance **11**, with a consequent rise of direct current through windings **7**, **8** and a decrease of permeability of cores **1** and **2**. Such a decrease in permeability results in a decrease of self-inductance of the A. C. windings **3**, **4**, **5**, **6**. By properly proportioning the value of resistor **11** to the rest of its circuit in ways readily apparent to those skilled in the electric art, this action of temperature-rise on resistor **11** can be made to exactly compensate the positive temperature-coefficient effect on these A. C. windings so that temperature-change will not alter the inductance of the A. C. windings.

However, where the A. C. windings and capacitor **12** form a resonant circuit, it will usually be desired to have the product LC stay constant in the face of temperature changes. As previously stated, the capacitance C of capacitor **12** usually increases with temperature, and to keep the product LC constant the inductance L of the A. C. windings must actually decrease. In such cases the value of resistor **11** would be proportioned to produce the same percentage decrease of inductance L with temperature rise as the percentage increase of capacitance C.

In general, my invention is applicable where, for any reason whatever, a certain percentage change in an inductor with temperature is desired. Where for any purpose it may be desired to increase the inherent positive temperature-coefficient of an inductance, a resistor with a large positive temperature-coefficient may replace resistor **11** herein and by properly proportioning, be made to yield an inductance with a positive temperature-coefficient of the desired magnitude.

While I have described an inductor arrangement comprising two units connected so that the voltages generated by the A. C. windings in their respective direct current windings oppose each other, such voltages are themselves very small since the alternating current windings are designed to make the alternating magnetic flux they induce in the middle leg of the core as near zero as is practicable, and for certain uses this middle leg flux is so close to zero that the voltage it induces in the direct-current winding is of negligible importance. Under such circumstances, the second core and its windings may be omitted from the system.

While I have shown my invention in only one form, it will be obvious to those skilled in the art that it is not

so limited, but is susceptible of various changes and modifications without departing from the spirit thereof.

I claim as my invention.

1. In combination, a pair of shell-type magnetic cores, each having a control winding on its middle leg and a pair of main windings on its outer legs so poled as to produce oppositely-directed fields in said middle leg, a source of direct current and a negative-temperature coefficient resistor sensitive to ambient temperature variations in series with said control windings, said control windings being respectively poled so that any alternating voltages induced in them by alternating currents in said main windings oppose each other in the direct current circuit, and a capacitance which increases in value with rise of temperature connected across said main windings to form a tunable L—C network with the main windings.

2. In combination, a shell-type magnetic core having a control winding on its middle leg and a pair of main windings on its outer legs so poled as to produce oppositely directed fields in said middle leg, a source of direct current and a negative-temperature coefficient resistor sensitive to ambient temperature variations in series with said control winding, said resistor being in thermal contact with at least one of said windings, and a capacitance which increases in value with a rise in temperature connected across said main windings to form a tunable L—C network with the main windings.

3. In combination, a pair of shell-type magnetic cores, each having a control winding on its middle leg and a pair of main windings on its outer legs so poled as to produce oppositely-directed fields in said middle leg, a source of direct current and a high-temperature coefficient resistor sensitive to ambient temperature variations in series with said control windings, and a capacitance having a temperature coefficient of a type opposite to said high-temperature-coefficient connected across said main windings to form a tunable L—C network with the main windings.

4. In combination, a shell-type magnetic core having a control winding on its middle leg and a pair of main windings on its outer legs so poled as to produce oppositely directed fields in said middle leg, a source of direct current and a high-temperature coefficient resistor sensitive to ambient temperature variations in series with said control winding, said resistor being in thermal contact with at least one of said windings, and a capacitance having a temperature coefficient of the type opposite to said high temperature-coefficient connected in shunt with said main windings to form a tunable L—C network with the main windings.

References Cited in the file of this patent

UNITED STATES PATENTS

1,986,112	Logan	Jan. 1, 1935
2,200,263	Kramolin	May 14, 1940
2,406,804	Chatterjea et al.	Sept. 3, 1946
2,423,114	Potter	July 1, 1947
2,473,617	Stiefel	June 21, 1949
2,529,450	Hornfeck	Nov. 7, 1950