Feb. 21, 1939. P. J. SCHWARZHAUPT 2,148,306

TEMPERATURE COMPENSATED INDUCTANCE COIL

Original Filed July 23, 1935

Fig. 1.

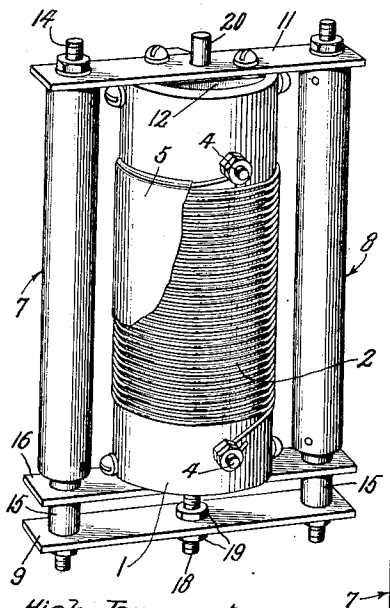
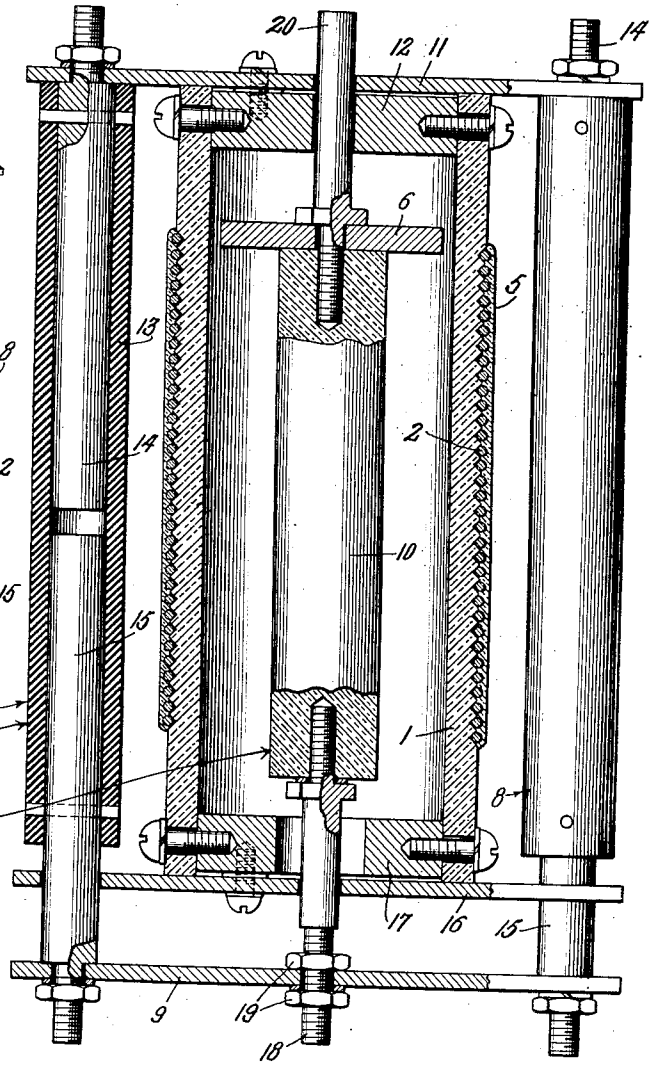


Fig. 2.



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Patented Feb. 21, 1939

2,148,306

UNITED STATES PATENT OFFICE

2,148,306

TEMPERATURE COMPENSATED INDUCTANCE COIL

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Application July 23, 1935, Serial No. 32,715
Renewed August 19, 1938

9 Claims. (Cl. 171—242)

My invention relates to inductance coils, and more particularly to inductance coils of the type including compensating means for maintaining the inductance substantially constant irrespective of temperature variations.

It is an object of my invention to provide an improved temperature compensating means for an inductance coil which is of simple and economical construction, and which is positive and reliable in its operation to effect the desired temperature-reactance compensation.

More specifically, it is an object of my invention to provide compensating means of the above type which includes a closed circuited conductor inductively coupled to the turns of a coil to be compensated, and a temperature responsive mechanism for moving the closed circuited conductor to effect the desired compensation.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation may best be understood by reference to the following specification taken in connection with the accompanying drawing in which Fig. 1 is a perspective view partially in section illustrating my invention; and Fig. 2 is a view partially in section showing the details of the temperature compensating mechanism.

Referring to Fig. 1 of the drawing, I have shown a temperature compensated inductance coil of improved construction which includes temperature compensating means constructed in accordance with my invention. The inductance coil comprises a hollow conductor supporting member 1 which supports the turns 2 of the coil in evenly spaced apart positions by means of circumferentially extending grooves cut in the member 1. The ends of the coil are secured to the binding posts 4 which form the terminals for connecting the coil to a utilizing circuit (not shown).

In the construction of the inductance coil described above, one end of the conductor from which the turns 2 are formed is secured to one of the binding posts 4 and the conductor is then wound under tension around the circumference of the member 1, the conductor being guided during the winding operation so that it falls in the spaced apart grooves in the member 1. When the last turn is in place the end of the conductor, still under tension, is wrapped around the remaining binding post 4, is securely fixed to the binding post and the excess of the conductor is clipped adjacent the post. Preferably the ends of the coil are secured to the posts 4 by brazing, although any other method capable of forming an integral union which will withstand high temperature may be employed.

Following the assembly of the coil in the manner as described above the turns thereof are secured to the body 1 by embedding the same in a layer 5 of enamel or other suitable material as shown in detail in Fig. 2. This may be accomplished by spraying the coil with vitreous enamel and baking the coil until the enamel is hardened.

The purpose of winding the turns of the coil tightly about the supporting member in a manner such that all of the turns are maintained under even tension, and imbedding the turns of the coil in the vitreous enamel layer, is to decrease the susceptibility of the coil to changes in inductance caused by changes in the physical dimensions thereof resulting from temperature variations. It will be seen that since all portions of the coil are substantially integrally united to the supporting body 1 any change in the physical dimensions of the turns will be primarily due to a change in the physical dimensions of the supporting body 1. By constructing the supporting body 1 of a suitable insulating material, such as porcelain, having a low temperature coefficient of expansion, it is possible to secure a coil having only a small inductance change for wide variations in the temperature of the coil.

In the use of the above-described inductance coil in certain applications, as for example, as the frequency determining element of a high frequency oscillator, it has been found to be desirable to provide means for further compensating the coil against changes in inductance due to temperature variations. As an additional compensating means I provide the arrangement illustrated in Fig. 2 which includes a closed circuited conductor 6 mounted within the coil and arranged in inductively coupled relation thereto; the inductive coupling being variable in accordance with temperature under the influence of a temperature responsive mechanism mounted on the coil supporting body 1.

The temperature responsive device comprises a pair of rods 7 and 8, having a relatively large temperature coefficient of expansion, suitably mounted at one end and arranged to transmit the movement of elongation and contraction to the closed circuited conductor 6 through a cross member 9 and a third rod 10 having a low temperature coefficient of expansion, upon which the conductor 6 is mounted. As shown, the rods 7 and 8 are fixedly mounted at one end on the body 1 by means of a bearing plate 11 extending across an end of body 1 and secured thereto by means of screws threaded into an end plate 12. The rods 7 and 8 are composite in structure and each comprises a tubular outer member 13 within which extend guide rods 14 and 15. The tubular members 13 are temperature responsive and are of the same size and length so that an equal expansion or contraction occurs for like variations in the temperature thereof. The rods 14 are each secured at one end to the bearing plate 11 and

the rods 15 are each secured at an end to the cross member 9. The guide rods 14 and 15 are secured to the tubular members 13 adjacent the outer ends thereof and function to prevent radial distortion of the members 13 under temperature changes.

It will be seen that the ends of the rods 15, upon which the cross member 8 is mounted are free to move in response to expansion and contraction of the tubular members 13 caused by temperature variations of the latter. In order to guide the free ends of the rods 15, a plate 16 is mounted on the end plate 17 having apertures therein through which the free ends of the rods 15 extend. The rod 10 is mounted on the cross member 9 by means of a stud 18 threaded into the rod 10, and is adjustably connectable at its threaded extremity to the member 9 by means of the two nuts 19. The rod 10 is guided in its movement by an aperture cut in the plate 16 through which the stud 18 extends, and a second stud 20 threaded in the upper end of the rod 10 and extending through an aperture in the bearing plate 11.

In the operation of the above-described device to effect temperature compensation of the associated inductance coil, temperature variations cause the rods 7 and 8 to expand and contract in an axial direction, thereby resulting in movement of the free ends thereof, which movement is transmitted to the conductor 6 through the cross member 9, the stud member 18, and the rod 10. Movement of the conductor 6 results in a change in inductive coupling between the conductor and the turns of the coil which, of course, corresponds to a change in the overall inductance of the coil. Thus, for example, if the temperature of the turns of the coil is increased, the turns tend to expand, thereby to increase the inductance of the coil. However, an increase in the temperature of the coil turns is accompanied by an increase in the temperature of the rods 7 and 8, causing the latter to expand to move the conductor 6 downward thereby to change the inductive coupling between the element 6 and the conductor coil turns. This change in inductive coupling tends to decrease the overall inductance of the coil. By a proper selection of the lengths of the rods 7 and 8, the movement of the conductor 6 with respect to the turns of the coil may be made to cause a change in the inductive coupling which exactly compensates for the change in the inductance of the coil due to the temperature variation.

Since the amount of movement of the conductor 6 is governed by the difference in the expansion and contraction between the rod 10 and the rods 7 and 8, it will be understood that the latter rods should be constructed of materials having a temperature coefficient of expansion different from that of rod 10 if an appreciable movement of the conductor 6 for relatively small temperature fluctuations is to be obtained. Preferably the tubes 13 are constructed of hard rubber having a relatively large temperature coefficient of expansion and the rod 10 is constructed of a ceramic material such as magnesium silicate having a small temperature coefficient of expansion. Obviously other materials may be used, the selection thereof being governed by the amount of movement necessary to obtain the correct compensation over the desired temperature range. The length of the rods 7 and 8 is also a controlling factor in fixing the amount of movement of the conductor 6 for a given temperature change. Obviously, the degree of compensation for a given temperature change may be varied by increasing or decreasing the length of the rods 7 and 8 to secure a correspondingly greater or smaller movement of the free ends thereof.

In order initially to secure the correct inductance value the adjustable connection between the stud 18 and the cross member 9 may be manipulated to change the position of the conductor 6 within the turns of the coil. Thus, if it be desired to increase the inductance of the coil the nuts 19 may be loosened and the conductor 6 moved upward until the correct inductance value is obtained, when the nuts may be tightened to secure the conductor 6 in its new position. Adjustment of the position of the conductor 6 within the coil also influences the amount of change in the inductance of the coil for a predetermined movement of the conductor corresponding to a given temperature change. Thus, if the conductor 6 be located outside the coil turns the flux which links the conductor is less than that which would link the conductor if it were located within the coil near the center thereof. Hence, as the conductor is moved toward the center of the coil the flux linkage between the coil turns and the conductor is increased. The increase in flux linkage and, therefore, the degree of compensation for a given movement of the conductor 6 is greater the nearer the conductor is moved towards the center of the coil. It will be seen, therefore, that an adjustment of the position of this conductor 6 within the coil not only influences the magnitude of the inductance of the coil, but also the degree of compensation for a predetermined temperature variation.

From the foregoing description it will be apparent that I have devised a temperature compensated inductance coil which is of exceedingly rugged construction and which is positive and reliable in operation. It will further be seen that the action of the inductance changing element 6 in no way influences the operation of the temperature responsive rods 7 and 8. Thus, the heat generated by the current in the short-circuited element 6 is not transmitted in any manner to the two actuating rods 7 and 8. In addition, since the temperature responsive members 7 and 8 are in close physical proximity to the turns of the coil they tend quickly to assume substantially the same temperature as the coil turns following a temperature variation of the latter, thereby insuring a rapid response of the mechanism to produce the desired compensation.

A further advantage of the device described is that of making the adjustment mechanism for changing the inductance value of the coil independent of the operation of the inductance changing element 6. Thus, the position of the rod 10 may be readily adjusted to alter the coupling between the coil and the conductor 6 and thereby change the coil inductance value without removal of the latter from within the member 1 and without altering the dimensions of the conductor 6. This obviously facilitates the adjustment of the mechanism to a marked degree.

While I have shown a particular embodiment of my invention, it will of course be understood that I do not wish to be limited thereto since many modifications in the structure may be made, and I contemplate by the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In combination, an inductance coil, and

means for compensating said coil against changes in inductance due to temperature variations, said means comprising a closed circuited conductor arranged in inductively coupled relation with said coil and temperature responsive means for moving said conductor to change said inductive coupling, said temperature responsive means comprising a pair of parallel rods, said rods being secured together at one end thereof and extending therefrom in proximity to said coil along a substantial portion of their length, one of said rods carrying near its opposite end said closed circuit conductor and the other rod being attached at its opposite end to said coil, said rods having different temperature coefficients of expansion whereby said conductor is moved in position with respect to said coil as the temperature varies.

2. In combination, an inductance coil, a closed circuited conductor mounted within said coil in inductive coupled relation therewith, and temperature responsive means for moving said conductor axially of said coil thereby to change the inductive coupling between said conductor and said coil in accordance with temperature variations to maintain the inductance of said coil substantially constant during variations in temperature, said temperature responsive means comprising a pair of parallel rods, said rods being secured together at one end thereof and extending therefrom in proximity to said coil along a substantial portion of their length, one of said rods carrying near its opposite end said closed circuit conductor and the other rod being attached at its opposite end to said coil, said rods having different temperature coefficients of expansion whereby said conductor is moved in position with respect to said coil as the temperature varies.

3. In combination, an inductance coil, a closed circuited conductor mounted within said coil in inductive coupled relation therewith, and means including a pair of rods having different temperature coefficients of expansion for moving said conductor with respect to said coil thereby to change the inductive coupling between said conductor and said coil in accordance with temperature variations to maintain the inductance of said coil substantially constant during variations in temperature, said rods being joined together at one end and extending therefrom along said coil, one of said rods being attached to said coil at its other end and the other end of the other of said rods carrying said short circuited conductor near the point where said first rod is secured to the coil.

4. In combination, a cylindrical inductance coil, a closed circuited conductor mounted within said coil in inductive relation therewith, and means including a rod fixed to said coil at one end thereof and expansible with temperature, said rod extending along said coil and subjected to the heat conditions of said coil for moving said conductor with respect to said coil thereby to change the inductive coupling between said conductor and said coil in accordance with temperature variations to maintain the inductance of said coil substantially constant during variations in temperature, said closed circuited conductor being mounted near said end of said coil and supported from the opposite end of said rod through a second rod having a temperature coefficient of expansion different from said first rod.

5. In combination, an inductance coil, a closed circuited conductor mounted in inductively coupled relation with said coil, temperature responsive means comprising a rod having a high temperature coefficient of expansion and subjected to the heat conditions of said coil for moving said conductor axially of said coil to vary the inductive coupling between said conductor and the turns of said coil, and means including a rod fixed to said first-named rod and having a low temperature coefficient of expansion for varying the amount of variation in the inductive coupling caused by a predetermined temperature change.

6. In combination, a supporting body, an inductance coil wound on said body, a pair of rods mounted on said body and having portions thereof free to move equal amounts in the same direction under like changes in temperature due to expansion and contraction thereof, a cross member carried by said portions of said rods, a third rod mounted on said cross member, said third rod having a temperature coefficient different from that of said pair of rods whereby relative movement occurs between said coil and said third rod during temperature changes, and a closed circuited conductor carried by said third rod and arranged in inductively coupled relation with said coil.

7. In combination, a hollow supporting body, an inductance coil wound on said body, a pair of rods mounted on said body and having ends free to move equal amounts in the same direction under like changes in temperature due to expansion and contraction of said rods, a cross member carried by the free ends of said rods, a third rod having a temperature coefficient of expansion different from that of said pair of rods, said third rod being mounted on said cross member and extending within said hollow supporting member, and a closed circuited conductor carried by said third rod and arranged in inductively coupled relation with said inductance coil.

8. In combination, a hollow supporting body, an inductance coil wound on said body, a pair of rods mounted on said body and having ends free to move equal amounts in the same direction under like changes in temperature due to expansion and contraction of said rods, a cross member carried by the free ends of said rods, a third rod having a small temperature coefficient of expansion, different from that of said pair of rods, said third rod being mounted on said cross member and extending within said hollow supporting member, a closed circuited conductor carried by said third rod and arranged in inductively coupled relation with said coil, and means for changing the inductive coupling between said conductor and said coil.

9. In combination, a hollow supporting body, an inductance coil wound on said body, a pair of rods mounted on said body and having ends free to move equal amounts in the same direction under like changes in temperature due to expansion and contraction of said rods, a cross member carried by the free ends of said rods, a third rod having a different temperature coefficient of expansion than said pair of rods, said third rod being mounted on said cross member and extending within said hollow supporting member, a closed circuited conductor carried by said third rod and arranged in inductively coupled relation with said coil, and means comprising an adjustable connection between said third rod and said cross member for changing the inductive coupling between said conductor and said coil.

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