May 30, 1933. D. H. VANCE 1,911,980

VARIABLE INDUCTOR

Filed March 31, 1932

Fig. 1.

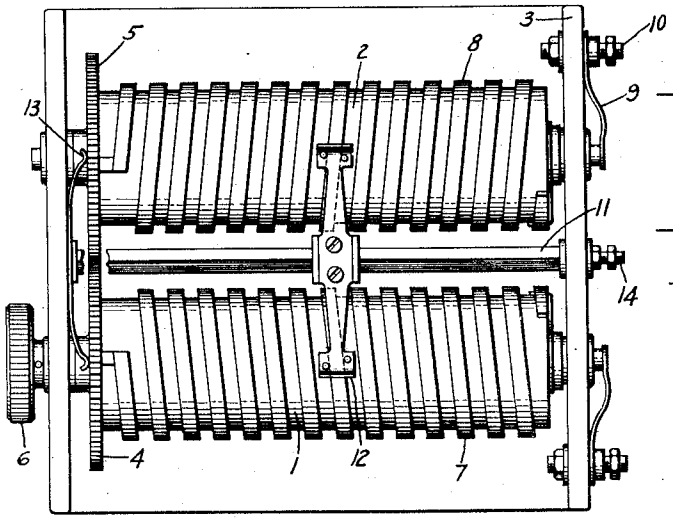


Fig. 4.

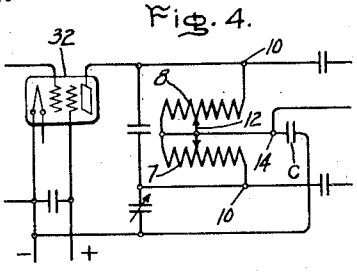


Fig. 2.

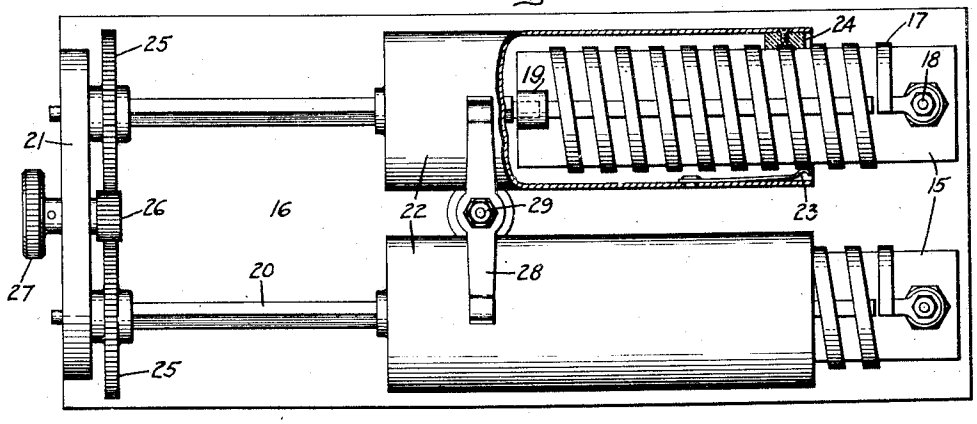


Fig. 3.

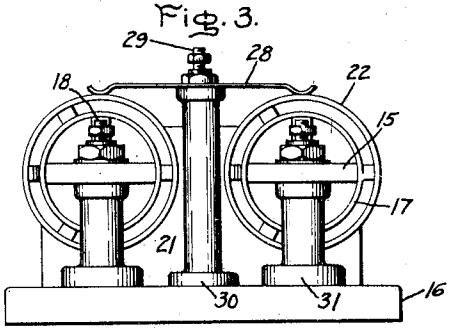
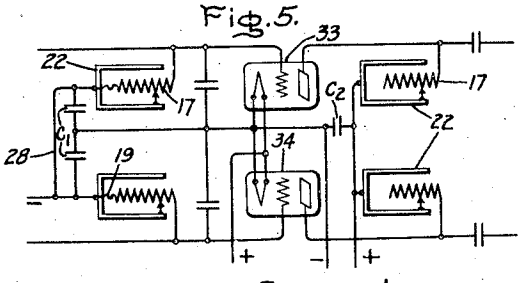


Fig. 5.



Inventor:
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UNITED STATES PATENT OFFICE

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VARIABLE INDUCTOR

Application filed March 31, 1932. Serial No. 602,201.

One of the objects of my invention is to provide an inductance device which is particularly adapted for use in circuits operating at ultra high frequencies and having an advantageous mechanical construction whereby its assembly in a particular circuit in which it is to be utilized and also its operation and adjustment when assembled are greatly facilitated.

While not limited thereto, inductance devices of the type to which my invention relates are commonly employed in circuits of the push-pull, or other type, in which it is important that opposite sides of the circuit be maintained in balanced relation with respect to ground. When so employed it is important that the mechanical construction of the inductance be such that equal distributed capacity effects between opposite points on the inductance and ground are readily obtained thereby to obtain symmetry in the operation of the circuit. It is also important that the inductance be of such construction that it is readily adjustable at all times, as by short-circuiting a variable portion of the turns thereof. This characteristic is particularly important where the frequency requirements of the circuit are strict and it is necessary rapidly to readjust the circuit to normal conditions in the event of any disturbance of the frequency.

One of the objects of my invention is to provide an inductance having a mechanical construction such that these advantages are obtained and which at the same time is of compact and rigid construction, capable of retaining its adjustment without the use of locking devices and the like, which necessitate manipulation or readjustment of the apparatus.

Still a further object of my invention is to provide such an inductance in which the short-circuited turns, which may be at the center of the coil and maintained at ground potential, are completely shielded, the shielding means being capable of repeated adjustment without disarrangement of the convolutions of the coil.

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, together with other objects and advantages thereof, will be better understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 illustrates one form of my invention; Figs. 2 and 3 illustrate a preferred embodiment of my invention, and Figs. 4 and 5 illustrate circuit arrangements in which my invention may be utilized.

Referring to Fig. 1 of the drawing, I have illustrated therein two rotatable insulated inductor forms 1 and 2 which are supported in parallel side by side relation to each other by shafts journaled in a frame 3. The inductor forms are arranged to be rotated by a set of gears 4 and 5 which are actuated by means of a knob 6. The inductor forms 1 and 2 are provided with helical conductors 7, 8, space-wound thereon so that he convolutions of the one form are in opposite direction to the convolutions supported by the other form. The inductors thus arranged parallel to each other are in inductive relation to each other and form what is commonly known as a pair of binocular inductors. Adjacent extremities of the convolutions of the inductors 7, 8, are each electrically connected to the supporting shafts of the respective inductor forms, each of which is provided with a suitable contact 9, which in turn is connected to a binding post 10. A shaft 11, extending between the frame 3, is arranged parallel to and between these inductors 7, 8, and an adjustable contact member 12 is mounted upon the shaft 11. The shaft 11, as illustrated, is of square cross-section, but may be of any other shape to prevent the rotation of the adjustable contact member 12 thereon. The adjustable contact member 12 comprises a pair of contact arms provided with pins at the extremities thereof to engage and contact with the convolutions of the bare conductors 7, 8 at adjacent positions thereon. Upon rotation of the inductor forms 1 and 2 by means of the knob 6, the adjustable member 12 engaging and contacting with the con-

volutions of the conductors 7, 8, will be moved longitudinally upon the shaft 11 because of the screw action exerted thereon by the convolutions of the conductors. The convolutions of the conductors 7, 8, at the extremities adjacent to the gears, are connected to the gears 4, 5 of the respective inductor forms 1, 2. At the extremity of the shaft 11, adjacent to the gears 4, a contact member 13 is provided to make electrical contact between the shaft 11 and the gears 4 and 5, thus electrically connecting together the conductors 7, 8, and the shaft 11. At the other extremity of shaft 11 a binding post 14 is provided for electrical connection therewith.

In operation, the inductor is connected so that the binding posts 10 are connected to the high potential portions of the radio circuit, while the binding post 14 is connected to that portion of the circuit which is at cathode potential. As the inductor forms 1 and 2 are rotated, the adjustable contact member 12 moving longitudinally upon the shaft 11 varies the effective inductance by varying the portions of the inductors 7, 8, included between the gears 4 and 5 and the adjustable member 12. These portions of the inductors 7, 8 are short-circuited and therefore are ineffective as an inductor.

When the inductor is used in a receiver or transmitter, the panel of the receiver or transmitter is usually of metal which is at ground potential. The arrangement of the inductor in binocular form as illustrated, has the important advantage that both ends of the active portions of the inductance may then be arranged at the same distance from the control panel, or other portion of the framework of the equipment whereby the active portions each have the same effective capacity to ground. Thus any unbalance of the circuit due to distributed capacity is wholly avoided. This permits the push-pull arrangement to operate at higher frequencies than push-pull circuits utilizing the ordinary form of variable inductor.

Referring to Fig. 2, I have illustrated therein a preferred embodiment of my invention which is capable of operating at still higher frequencies than the embodiment shown in Fig. 1. A pair of insulating supports 15 arranged parallel to each other is mounted upon a base member 16. Each of these supports 15 is composed of two flat insulating members arranged to form a cross when viewed from the end. This form of support permits but a minimum amount of contact between the insulator and the conductor wound thereon, thus providing an efficient structure. Upon each of the insulated supports 15 a bare electrical conductor 17 is wound to form a cylindrical helix. A binding post 18 is provided at one extremity of the support 15 for making electrical connection to the helical conductor 17. At the remaining extremity of the support 15 a journal 19 is provided for the shaft 20 which extends from the support 15 to a supporting member 21 which is at one end of the base member 16. In some instances it may be desirable to connect the extremity of the helical conductor 17 to the journal 19 in order to make contact with the shaft 20. A cylindrical shield 22 of suitable low resistance conductive material such as copper, and of sufficient diameter to surround the helical conductor 17 is loosely supported upon the shaft 20. At the free end of the shield 22, there is provided a spring contact 23 for contacting with the helical conductor 17, and a member 24 for engaging the conductor. It is to be understood, however, that the engaging member 24 and the contact 23 may be combined in a unitary structure, but for the sake of clearness have been shown as two distinct elements. The shafts 20 and the shields 22 are rotatable, and the shafts 20 are so shaped as to preclude rotation of the shields 22 thereon. Adjacent to the supporting member 21, the shafts 20 are provided with gear wheels 25 for rotating the shafts 20 and the shields 22. A driving gear wheel 26 engages the gear wheels 25 and is rotated by means of a knob 27. The engaging members 24 at the extremities of the shields 22 engage the helical convolutions of the conductors 17 to cause the conductive shields 22 upon rotation to move longitudinally upon the shaft 20, thereby varying the effective inductance of the helical conductors 17 by shielding the unused portions.

Reference may now be made to Fig. 3 which shows an end view of the apparatus disclosed in Fig. 2. A contact member 28 provided with a binding post 29 for making electrical conection thereto engages both of the conductive shields 22. The contact member 28 and the binding post 29 are supported by a suitably insulated base 30 located between the two shields 22. The insulated supports 15 for the helical conductors 17 are each supported at the binding post extremity by an insulated post 31 which is mounted upon the base member 16.

As thus constructed it will be seen that the short-circuited turns of the inductors are completely enclosed within the shields 22 and are thereby prevented from causing any undesired effects in the operation of the apparatus. It will further be noted that the shields 22 engage the conductors only through the contacts 23 and 24. In this way the shields are readily rotatable with respect to the coils, thereby avoiding any buckling of convolutions of the coil, or loosening thereof from the supports due to the frictional engagement of the coil with the shield. At the same time the construction is such that the shields and contacts 23 and 24 retain their

adjustment with respect to their coils and make firm contact therewith without the use of any locking devices and the like which require manipulation in adjusting the inductance of the coils.

Referring to Fig. 4, I have illustrated therein one of the circuits in which an apparatus, such as shown in Fig. 1, may be utilized. A pair of binocular inductors 7, 8 are connected in the anode circuit of an electron discharge device 32. The anode circuit shown is arranged to be connected to a push-pull amplifier such as is shown in Fig. 5. A condenser C connected between the cathode and the binding post 14 of the inductor apparatus maintains the unused portion of the inductor which has been short-circuited by the contact 12 at a radio frequency potential which is equal to the cathode potential of the electron discharge device used. Parasitic oscillations in the unused portions of the inductor are prevented from being built up by maintaining these portions of the inductor at cathode potential.

Referring to Fig. 5, I have illustrated therein a push-pull or balanced circuit using the type of inductance shown in Figs. 2 and 3. This inductance is capable of operating at higher frequencies than the device shown in Fig. 1, because of the improved mechanical construction thereof and the fact that the shielded unused portions of the inductors are unable to influence the remaining portions of the inductors. A pair of such shielded inductors 17 is connected in the input circuit of a pair of electron discharge devices 33 and 34. In this instance the binding post extremities of the helical inductors 17 are connected to the grids of the electron discharge devices 33 and 34. The remaining extremities of the helical conductors 17 are each connected to their respective journals 19 which in turn are electrically connected with the shields 22 and the contact member 28. The contact member 28 is connected to the cathodes of the electron discharge devices 33 and 34 through a grid biasing potential. To maintain the unused portions of the inductor 17 and the shield members 22 at radio frequency cathode potential, a pair of capacitors C_1 is connected between the shield members 22 and the cathodes of the electron discharge devices. If the push-pull amplifier is to be operated at a lower range of frequencies, an inductor of the type shown in Fig. 1 may be substituted for the shield inductor 17 shown in the input circuit of the electron discharge devices 33 and 34. In the output circuit of the electron discharge devices 33 and 34 an inductor of the type shown in Figs. 2 and 3 is utilized which does not have any connection to the one extremity of the helical conductor 17. To maintain the shield members 22 at cathode potential, a capacitor C_2 is connected between the connector 28 and the cathodes of the electron discharge devices 33 and 34.

The preferred embodiment of my invention has the advantage that the conductors are supported by a minimum amount of dielectric material which results in greater efficiency and lower inherent capacity, and the shields which maintain the unused inductor portions at cathode potential may be readily adjusted and maintained in any desired position by operation of a single control member.

While I have shown certain specific embodiments of my invention, it will, of course be understood that I do not wish to be limited thereto, since it is apparent that the principles and apparatus herein disclosed are susceptible of numerous other applications, and modifications may be made in the circuit arrangements and in the instrumentalities employed without departing from the spirit and scope of my invention as set forth in the appended claims.

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

1. In a high frequency inductor, the combination of a pair of cylindrical helical conductors supported on insulating frames, said helical conductors being arranged side by side and in parallel relation to each other and having one set of adjacent ends connected together to provide a common connection, an adjustable means connected to said common connection and operating in a path between said helical conductors for simultaneously making contact at adjacent points on said helical conductors at any point of each of the convolutions thereof whereby the inductive effect of the portions of said helical inductors included between said adjustable means and said common connection is made ineffective, means for adjusting the position of said adjustable means, and means for each of said helical conductors for making connections to the remaining ends of said conductors.

2. The combination, in an inductance device, of a conductor arranged in the form of a helix, supporting means for said helix, means for making electrical connections to one end of said helix, a conductive shield arranged to enclose the opposite end of said helix, means for rotating said shield with respect to said helix and contact means within said shield and attached thereto and arranged to engage a convolution of said conductor to cause progression and recession of said shield over said helical conductor as said shield is rotated with respect to said helix, said shield being of such dimensions with respect to the helix that the enclosed end of the helix is electrically free there-

from, and means for making electrical connections to said shield.

3. In a high frequency radio tuning apparatus, the combination of a plurality of inductors each comprising a helical conductor mounted upon an insulating support, said inductors being arranged in parallel side by side relation, means for making electrical connections to one extremity of each of said inductors, said other extremities being free, a conductive shield for each inductor adjustable with respect thereto, a contact at one end of each of said shields for making electrical contact with said helical conductors, a common means for making electrical contact with said shields, means for simultaneously adjusting said shields with respect to the free ends of said inductors whereby the inductance of said shielded portions of said inductors is rendered ineffective.

4. A radio tuning apparatus for push-pull operation comprising a pair of inductors arranged parallel to each other, said inductors comprising helical bare conductors having the same convolute directions to reduce the effective inductance thereof, each of said conductors being supported by an insulating member, means near one set of adjacent extremities of said inductors for progressively and simultaneously rendering ineffective equal and adjacent portions of said inductors, said means including a rotatable conductive shield for each inductor and a contact thereon near one extremity for continuously making contact with the succeeding convolutions of said helical conductor as said shield is rotated, means for simultaneously rotating said shields, means for each inductor for making electrical connection to the extremity of said inductor, and means common to said shields for making electrical connection thereto.

5. In combination, a pair of inductors each comprising a helical conductor mounted on an insulated support, said inductors being arranged parallel to each other and having the same convolute direction of the helical conductors for reducing the effective inductance thereof, a pair of rotatable conductive shields having means near one extremity for engaging and making contact with the convolutions of the helical conductors, said shields being connected to adjacent ends of said inductors, means for electrically connecting said shields together, means for each of said inductors for making connection to the other extremities thereof, means connecting the shielded extremities of said inductors to said shields and means for simultaneously rotating said shields whereby said shields and engaging means follow the convolutions of said inductors to simultaneously render equal portions of said inductance ineffective by short-circuiting and shielding said portions.

6. In a high frequency radio apparatus, the combination of a set of rotatable binocular inductors comprising helically wound bare conductors upon insulating supports, a contact for connecting together adjacent extremities of said binocular inductors, adjustable means connected to said contact for simultaneously engaging the helical conductors at adjacent points along the length thereof, means adjacent to said inductor extremities for simultaneously rotating said binocular inductors and for adjusting said engaging means along the length of said helical conductors whereby the effective inductance of said inductors is altered, and means for making connections to the remaining extremities of said inductors.

7. In combination, a set of binocular inductors comprising rotatable insulated supports helically wound with bare conductors, a contact for connecting together one set of adjacent extremities of said binocular inductors, a shaft connected to said contact, means adjustably mounted upon said shaft for simultaneously engaging and contacting with said helically wound conductors at adjacent points along the length thereof, means for rotating said binocular inductors whereby the position of said engaging and contacting means will be adjusted to change the inductance of said binocular inductors, and means for making connections to the remaining extremities of said inductors.

8. In an adjustable inductor, the combination of a pair of rotatable insulated supports, a helical conductor for each of said supports, said helical conductors having opposite convolute directions, said supports being parallel and adjacent to each other, a member for connecting together one pair of adjacent extremities of said conductors, an adjustable means mounted upon a shaft extending between said coils and connected to said member for contacting and engaging said conductors on said supports at adjacent points, means adjacent to said member for connecting together said conductor extremities for simultaneously rotating said conductors and supports whereby said adjustable means will be moved by the rotation of the convolutions of said conductors to vary the inductance thereof, and means for making connections to said connecting member and the other extremities of said conductors.

It witness whereof I have hereunto set my hand.

DONALD H. VANCE.