Oct. 10, 1939. H. N. BLISS 2,175,554

VARIABLE INDUCTANCE

Filed Nov. 14, 1936

Fig. 1.

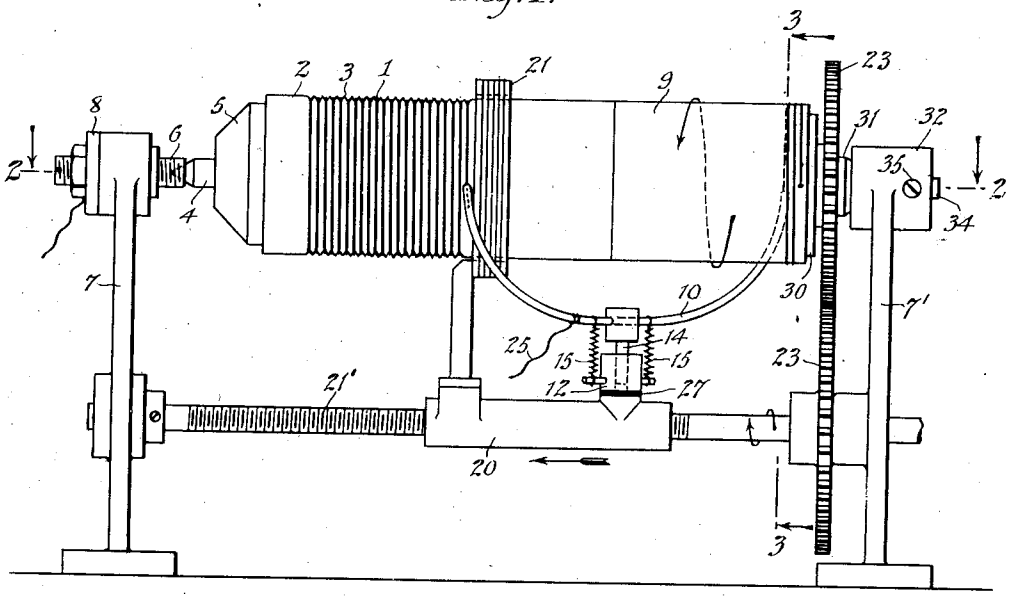


Fig. 2.

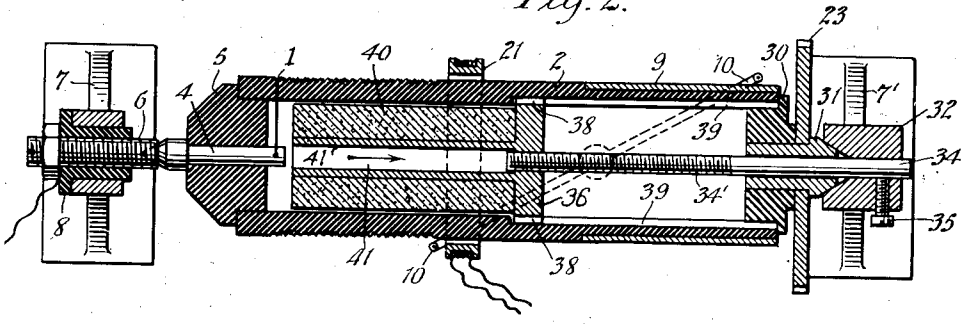
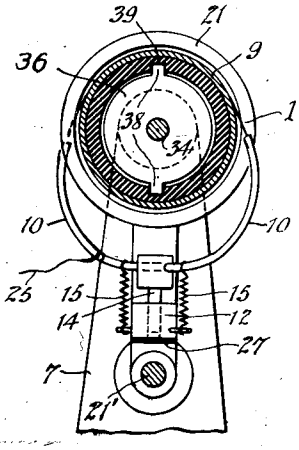


Fig. 3.



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VARIABLE INDUCTANCE

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9 Claims. (Cl. 171—119)

This invention relates to electricity, and particularly to a variable coil of compact construction capable of a great range of variation in inductance through continuous fine gradations, without the use of switches. In my prior Patent No. 2,037,061, issued April 14, 1936, I described a variable coil whose effective length could be readily changed by any small fraction of a turn, without the use of extraneous reeling coils, so that it could be mounted as a unitary device. The present invention is an improvement thereon, and is generally applicable to various scientific and commercial applications, wherever fine gradations in the length or number of turns of a coil are desired, with a wide range of variation. It is particularly applicable to the radio art, as it makes possible the practical manufacture of all-wave receivers without the multiplicity of coils and band switches with which they are at present encumbered. The invention also gives easier tuning and more efficient reception.

In the ordinary radio receiver, tuning to the various wave lengths has generally been done by turning the condensers to various degrees of capacity C. It has long been recognized that for ideal reception the inductance coils (controlling the inductance L), should also be varied for various wave lengths, in order to maintain desirable L/C ratio; but as a practical matter it has been found difficult to make variable coils of reasonable size and good characteristics, and consequently the use of fixed inductance coils has remained standard practice on commercial receivers.

Fixed inductances L approximating the desired value have been used in conjunction with variable condensers C, and in practice could cover a fair range without the L/C ratio becoming so bad as to spoil reception. While the sacrifice in reception could be tolerated in the ordinary broadcast range, it was found that the difficulties increased with the shorter wave lengths, so that the same coils could not be used, and it has been commercial practice to then substitute other fixed coils, with attendant switches and complexity, so that a commercial universal or all-wave receiver has become a very complicated device.

The present invention therefore has a particular application to short-wave radio, in that it permits a few simple coils to take the place of many, and with better results, since the few variable coils attain with precision the desired L/C ratio which the many fixed coils only approximated. With the improvements to be described it is possible to make a so-called "all-wave" radio receiver which can be tuned from ordinary long wave broadcast range down to the short waves for foreign reception without a break or switch, all on the same simple set of coils.

As distinguished from my prior patent above mentioned, the present invention extends the range by varying the core as well as the coil, reduces the diameter, shortens the apparatus by eliminating the longitudinal travel of the coil sleeve, and provides an improved transfer mechanism for leading the wire from one end of the core to the other.

Referring now to the drawing:

Fig. 1 is a side elevation of one of the coil units, showing the variable coil and transfer mechanism.

Fig. 2 is a cross sectional view of the sleeve on which the coil is wound and unwound, showing the internal construction including the movable iron core.

Fig. 3 is a cross-section on line 3—3 of Fig. 1, showing the feather key, and the transfer mechanism, from which, in conjunction with Fig. 1, it can be seen that it has a diagonal position.

Similar reference numerals refer to similar parts throughout the various views.

Referring now to Fig. 1 and Fig. 2, the movable wire 1 is wound on an insulated sleeve 2, which is preferably made of rubber, "Bakelite", or some similar material, this insulated sleeve 2 preferably being provided with screw threads 3 to receive and guide the wire 1 in its winding and unwinding. The end of the wire 1 is secured to a central pivot pin 4, as shown in Fig. 2, which passes through an insulated plug 5 to a pivot bearing 6, which is insulated from the frame 7 by the insulating bushing 8 of rubber, "Bakelite", or other suitable material. This pivot bearing 6 provides the electrical take-off for the end of the coil.

The other end of the insulated sleeve 2 is preferably provided with a sleeve 9 of brass or other conducting material on which the other end of the wire 1 is wound and unwound. This brass sleeve 9 short circuits the turns of wire 1 wound on it, so that they are inactive. An insulating bushing 30 insulates the brass sleeve 9 from the pivot 31, which turns in the pivot bearing 32, thus supporting the right hand end of the sleeve 2.

The transfer mechanism for carrying the wire 1 quickly from the active end to the inactive end preferably consists of a metal tube 10 of fine bore, sufficient to easily accommodate the wire 1, this tube 10 being bent in a U shape and placed so

as to diagonally straddle the sleeve 2 and 9. This is shown in Fig. 1 and also in Fig. 3, which is an end view. While a tube is preferable, a U-shaped slot or groove in a segment may be used, or any other element guiding the wire 1 in the same general manner. When the wire 1 is threaded through the tube 10, the wire 1 is carried from one side—such as the front in Fig. 1—diagonally to the other side—or back of the sleeve 9 in Fig. 1—at the same time being carried along the length of the sleeve a sufficient distance so that no objectionalble self-induction effects are set up between the coils at the two ends. The tube 10 is rotatably and slidably mounted in the bearing sleeve 12 by means of the pivot pin 14, which is held in place by the tension of the coil springs 15. These springs 15 tend to pull the U tube 10 downward as shown in Fig. 1, or away from the sleeve 2, and thereby maintain the wire 1 at a suitable tension for winding or unwinding. The tube 10 can also oscillate or rotate to a certain extent about the pin 14 as a pivot. This allows the tube 10 to adjust itself to the position of the wire 1 as it leaves the sleeve 2, and gives a free running mechanism capable of guiding the wire 1 into the grooves 3.

The tube 10 and pivot pin bearing 12 are mounted on the threaded block 20, which also carries the primary coil 21. This threaded block 20 is carried by the screw 20', whose pitch and hand are such as correspond in action to the thread 3, so that the transfer tube 10 and primary coil 21 are caused to follow the pitch of the wire winding on the thread 3. Thus the primary 21 is maintained constantly adjacent to the last turn of the active coil of the wire 1. The actual pitch and hand of the respective threads will of course depend on the gearing 23 connecting them, which may vary in different installations, as will be apparent to those skilled in the art. The low or grounded end of the coil may be led in through the wire 25.

When the coil is used in a circuit having automatic volume control, the bearing sleeve 12 is insulated from the grounded framework 7 by the insulation 27; the wire 25 may then be attached to the automatic volume control circuit, as will be apparent to those skilled in the art. For the same reason, the sleeve 9 is insulated so as to have no electrical contact to the framework 7.

The pivot 34, which supports the right hand end of the rotatable sleeve 2, is hollow, and through its opening passes the fixed rod 34, locked to the frame 7' by the set-screw 35. This fixed rod 34 is provided with a screw-thread 34' inside the sleeve 2. On this screw-thread 34' is mounted a nut or hub 36, provided with corresponding screw threads to run on the screw 34', and having projecting keys 38 to engage two splines or keyways 39 cut inside the sleeve 2, so that the hub 36 will rotate with the sleeve 2 and so be screwed up and down the rod 34. The hub 36 is loose enough to slide freely within the sleeve 2, but owing to the keys 38, must revolve with it, so as to be screwed longitudinally.

The hub 36 carries a magnetic core 40 of radio frequency iron core material having low hysteresis, such as has been specially developed for high frequency work as is well known in the art in stationary coils. This radio frequency iron core 40 is mounted on a tubular projection 41 of the hub 36, through which the screw 34' may pass.

The pitch and hand of the threads 21' and 34'—in conjunction with whatever gearing is used between them—are so proportioned and selected that when the variable coil 1 is wound to its full number of turns the iron core 40 is moved to the left in Fig. 1 so as to be fully inserted in the variable coil 1; and when the variable coil 1 is unwound to a few turns the iron core 40 is withdrawn back to the right-hand end of the sleeve 2, so as to be removed from the field of the coil 1, so that it may have its minimum inductance. In other words, as the variable coil 1 is wound larger, the core 40 is gradually inserted to assist in increasing the inductance, and as the coil 1 is unwound the core 40 is gradually withdrawn to assist in diminishing the inductance.

By this simultaneous combined action of a variable coil and variable core, a very rapid and smooth change of inductance is made possible, thus creating a variable coil of very high efficiency. By this means a relatively small coil may be made to cover a very large range of useful inductance, and much more simple and compact radio sets can be constructed. The presence of the iron core 40 at the low frequencies also increases the coupling of the primary coil to the secondary at those frequencies, a valuable feature as the primary coil must be small enough to be efficient at the highest frequencies encountered.

In my prior patent above mentioned it will be noted the sleeve 2 moved longitudinally during the winding while the primary 21 and transfer mechanism 10 were stationary, whereas in the present form the sleeve 2 is fixed longitudinally and the primary 21 and transfer mechanism 10 are fed along; thus the total length of the mechanism is considerably shortened in the present form, which with the reduction in diameter above described permits a very compact device.

While I have in the foregoing described certain specific examples, it will be understood that they are merely for purposes of illustration, to make clear the principles of the invention, which is not limited to the particular forms shown, but is susceptible to various modifications and adaptations in different installations, as will be apparent to those skilled in the art, without departing from the scope of the invention as stated in the following claims.

What I claim is:

1. A variable inductance device, including in combination a coil, means for winding and unwinding a variable number of turns of said coil, a magnetic core, and means for inserting the magnetic core simultaneously with the winding and withdrawing the magnetic core simultaneously with the unwinding, so that when the coil is substantially fully wound the core is strongly inductively associated therewith, and when the coil is unwound to a few turns the core is withdrawn to such a distance as to have little effect on the inductance of the coil.

2. In a variable inductance, the combination of a primary coil, a variable secondary coil coupled thereto, means for winding and unwinding said secondary coil to give various degrees of inductance, a movable magnetic core, means for moving said core into the variable coil when it is wound for the higher degrees of inductance, so as to increase the inductance and increase the coupling between the primary and secondary coils, and for withdrawing the core so as to reduce the coupling and be ineffective on the coils when the variable coil is unwound to low degrees of inductance.

3. In a variable inductance, the combination of a rotatable sleeve, means for winding wire on said

sleeve in various degrees to form a variable coil, a magnetic core located within said sleeve, and means for moving said core axially relative to the coil and simultaneously with the variation in the coil, the axial motion of the core relative to the coil being in a direction opposite to that in which the coil is winding, so that when the coil has a few turns the core is entirely withdrawn from the coil, and when the turns are increased the core is increasingly inserted therein, to create a rapid variation in inductance.

4. In a variable inductance, a rotatable member, a coil of wire arranged to wind on one end of said member and simultaneously unwind from the other end, means for rendering the coil at one end inactive while the coil at the other end is active, and transfer means for carrying the wire between the active to the inactive coils comprising a U-shaped guide located diagonally relatively to the space between said coils and arranged to take the wire from one side and return it to the other side of said rotatable member, so that as it is unwound from one end it will wind up on the other end.

5. In a variable inductance, a rotatable member, a coil of wire arranged to wind on one end of said member and simultaneously unwind from the other end, means for rendering the coil at one end inactive while the coil at the other end is active, and transfer means for carrying the wire between the active to the inactive coils comprising a U-shaped guide, partially embracing said rotatable member in a diagonal direction so as to take the wire from one coil and feed it to the other coil on the opposite side of the rotatable member, whereby the wire may be interchanged between coaxial coils with the same direction of rotation.

6. In a variable inductance, the combination of a variable coil of wire, a rewinding coil coaxial with the first-mentioned coil, and a transfer means for carrying the wire between the two coils, said transfer means comprising a U-shaped guide picking up the wire as it leaves one side of one coil and guiding it diagonally so as to deliver it to the other side of the other coil, said wire sliding through said guide with frictional contact, and means for keeping said wire under tension.

7. In a variable inductance, the combination of a winding drum, a rewinding drum, wire arranged to wind and unwind between said drums to form a variable inductance, a curved guide for said wire for transferring it from one drum to the other, said guide extending diagonally and partially embracing said drums, and yieldable means for urging said guide away from said drums, whereby the wire is maintained under tension.

8. In a variable inductance, the combination of a variable coil of wire, a rewinding coil, a transfer means between said coils comprising a curved guide external to said coils and placed diagonally so as to take the wire from one side of one coil and deliver it to the other side of the other coil, a pivot for said guide about which it may oscillate, and spring means tending to move said guide away from said coils, whereby the wire is maintained under tension.

9. In a variable inductance, the combination of a variable coil of wire, a rewinding coil, a transfer means between said coils comprising a curved guide external to said coils and placed diagonally so as to take the wire from one side of one coil and deliver it to the other side of the other coil, yieldable means for urging said guide away from said coils to maintain the wire under tension, a magnetic core movable relative to the variable coil oppositely to the direction in which the coil is winding, so that when the coil has a few turns the core is withdrawn from it to reduce the inductance, and when more turns are wound on the coil the magnetic core is simultaneously increasingly inserted therein, so as to create a rapid rate of increase in the inductance.

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