PERMEABILITY TUNED RESONANT CIRCUIT

Filed July 8, 1933
The present invention relates broadly to resonant circuits, and more particularly to those cases wherein it is necessary or desirable to provide a plurality of adjustments. In cases where several resonant circuits are used, for example in a cascade arrangement, or in cases where particularly refined tuning adjustments are to be made, it is usual to employ several adjustments to establish the initial electrical and mechanical conditions in the system. The novel arrangements and devices herein disclosed are especially advantageous in systems in which the tuning operation is accomplished by the insertion into the coil which forms a part of the resonant circuit, of a magnetic core body, such, for example, as is described in my co-pending application No. 523,112 on Magnetic core materials. The invention herein disclosed may, however, have utility in systems tuned by other methods of inductance variation, or in systems tuned by capacity variation. It may also be useful in systems wherein no means is provided for tuning over any considerable band of frequencies, but in which adjustments are nevertheless desired to tune the circuit or system to a particular single frequency.

In my co-pending application No. 667,368, for "Improvements in inductive tuning systems", which is addressed more particularly to systems in which a plurality of resonant circuits is used, I have shown that it is desirable to have not less than three adjustments in each of the resonant circuits of the system, or in at least all but one of the circuits. These adjustments are additional to the means by which the frequency can be varied. In this system, the electrical and mechanical behavior of these adjustments, and a preferred mechanical arrangement embodying them, are adequately set forth in the co-pending application referred to. In the manufacture of those classes of apparatus in which resonant circuits are employed, which apparatus, in general, includes many other parts and devices, it is usually not possible to completely adjust the resonant circuits before they are assembled with the other parts. The final adjustments are ordinarily made, therefore, after the apparatus has been assembled, and after all necessary wiring has been installed. In the mechanical design of such apparatus, it is frequently a matter of considerable difficulty to so arrange the numerous parts that access can still be had to the means for adjusting the resonant circuits. Moreover, the assembled apparatus frequently has considerable weight and bulk. Inconvenience and unnecessary increase in production cost result if the adjustments are difficult to reach, or if the complete apparatus must be turned around, or turned over, in order to gain access to them. It is obviously desirable, therefore, that all the adjustments for the plural resonant circuits which must be finally set after assembly should be located on one side or face of the apparatus, or so that they can be easily reached from one side. The side or face chosen will depend on the design of the apparatus, and the method and arrangements employed in the assembly and test, but the tuning unit, or the unit which includes the plural resonant circuits, will be so placed as to give the maximum convenience in adjustment.

In systems tuned by inductance variation produced by relatively movable magnetic cores, there are two adjustments on each resonant circuit, in addition to adjustment means on the cores themselves. The core adjustments are ordinarily made before the cores are assembled onto the apparatus, but the remaining two adjustments are preferably made after assembly. One of these adjustments is to establish the capacity in each circuit at the proper value, and the other is to establish each coil in its proper position relative to its operating core.

The principal object of the present invention is to provide mechanical means for these two final adjustments, which will satisfy the conditions outlined above in a simple and reliable manner. As will be set forth in detail, in connection with the description of the drawing, the adjustments for each one of the several tuned circuits are conveniently brought out at one side of the tuning unit or circuit assembly, and may be easily and accurately set at the desired position by the use of suitable tools. Further objects of the invention, and advantages resulting from its use, will be apparent from what follows.

Referring now to the drawing, which is illustrative of a preferred embodiment of the invention, and in which the numerals refer to the same parts in all views: Fig. 1 is an elevation, partly in section, of a
complete tunable resonant circuit, except that no means for moving the magnetic core relatively to the coil are shown;

Fig. 2 is a view of the lower or left hand end of
5 Fig. 1, showing that a different form of mounting plate is shown;

Fig. 3 is an enlarged partial section corresponding to a portion of Fig. 1;

Fig. 4 is a diagrammatic representation of circuits similar to that of Fig. 1, arranged in a tuning unit; and

Fig. 5 is a wiring diagram showing how such a system of resonant circuits may be effectively connected for use.

The resonant circuit illustrated in Fig. 1 consists of a coil structure, 1, and a condenser, 2. The circuit is tuned over a desired band of frequencies by varying the effective permeability of the space surrounding the coil. This is accomplished by the magnetic core, 3, which is arranged, by any suitable mechanical means, to be moved relatively to the coil structure, 1. As will be seen, the core, in this case, has been designed with an annular recess or cavity, 3a, to receive the coil, the relative motion of the core and coil being parallel with their common axis. With the core in the position, relative to the coil, shown in Fig. 1, the core has a negligible effect upon the effective value of the inductance of the coil, and the inductance in the resonant circuit is therefore at a minimum value. As the core and coil are telescoped, the core increases the effective permeability of the space surrounding the coil, and the effective value of the inductance in the resonant circuit is increased. When the coil has advanced into the recess as far as it will go, the maximum value of effective permeability is attained, and the effective inductance in the tuned circuit is at a maximum.

The coil structure, 1, consists of a moulded form, 4, preferably slightly tapered toward its open or free end, and carrying a coil, 5, preferably of Litz wire, and having a single layer, wound in a thread moulded into the form. The form, 4, is closed at the fixed end and carries a stem, 6, threaded at its outer end, the stem, 6, being moulded into the form, 4, as an insert.

The coil structure, 1, is adjustably mounted upon a base, 7, which is preferably of a high-grade ceramic insulation material. Through the base, 7, passes a sleeve, 8, threaded at one end, and having a head, 9, at its other end, of hexagonal or other suitable non-circular section. The base, 7, has a hexagonal recess, which receives a nut, 10, which, in turn, secures the sleeve, 8, to the base, 7. The stem, 6, of the coil, 1, passes through a hole in the sleeve, 8, and the hexagonal head, 9, engages a hexagonal recess in the base of the moulded coil form, 4. Between the end of the coil form, 4, and the base, 7, there is a compression spring, 11, which tends to push the coil, 1, away from the base, 7. At the outer end of the stem, 6, there is a nut, 12, by which the coil may be axially adjusted to any desired position with respect to the base, within the limits set by the engagement of coil form, 4, and hexagonal head, 9, and against the suitable dielectric members, 15. There are two plates, 13, 13a, which form one side of the condenser, the plate, 14, which forms the other side, being mounted between the two plates, 13, 13a, and being insulated from them by mica members, 15. The outer plate, 13, is preferably heavier than either of the plates, 13a, 14, is made of spring metal, and is slightly bent, so that normally only its edges bear on the mica.

Each of the plates, 13, 13a and 14, and the mica members, 15, has a large hole at its center, of such size as to adequately space them from the sleeve, 6. On the end of this sleeve there is a nut, 16, separated from the outer plate, 13, by an insulating washer, 17. By adjusting this nut on the sleeve, 8, the bent outer plate, 13, may be deformed so as to bring more or less of its surface into contact with the mica member, 15. This increases or decreases the capacity of the condenser, 2, and permits accurate tuning of the resonant circuit to a particular desired frequency.

The plates, 13, 13a and 14, of the condenser, 2, have ears, 18, 19, which project through holes in the base, 7. These ears are provided with small holes at their ends, and serve as terminals to which the ends of the winding, 5, may be soldered, as shown, to form the resonant circuit. Connections from the resonant circuit to other parts or devices, not shown, may be conveniently soldered to these same terminals. The ears, 18, 19, also serve as a support for the assembly on the base, 7, and to prevent it from turning.

All the metal parts, 6, 8, 10, 11, 12, 13, 14 and 16, are preferably made of a non-ferrous metal such as brass, in order not to affect the inductance of the coil, 1, and in order not to increase electrical losses excessively. The outer plate, 13, is of spring metal, such as spring brass, or phosphor bronze.

From the above description, it will be seen that the two nuts, 12 and 18, which are both accessible on the outer end of the resonant circuit assembly, accomplish the two necessary adjustments, namely, an adjustment of the capacity of the resonant circuit by the nut, 16, and an adjustment of the position of the coil, 1, with respect to the core, 3, by the nut, 12. It will also be noted that in both cases the adjustment is against the action of a spring member (11 and 13) and that therefore both adjustments are of such a nature that they will not change due to shocks or vibration.

The base, 7, which carries the complete resonant circuit, may be mounted on any suitable supporting member, 21. This support, which may be the chassis pan of a radio receiver, or which may be a separate member intended to support the several bases for the plural tuned circuits in a tuning unit, may have holes, 22, large enough to admit the base, 7, with small inwardly-projecting ears, 23, which are received in the recesses, 20, of the base, 7. An alternative method of mounting the base, 7, on the supporting plate, 21, is to use small spacing blocks, not shown, at the recesses, 20, to raise the base off the supporting plate, and to provide clearance for the condenser plate, 13, and insulating washer, 17, in which case the hole in the supporting plate need only be large enough to admit the wrenches used to adjust the nuts, 12 and 18, as indicated by the action of the spring, 11.

In general, it is desirable to shield resonant circuits of this type, and particularly is this the case where several such circuits are to be used in the same apparatus, and it is desired to mount them as close together as possible. Such a shield, 24, is shown in Fig. 1, and consists of a non-ferrous metallic cylinder, surrounding and co-axial with the coil structure, 1, and the core, 3, and extend-
The method of connecting the condenser, 2, has the advantage that the internal plate, 14, which is connected to the plate, 27, or grid, 28, of a vacuum tube, is at least partially shielded by the outer plates, 13, 13a, which are at low high-frequency potential.

Having thus described my invention, what I claim is:

1. A resonant circuit including an inductance coil, a condenser, and a relatively movable magnetic core for tuning said circuit over a band of frequencies, said coil and said condenser being mounted on opposite sides of a base, and means external to the condenser and coaxial with the condenser and the coil whereby the capacity value of the condenser and the position of the coil relatively to the core may be initially established.

2. A resonant circuit including an inductance coil, a condenser, a magnetic core, means for relative motion between said coil and said core for tuning said circuit over a band of frequencies and additional means external to the condenser and coaxial with the coil whereby the effective capacity and the effective inductance of said circuit may be adjusted for any position resulting from said relative motion.

3. A resonant circuit including an inductance coil and a condenser, a relatively movable magnetic core for tuning said circuit over a band of frequencies, and means external to the condenser and coaxial with the coil whereby the effective capacity and the effective inductance of said circuit may be independently adjusted.

4. A resonant circuit including an inductance coil, a condenser, and a relatively movable magnetic core, said coil and said condenser being mounted upon opposite sides of a base and having their terminals connected to form said resonant circuit, the end of said coil adjacent said base being so connected as to be at high high-frequency potential.

5. A resonant circuit including an inductance coil, a condenser, and a relatively movable magnetic core for tuning said circuit over a band of frequencies, said coil and said condenser being mounted upon opposite sides of a base and means adjacent the external face of the condenser whereby the capacity value of the condenser and the position of the coil relatively to the core may be initially adjusted to a desired value and to a desired position respectively.

6. A coil and a condenser arranged to be connected to form a resonant circuit and mounted upon opposite sides of a base and means external to the condenser and coaxial with the coil for adjusting the capacity of the condenser and the position of the coil relative to the base.

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