Sept. 9, 1941. R. K. FRAZIER 2,255,730

HIGH FREQUENCY COIL ASSEMBLY

Filed June 2, 1938

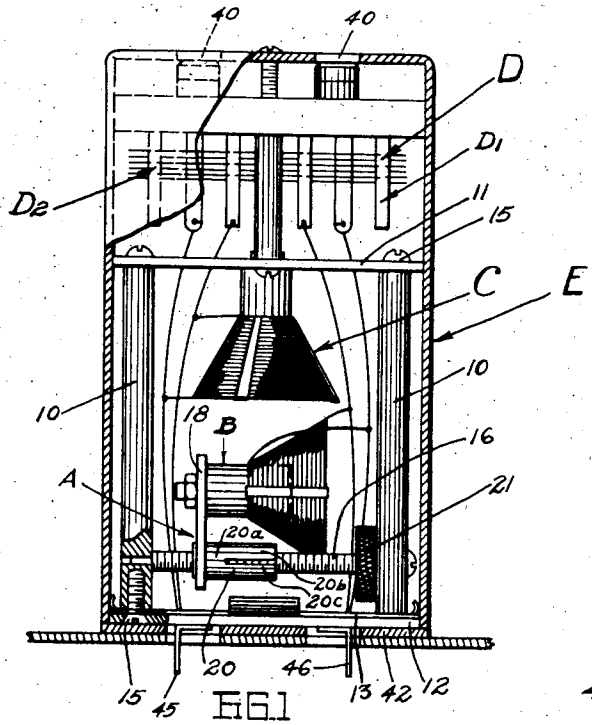


FIG. 1

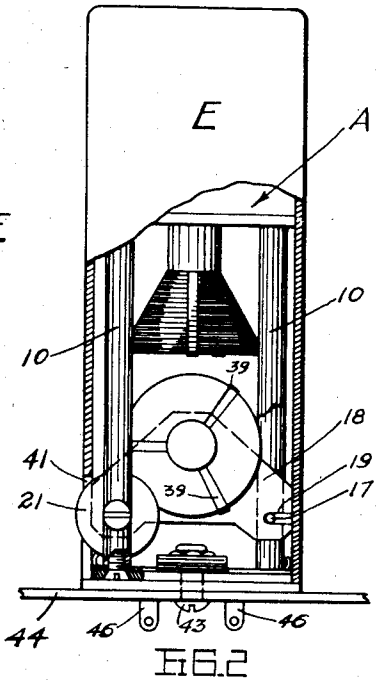


FIG. 2

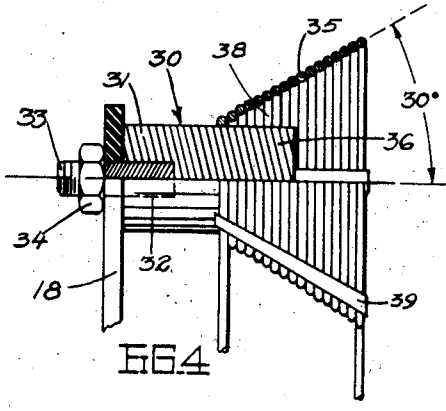


FIG. 4

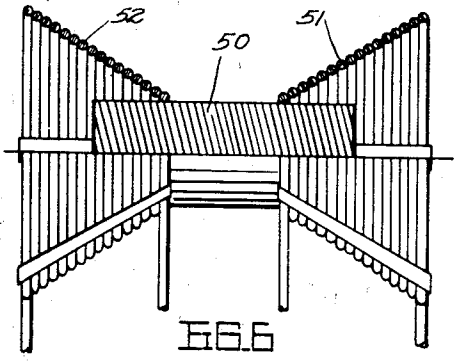


FIG. 6

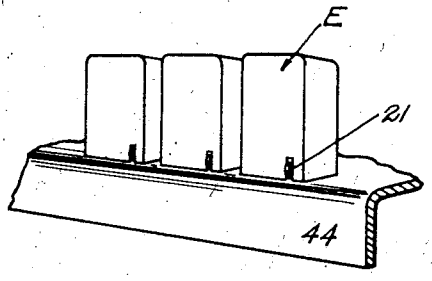


FIG. 3

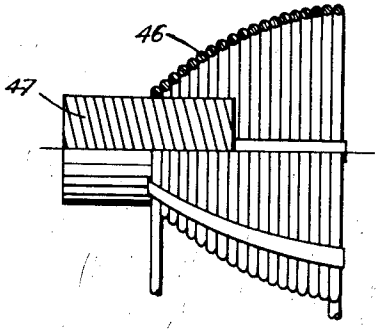


FIG. 5

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2,255,730

HIGH FREQUENCY COIL ASSEMBLY

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Application June 2, 1938, Serial No. 211,361

7 Claims. (Cl. 175—356)

This invention relates to a high frequency coil assembly, and deals with a coil assembly particularly adapted for use in radio circuits.

An object of the invention is to provide an inductor suitable for use in connection with high frequencies and which has a very high reactance as compared with its resistance. It is also desired to provide an inductor which will have high reactance as compared with its resistance even when used within a magnetic shield.

Another object of the invention is to provide an assembly in which two inductors are magnetically coupled, and which, though magnetically shielded, may be easily adjusted from the exterior of the shielding to vary the coupling between the inductors.

A quality of inductors which is particularly critical in coils for use in radio circuits, is the quality which may be defined as the ratio of the coil reactance to the coil resistance at the frequency being used; this quality is commonly known as the "Q" of the coil. It is an important object of this invention to provide a coil which will have a very high Q at high frequencies, even though the coil be disposed within a magnetic shield.

In high frequency radio work it is common practice to use coils of cylindrical form which may have either an air core or an iron core of finely divided comminuted iron particles. The use of cores made of comminuted iron particles is generally considered superior because of the increased magnetic permeability. However, there has been no known way to construct iron core inductors which have very high Q ratings. It has been possible to construct air core coils of a very high Q value. For example, a cylindrical air core coil of about 3 inches in diameter and 4 inches in length may be constructed which has a Q as high as 400, but coils of such size are too large and cumbersome to be suitable for radio use. Also it has been found that magnetic shielding of radio frequency inductors of known types tends to materially reduce their Q rating. Accordingly, it is an important object of this invention to provide an iron core inductor which is compact in form and which has a very high Q rating. It is also desired that the Q of the coil be diminished by a minimum when the inductor is magnetically shielded.

I have found that by making the coil of the inductor in the form of a conoid or ellipsoid and mounting this coil on the end portion of a magnetic core, a structure is produced which will yield a very high Q rating, and that this structure may be magnetically shielded with but a small decrease in the Q rating of the device.

The improved coil end assembly will be more clearly understood with reference to the accompanying drawing in which—

Figure 1 is an elevational view partly in section of a structure embodying the invention, the casing being broken away to show the interior structure;

Figure 2 is a view similar to Figure 1 but in end elevation;

Figure 3 is a perspective view of a series of the structures shown in Figures 1 and 2, mounted on a radio chassis;

Figure 4 is a detailed view of one embodiment of the improved inductor, the view being taken partly in section;

Figure 5 is a view of a modified form of inductor embodying the features of this invention, and

Figure 6 is another view of a modified form of inductor assembly, this modification being in the form of a transformer.

As illustrated in Figures 1 to 4 of the accompanying drawing, A designates a frame; B, a primary coil mounted in the frame; C, a secondary coil mounted in the frame; D, condensers electrically associated with coils B and C; and E, a magnetic shield about the structure.

The frame A may be of any suitable type, and as here shown comprises the posts 10, of any suitable material, which extend between the end-plates 11 and 12. These plates may be of any suitable insulation material. Between posts 10 and bottom plate 12 is a shield plate 13 which forms a part of the magnetic shield about the assembly. The screws 15 extending through end plates 11 and 12 secure these plates firmly to post 10.

On the front side of frame A is the screw member 16 which has its ends journalled in the front pair of posts 10. On the rear side of frame A is the guide bar 17 which has its ends secured in the rear pair of posts 10. Carried by screw member 16 and the guide bar 17 is the coil carrier 18 which, as here shown, comprises a plate of insulating material of the general shape shown, having a slot 19 which engages the guide bar 17, and having the tapped piece 20 which engages the screw member 16. In the construction shown the piece 20 has a slot 20^a and the tiny portions 20^b and 20^c may be squeezed together to form a tight frictional engagement with the screw member 16. Secured to one end portion of the screw member 16 is a knurled wheel

21 which may be operated to rotate the screw 16 for moving the carrier 18 axially of the screw.

Mounted on carrier plate 18 is the improved inductor, more clearly illustrated in Figure 4 of the drawing. As illustrated, the inductor comprises a magnetic core 30 preferably composed of finely divided iron particles and having a substantially cylindrical outer surface. At the rear end portion 31 of this inductor is an axial indentation 32 into which is secured a threaded mounting bar 33. The core 30 may be conveniently mounted to plate 18 by having the bar 33 extended through an opening in this plate and a nut 34 turned on to the end of bar 33.

The coil 35 comprises a number of turns of wire and is in the form of a conoid. The smaller end of the coil is secured to the surface of the core 30, and the outer larger end of the coil extends beyond the end of this core. Preferably, the surface formed by the coil 35 makes an angle of substantially 30° with the axis of the coil. Other inclinations such as 20° or 45° may be used to secure good results, but I have found that an inclination of about 30° is preferable. The end portion 36 of the core 30 extends through the opening in the smaller end of the coil to about the longitudinal center of the coil. As will be observed from Figure 4, the coil 35 is spaced from and is out of contact with the extended end of the core.

In constructing the improved inductor, the wire, which may be cotton covered or otherwise insulated, is wound upon a conical mandrel. If desired, one or more strips of cotton tape 39 may be extended longitudinally of the coil for providing structural support. After the winding is formed, a coating of some dielectric binder such as "Q-max" is applied to the turns and cotton strips for structurally securing the turns in place. The coil is then removed from the mandrel and the core 30 inserted into the opening in the smaller end.

The core and coil may be dipped into the Q-max or other dielectric binder and the turns of the coil thus firmly secured together and to the core. I have found that best results are obtained if only the end turn or perhaps two turns at the end of the coil 35 are in contact with the core. It is essential that the end portion of the core which is disposed within the coil be free from and not in contact with the inner surface of the coil. As shown in Figure 4, an airspace 38 extends between the turns of wire and the portion 36 of the core. This construction is believed to be important in obtaining a very high Q value. I have found that very good results may be obtained by using a coil of 23 turns and formed of size No. 24 cotton covered wire, and with a core of about ⅜" diameter and ⅝" long, for frequencies of from 6 to 9 megacycles. However, other sizes of core and wire and other numbers of turns may be used.

Mounted on the top frame plate 11 is a secondary inductor C which may be structurally the same as inductor B just described. Inductor C has its axis extending vertically and is disposed immediately over the inductor B. Thus it will be clear that the two inductors B and C are magnetically coupled.

In the illustrated construction, a pair of condensers D are mounted on the top side of plate 11. One of these condensers, D_1, is electrically connected in parallel with the coil 35 of inductor B; and the other of these condensers, D_2, is electrically connected in parallel with the coil of inductor C.

The magnetic shield E comprises a metal can of rectangular shape which fits over the condensers D and frame A enclosing the magnetically coupled inductors. The shield E, however, may take any other suitable form. At its top are the two openings 40 which provide means for access for tuning the condensers D, and on the front side of this shield is a slot 41 through which the knurled wheel 21 extends.

The base plate 12 rests upon an insulated plate 42 and is secured by such as the bolt 43 to any suitable base frame or chassis such as 44 seen more clearly in Figure 3 of the drawing. The bottom edge of the shield can E is adapted to resiliently engage the plate 13 and to be removable therefrom when desired.

As seen more clearly in Figures 1 and 2, contacts 45, which extend through openings in frame pieces 42 and 44, may be electrically connected through opposite ends of the coil on inductor C; and the contacts 46, which also extend through openings in frame members 42 and 44, may be electrically connected through the opposite ends of coil 35 on inductor B. The structure above described provides a pair of inductively coupled circuits which may be tuned to the same frequency. Any number of these structures may be used in the latter apparatus as may be desired; as shown in Figure 3, three of such units are shown mounted side by side on the same frame base.

To adjust the apparatus for closer or looser coupling between the inductors it is not necessary for the operator to remove the magnetic shield, but through simple manipulation of the knurled wheel 21 which is accessible from the exterior of the casing, he may adjust the coils to such position as to yield the desired coupling between the circuits. Turning of the knurled wheel causes screw member 16 to rotate and this produces axial movement of the inductor B which changes the linkage of flux between inductors B and C.

With the shield can E removed, I have found that the inductors of the improved construction just described, yield a much higher Q value. I found that with coils of the ordinary type in which a number of turns are wound in contact with a cylindrical core, the Q value obtained in one instance was 180, while with the improved inductor of this invention the Q value obtained was 240. In the same situation I found that when an inductor having its winding in the form of a 45° conoid was used, the Q rating was 210. Also I found that the addition of a metallic shield reduced the Q of the ordinary coil from 180 to 130, while in the case of the improved inductor the Q was reduced from 240 to 215. Thus it is clear that the improved inductor is not only more efficient but is less affected by the presence of a metallic shield. The quantities mentioned in the above example are illustrative only and are given only for the purpose of indicating the advantage to be gained by the inductor of improved construction.

In Figure 5 is shown a modified form of inductor which is identical with the type shown in Figure 4 except that the winding 46 determines substantially the surface of an ellipsoid rather than a conoid. As here shown the winding 46 flares outwardly from its smaller end and is entirely free from the extended core end 47. This form of inductor may be constructed substantially the same as was explained in connection with the construction of Figure 4. This modified type of inductor also yields a very high Q value which

may even be greater than that obtained by use of the type shown in Figure 4. Due to the curvature of the coil surface, however, more difficulty may be experienced in forming the coil turns and in making them structurally secure. This modified type of inductor may be mounted just as was described in the case of inductor B and may be substituted for inductor B whenever desired.

Another modified construction is shown in Figure 6. This modification comprises a core 50 in the form of a bar which may be cylindrical in shape. About one end portion of the bar extends a primary coil 51 which is a coil similar to coil 36 already described. Coil 51 has its smaller end secured to the exterior of core 50 and determines a surface which makes an angle of about 30° with the axis of the core. As in the case of the first described embodiment, the core 50 extends into the interior of coil 51 to about the longitudinal center of the coil. Extending about the other end of core 50 is the coil 52 which has its smaller end secured to this core, and which determines a surface making an angle of about 30° with the axis of the core 50. The construction of this embodiment may be generally the same as already described in the first mentioned embodiment. Preferably the core 50 is of finely divided magnetic materials firmly bound together in a way already known to the art. The structure shown in Figure 6 may be used as a high frequency transformer, one of the coils 51 and 52 being the primary winding, and the other of these coils being the secondary winding. The same advantages as to high Q quality is here obtained as in the case of the preferred embodiment.

It is apparent that many other embodiments may be constructed, and many changes may be made in the details of construction without departing from the spirit of the invention. The foregoing detailed description has been given for clearness of understanding only and no unnecessary limitations should be understood therefrom but the appended claims should be construed as broadly as permissible in view of the prior art.

What I claim is:

1. An electrical inductor comprising a coil having a plurality of turns and determining an outwardly flaring surface toward its larger end, said coil having openings at each of its ends, and a magnetic core of finely divided comminuted magnetic material disposed within the opening at the smaller end of said coil and extending axially within said coil to a terminus substantially mid way between said ends, the extended end of said core being spaced from and out of contact with said coil.

2. An electrical inductor comprising a magnetic core of finely divided materials and cylindrical in form, and a coil of wire comprising a plurality of turns and determining a conical surface which makes an angle of substantially 30° with its axis, said coil being disposed coaxially with said core and having one of its turns at its smaller end secured to the surface of said cylindrical core, and the larger end of said coil extending axially beyond one end of said core with the coil being spaced from the said end of the core.

3. An electrical transformer comprising a magnetic core of finely divided materials and in the form of a bar, a primary coil having a plurality of turns and determining an outwardly flaring surface towards its larger end, said coil extending about one end portion of said core and having its larger end extending axially beyond and free from said end of the core, and a secondary coil comprising a plurality of turns and determining an outwardly flaring surface towards its larger end, said secondary coil extending axially beyond and free from the extreme end of the other end portion of said core.

4. An electrical inductor comprising a coil having a plurality of turns and determining a surface substantially in the form of an ellipsoid, said coil having a smaller end opening and a larger end opening, and a magnetic core extending through said smaller end opening and terminating within the interior of said coil, said coil being spaced and free from the interior end of said core.

5. An electrical inductor comprising a coil having a plurality of turns of insulated wire and determining a flaring surface substantially in the form of an ellipsoid and having a small end and a large end, and a magnetic core substantially cylindrical in form and comprising finely divided comminuted magnetic material, said core being secured to said small end of the coil and extending into the interior of said coil to a terminus point substantially equal to one-half the length of said coil, said coil being free and spaced from the extended end of said core.

6. An electrical inductor comprising a coil having end portions of different diameters, said coil having openings at each of said ends, and a magnetic core supporting said coil and extending through the opening of the smaller of said end portions and terminating within said coil at a point intermediate said end portions.

7. An electrical inductor comprising a coil having end portions of different diameters, said coil having openings at each of said ends, and a cylindrical magnetic core supporting said coil and extending through the opening of the smaller of said end portions and terminating within said coil at a point intermediate said end portions, the major portion of said core being disposed outside the limits of said coil.

RADFORD K. FRAZIER.