April 6, 1948. H. WALKER 2,439,277

HIGH-FREQUENCY COIL

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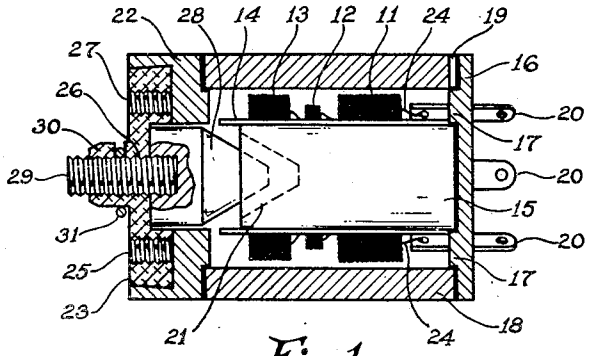


Fig. 1

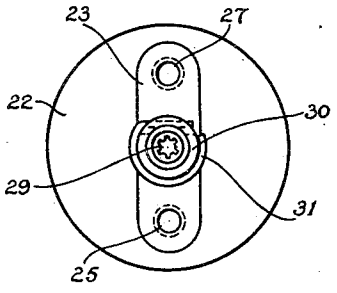


Fig. 3

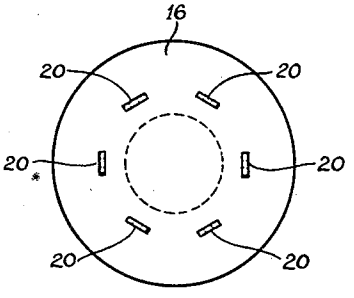


Fig. 2

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HIGH-FREQUENCY COIL

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5 Claims. (Cl. 171—119)

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This invention relates to coils for use at radio frequencies and more particularly to coils of this type located within a magnetic housing.

Within the past decade, material changes have taken place in the design of radio frequency coils due to the increasing use of powdered iron magnetic circuits for these units. In the earlier employed air core coils, the diffuse distribution of the magnetic field of the coil required the use of shielding containers which were necessarily large in size if losses introduced in the coil were to be minimized. Introduction of a ferromagnetic core within the coil increased the inductance and Q thereof, but did not materially restrict the field distribution. At the present time best practice locates the coil on a core within a magnetic shell concentrating and confining the magnetic field. Openings are provided in the middle of the magnetic shell through which leads connected to the internal coils are brought, and the entire assembly is clamped in a container of low loss insulating material. Terminals are mounted in the insulating case and the wire leads referred to are connected to these terminals after threading through the openings in the magnetic shell from the interior thereof. This assembly, which is most widely used at present, has a number of defects limiting its utility in application to contemporary electronic equipment. Since the case serves as the clamp, the coil and magnetic circuit assembly are not conveniently handled apart therefrom, the volume of the complete unit ready for installation considerably exceeds that of the coil and magnetic circuit assembly alone, and the threading of the wire leads through the openings in the shell and subsequent manipulation of same cause lead breakage, forcing the rejection of otherwise acceptable units. Also, relative movement between the case and the coil unit after assembly may break or short circuit the connecting leads to the terminals carried by the case.

One of the principal objects of the invention is to provide a new and novel radio frequency coil assembly of reduced volume and greater durability.

Another object of the invention is to provide a new and novel radio frequency coil assembly in which the connecting terminals are carried directly by the magnetic member associated with the coil.

A further object of the invention is to provide a new and novel radio frequency coil assembly in which the magnetic circuit member associated with said coil simultaneously performs the functions of mounting, shielding and support of the connecting terminals.

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Yet another object of the invention is to provide a new and novel completely enclosed radio frequency coil assembly in which the connecting leads to the coil may be attached to the fixed terminals without threading through the surrounding magnetic shell.

The above objects and advantages of the invention are realized in a structure in which the coil is mounted on a magnetic core affixed to a disc of non-conducting magnetic material carrying a plurality of conducting terminals embedded therein. This disc abuts a hollow shell within which the coil is located and whose other end may be closed by a second member of magnetic material. A threaded insert in said second member may afford means for securing the assembly to the surface of a panel in the operative apparatus.

Other objects and advantages of the invention will in part be disclosed and in part be obvious when the following specification is read in connection with the drawings in which:

Figure 1 is a sectional view showing the improved coil assembly.

Figure 2 is an end view of the terminal end of said assembly.

Figure 3 is an end view of the mounting and adjustment end of said assembly.

Referring now to Figure 1, a sectional view of the completed assembly may be seen, in which the coils 11, 12 and 13 are cemented in place on the paper or plastic sleeve 14 slipped over the magnetic core 15, which may be cemented at its base to the end cap 16, also of magnetic material. As the assembly is intended for use at frequencies in the radio frequency spectrum, i. e. above 15,000 cycles per second, the magnetic members are preferably formed of insulated finely divided particles of ferromagnetic material. These materials are available in two general forms, one of which makes up into conductive bodies having high permeabilities, while the other makes up into non-conducting bodies having relatively low permeabilities. In the manufacture of bodies of the second class, iron particles having a diameter of 0.005 inch or less may be mixed with a synthetic resin, the resulting mass pressed into the desired shape, and the body hardened in the final form by polymerization of the resin. Considered macroscopically, this results in a non-conductive magnetic material, though from a microscopic viewpoint the body is constituted largely of conductive particles. It is the macroscopic view which is here adopted,

and where the term non-conductive magnetic material is employed it is to be given its macroscopic meaning. With the exception of the disc shaped cap 16, which must be of the non-conducting type of material, the magnetic members of the assembly may be made of either type of material. The coil losses will be somewhat lower if the non-conducting type be employed throughout. The end of the core 15 remote from the disc 16 is provided with a conical depression 21 to facilitate adjustment of the coil in the finished assembly as will be described later.

The disc 16 is provided with an annular locating projection 17 over which is slipped the tubular shaped magnetic shell 18. The shell 18 and disc 16 may be provided with a cooperating lug and notch as at 19 for the purpose of relatively indexing the members to a predetermined position, and be cemented together at the plane of juncture.

In the particular embodiment illustrated, six conducting lugs 20 are molded into and supported directly by the disc 16, the lugs extending for an appreciable distance from either side of the disc. These lugs may conveniently be made of brass and be cadmium plated or tinned to facilitate soldering of wire leads 24 thereto. The other end of the shell 18 is closed by the cap 22 of magnetic material which may have molded therein the mount bar 23 provided with the threaded apertures 25, 26 and 27. The end apertures 25 and 27 serve to receive the mounting screws used to secure the coil assembly in position in the operating apparatus, while a conical shaped movable core piece 28 is carried by the threaded rod 29 situated in the central aperture 26. The mount bar 23 is provided with an extended boss 30 at the central aperture 26, and this extension 30 is under cut at one side to permit a locking spring 31 slipped over the extension 30 to ride on the screw 29, preventing undesired disturbance of the inductance setting. Rotation of the adjusting screw 29 clockwise or counterclockwise serves to increase or decrease the inductance of the coils within the assembly as the effective air gap is decreased or increased.

The arrangement of the connecting terminals 20 in the disc 16 is clearly shown in Figure 2, indicating the radial distribution of these elements about the center of disc 16. The leads from the circuits in which the inductances are to operate are connected directly to the terminals 20.

The structure of the mounting end of the coil assembly may be most clearly seen in Figure 3, which is an end view thereof. The mounting screws are introduced in the threaded apertures 25 and 27, while the central boss 30 and adjusting screw 29 project through an opening in the mounting surface for easy accessibility.

A typical assembly procedure will now be outlined, assuming that all the component parts have already been fabricated. The core 15 is first cemented to the end disc 16 and the sleeve 14 bearing the coils 11, 12 and 13 is slipped into position on the core 15 and likewise cemented in place. The wire leads 24 of the various coils are now brought down and soldered to the appropriate terminals 20. As the shell 18 is not yet present, these connections are made simply and with ease, and since the coils and the terminals are carried on the same support, the danger of breakage due to subsequent displacement is eliminated. Meanwhile, the cap 22 has been fitted with the movable core piece 28 and cemented to the shell 18, and this sub-assembly is now similarly secured to the

disc 16 carrying the coils and their associated terminals. By connection of the coils to appropriate test apparatus through the leads 20, the inductance values may now be adjusted to the desired final magnitude by rotation of the adjustment screw 29 in one direction or the other.

It has generally been the practice in the manufacture of adjustable inductors to incorporate an adjustable air gap in which the surfaces of the adjustable members were parallel and disposed normally to the direction of relative motion. The herein disclosed form of the relatively movable members has been found to afford much smoother control of inductance throughout the range of variation. Whatever the precise form, however, it is preferable that the form of the cooperating members be that of a figure bounded by a surface of revolution.

It will be obvious that many changes and modifications may be made in the invention without departing from the spirit thereof as expressed in the foregoing description and in the appended claims.

I claim:

1. In induction apparatus, a coil provided with connecting members, a magnetic shell disposed externally of said coil, a substantially non-conductive end member including magnetic material abutting one end of said shell and having embedded therein a plurality of conductive terminals extending completely through and in electrical contact with said end member, said terminals engaging said connecting members, a core of magnetic material abutting said end member and extending within said coil, a second end member of magnetic material engaging the other end of said shell, provided with a threaded aperture, and a magnetic member supported on a screw engaging said threaded aperture.

2. In induction apparatus, a coil provided with connecting members, a magnetic shell disposed externally of said coil, a substantially non-conductive end member including magnetic material abutting one end of said shell and having embedded therein a plurality of conductive terminals extending completely through and in electrical contact with said end member, said terminals being connected to said connecting members, a core of magnetic material within said coil abutting said end member at one end and terminating in a conic depression at the other end thereof, a second end member of magnetic material engaging the other end of said shell provided with a threaded aperture, and a magnetic member of conic form supported on a screw engaging said threaded aperture.

3. In induction apparatus, a coil provided with connecting members, a magnetic shell disposed externally of said coil, a substantially non-conductive end member including magnetic material abutting one end of said shell and having embedded therein a plurality of conductive terminals extending completely through and in electrical contact with said end member, said terminals being connected to said connecting members, a core of magnetic material within said coil abutting said end member at one end and terminating in the form of a figure of revolution at the other end thereof, a second end member of magnetic material engaging the other end of said shell provided with a threaded aperture, and a magnetic member in the form of a figure of revolution complementary to said first mentioned figure of revolution supported on a screw engaging said threaded aperture.

4. In induction apparatus, a coil provided with connecting members, a magnetic shell disposed externally of said coil, a substantially non-conductive end member including magnetic material abutting one end of said shell and having embedded therein a plurality of conductive terminals extending completely through and in electrical contact with said end member, said terminals being connected to said connecting members, a circularly symmetrical core of magnetic material within said coil abutting said end member at one end and terminating in the form of a figure of revolution at the other end thereof, the axis of symmetry of said figure coinciding with the axis of symmetry of said core, a second end member of magnetic material engaging the other end of said shell, a mounting member having three linearly spaced threaded apertures embedded in said second end member, and a magnetic member in the form of a figure of revolution complementary to said first mentioned figure of revolution supported on a screw engaging one of said threaded apertures, the axis of the figure of revolution of said magnetic member coinciding with the axis of said screw.

5. In induction apparatus, a tubular shell of magnetic material, a cylindrical coil of wire coaxially located within said shell, a substantially non-conductive disc including magnetic material abutting one end of said shell and having embedded therein in radially disposed fashion about the center thereof a plurality of conductive terminals extending completely through and in electrical contact with said disc, lead wires connecting said coils with said terminals, a cylindrical core of magnetic material coaxially disposed

within said coil abutting said disc at one and terminating in the form of a figure of revolution at the other end thereof, the axis of symmetry of said figure coinciding with the axis of symmetry of said core, a second disc of magnetic material engaging the other end of said shell, a mounting member having three linearly spaced threaded apertures embedded in said second disc, one of said apertures lying on the axis of said shell, and a magnetic member in the form of a figure of revolution complementary to said first mentioned figure of revolution supported on a screw engaging said one of said threaded apertures, the axis of the figure of revolution of said magnetic member coinciding with the axis of said screw.

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