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W. D. LA RUE ET AL

2,168,351

ADJUSTABLE MAGNETIC-CORE INDUCTOR

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Fig. 1.

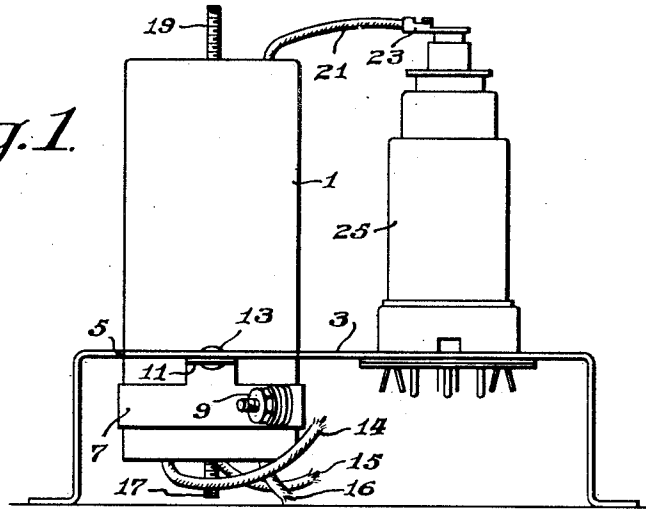


Fig. 2.

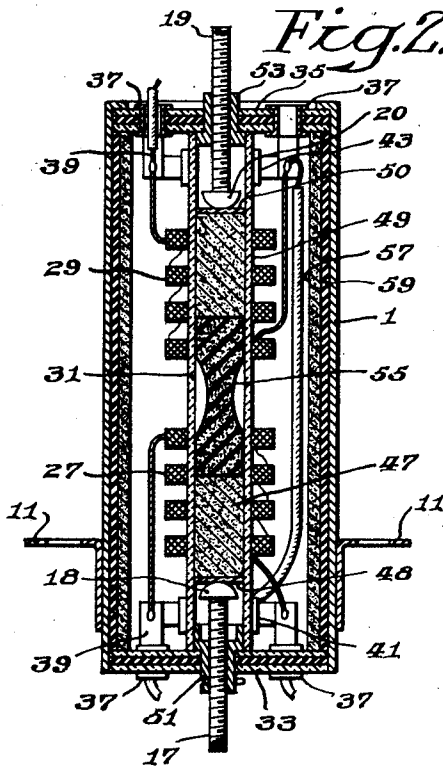
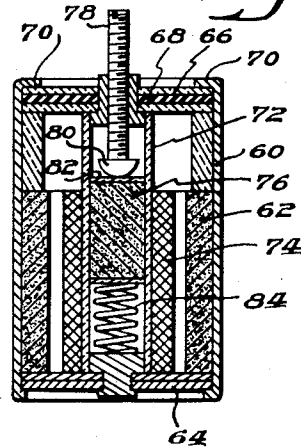


Fig. 3.



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ADJUSTABLE MAGNETIC-CORE INDUCTOR

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Application August 31, 1936, Serial No. 98,748

3 Claims. (Cl. 171-242)

This invention relates to high frequency paramagnetic core inductors, particularly to adjustable magnetic core inductor units for use in radio and other systems for the communication of intelligence, and has special reference to the provision of improvements in adjusting mechanisms for such devices.

High frequency inductor units of the type which include comminuted magnetic cores for increasing the effective inductance of the windings at radio frequencies find useful application in radio receivers where they may be employed, for example, as coupling units. Such coupling units are fast supplanting other types of couples in applications where accuracy of tuning, ease of assembly and adjustment, compactness, and low cost are prime desideratum.

Present day magnetic core inductors are usually constituted, essentially, of a shielded casing enclosing an inductor and a core of laminated or of molded comminuted magnetic material within the inductor. The magnetic core has embedded, or otherwise affixed therein, an adjusting screw which terminates exterior of the casing, and which supports the core for adjustment within the inductor.

It has been found that in devices so constructed the very presence of a metal adjusting screw sets up undesired eddy currents in the device. Among the other disadvantages inherent in units wherein the adjusting screw is embedded in the core are (a) large breakage losses in manufacture and (b) wear about the surface of the core due to turning in the adjusting operation.

Accordingly, an object of the present invention is to provide an adjustable high frequency inductor wherein losses due to eddy currents are substantially obviated.

Another object of the invention is to simplify the construction and operation of high frequency, adjustable, inductor units whereby to prevent shrinkage in manufacture and to minimize wear in use.

Still another object of the invention is to provide a rugged coupling unit which is substantially immune to the effects of jars and jolts during manufacture, transportation, assembly and operation.

A further object of the invention is to provide a simple, inexpensive, trouble-free, adjustable, coupling unit and one which lends itself readily to mass production methods.

The above and other objects are accomplished in accordance with the invention by the provision within the inductor element of a magnetic core

adapted to be adjustably positioned therein by straight line movement with a minimum of friction and without any twisting or turning movement. The core itself has no protuberances, that is to say the shaft, rod, or screw for imparting movement to the core is not embedded therein but forms a separate element touching the core only adjacent the end of the casing about the core. A spring of rubber or other non-magnetic material is provided contiguous the opposite end of the core and the adjusting force applied by the shaft to the core is exerted against this spring which is compressed thereby to effect movement of the core in the return direction whenever such movement is required.

While the invention will be described as embodied in a paramagnetic core inductor unit which is similar in many respects to the coupling unit disclosed in copending application Serial No. 56,993 filed December 31, 1935, to Robert L. Harvey it is to be understood that the invention is not to be limited in its useful application to such embodiment as the disclosure in this respect is merely illustrative for purposes of explaining the inventive concept.

In the accompanying drawing—

Figure 1 is a side elevational view of a portion of a radio chassis having mounted thereon a radio tube and a coupling unit therefor of the type shown in the earlier Harvey case and illustrative of one type of device wherein the adjusting mechanism of the present invention may be advantageously employed.

Figure 2 is a side elevational view in section of an intermediate frequency transformer or coupling unit including a magnetic core and embodying a core moving mechanism constructed in accordance with the invention, and

Figure 3 is a side elevational view, partly in section, of a radio frequency inductor unit showing a modified form of the invention.

Referring first to Fig. 1 which shows an assembly of a coupling unit and a radio tube similar to that shown in the above identified Harvey application. An intermediate frequency coupling unit housed in a shielding container 1 is mounted on the metal chassis 3 of a superheterodyne radio receiver, preferably with the unit extending through an opening 5 in the chassis. For the conservation of space, the lower portion of the unit extends below the lower surface of the chassis and is preferably mounted thereon by means of a clamp 7 which encircles the container 1 and is clamped thereto by means of a bolt and nut 9. The clamp is provided with a pair of hori-

zontal flange portions 11 which are riveted to the chassis at 13 in a manner that will appear obvious. The unit may readily be removed for servicing by disconnecting the outer ends of leads 14, 15 and 16 and loosening bolt 9. The coupling unit is provided with tuning adjustment screws 17 and 19 at its respective ends, below and above the surface of the chassis, respectively. This provides a very convenient and accurate adjustment means without the use of special tools, for purposes of convenient assembly as well as subsequent servicing if necessary.

For the reduction of capacity coupling, one of the leads 21 from the unit is brought out from the top and is provided with a clip 23 adapted to engage the grid terminal of a vacuum tube 25, one of the new metal envelope, small size, vacuum tubes (Radiotron type No. 6K7 being shown).

Referring now in detail to the interior of the coupling unit as shown in Fig. 2, the transformer consists of universal sectional wound primary and secondary coils 27 and 29 fixedly mounted on a sleeve 31 of insulating material such as fibre tubing. The tubing is concentrically mounted within the shield container 1 by means of the end closing plates 33 and 35, respectively. The end plates are provided with eyelets 37 from which depend terminals 39 which in turn support and electrically connect condensers 41 and 43, respectively. The terminal ends of the coils 27 and 29 are also electrically attached to these terminals 39.

The transformer coils 27 and 29 are provided with adjustable cores 47 and 49, respectively, disposed in sliding relation within the bore of the sleeve or tube 31. The cores consist preferably of granular magnetite ore. This material, as sifted natural sized sand particles or as granules crushed from larger sized pieces of ore, is mixed with an insulating binder, preferably phenol condensation resin, of the type commercially known as "Durez resin #S6606". The mixture is sand-like and is poured into a suitable mold which is heated to a temperature of about 140° C. and subjected to a molding pressure of about twenty-five tons per square inch for a period of about one second to allow the binder to flow but not become cured. The specified ore and resin, so treated, have been found to produce low-loss cores of greater mechanical strength than cores molded in the usual manner and with other materials.

The adjusting screws 17 and 19, which are preferably of brass or other non-magnetic material, are not embedded in the cores, as dictated by the prior art, but constitute separate elements journaled in preferably counter-sunk bushings 51 and 53 adjacent the respective ends 33, 35 of the container. The cores 47 and 49 are each provided with an insulating washer 48, 50 cemented, glued, or otherwise affixed to the respective core outer ends and against which the adjusting forces transmitted by the screws 17, 19, through their screw heads 18, 20 are exerted. Alternatively, the screw heads 18, 20 or the heads of the screws may be formed of hard rubber or of other suitable non-magnetic insulating material, in which case the insulating washers may be omitted.

A spring 55, which may be constituted of a mass of soft or sponge rubber, occupies the space between the respective opposite inner ends of the cores 47, 49, within the bore of the tube or sleeve 31. The adjusting force applied in the inward direction by the screws 17 and 19 to the cores

47 and 49, is exerted against this spring 55 which is compressed thereby to effect movement of the cores in the return or outward direction when the screws are turned in the direction opposite to that required to effect inward movement of the cores. Preferably, the device is assembled with the spring material at least slightly compressed when the cores are separated the maximum permissible distance. The cores in the drawing are shown in about the normal intended operating position.

As taught by the earlier Harvey application, it is desirable that the circuit constants be made such that it is not necessary to insert the cores into the support sleeve 31 a distance further than about midway between the innermost adjacent two sections of each of the transformer windings 27, 29. The cores may be adjusted to this "maximum" position to vary the self-inductance of each coil without materially changing the coefficient of coupling between primary and secondary. In order to insure against travel of the cores beyond this point, various limiting structures may be employed if desired. It is not always necessary, however, to complicate the device by the addition of such auxiliary limiting means as the rubber can be of such consistency as to reach its limit of compression at a point corresponding to that of the "maximum" position of the core.

As in the Harvey application, an interlining 57 is provided for the shielding case. It may be of the same molded magnetic material as in the cores. This interliner may be molded in sections, two sections being shown in the drawing and assembled into the container, and separated therefrom by a thin sheet of insulating material 59, if desired. The insulation may be omitted and the interliner cemented in the container. The effect of the molded shielding interliners is to effectively reduce the reactive effect of the shielding container upon the coils. This advantage can be used to improve the efficiency or factor of merit of the coils with a given construction, or can be used to make possible a substantially smaller overall construction of coupling unit, with the same efficiency as before.

In the embodiment of the invention shown in Fig. 3, 60 designates the outer shielding casing or can and 62 is an inner shield of magnetite molded under pressure within the shielding container and forming a unitary construction provided with end plates or closures 64 and 66. The plate 66 is held in spaced relation by means of a spacer 68 of insulating material, the ends of the shielded container being bent over at 70 to secure the parts in place. As in Fig. 2, a centrally disposed hollow sleeve, here designated 72, is provided. The coil 74 wound thereabout may represent a single inductor or a primary and secondary, respectively, of a broadly tuned radio frequency or intermediate frequency transformer wherein the distributed capacity of the coils is used instead of physical condensers as part of the tuned circuits. Here but a single core 76 is provided within the hollow sleeve 72. As in the device of Fig. 2, the core may be moved inwardly, by turning a screw 78 which passes through the end plate 66; this screw is provided adjacent the core 76, with a rounded head 80 which contacts an insulating washer 82 fixed to the end of the core. Movement of the core within the sleeve is effected without imparting appreciable twisting or turning movement thereto.

A spring 84 which is preferably composed of brass or other non-magnetic material is fitted in

the sleeve 72 between the lower end-plate 64 and the core 72. When the spring is of metal it is preferably sheathed in rubber so that its turns may not be short circuited to form a current carrying loop. The spring 84 maintains the opposite end of the core 76 against the screw-head 80 and the adjusting force applied by the screw, in the inward direction, to the core is exerted against this spring which is compressed thereby and effects movement of the core in the return direction when the screw 78 is adjusted to permit of such movement.

Other modifications and applications of the invention will suggest themselves to those skilled in the art. It is to be understood, therefore, that the foregoing is to be interpreted as illustrative and not in a limiting sense except as required by the prior art and by the spirit of the appended claims.

What is claimed is:

1. A high frequency inductor unit comprising a hollow sleeve of insulating material supporting means disposed at each end of said sleeve, a transformer comprising primary and secondary inductors mounted in spaced relation along said sleeve, a pair of cores individual to said primary and secondary inductors within said sleeve,

means individual to each of said cores and extending between each of said supporting means and the core next adjacent thereto in the interior of said sleeve for moving said cores respectively in a given axial direction with respect to said inductors whereby to independently change the self-inductance of each of said inductors, and separate means within said sleeve and positioned between said cores for effecting movement of said cores in the reverse direction with respect to said primary and secondary inductors of said transformer, said cores being spaced from each other a distance substantially greater than that between said inductors to prevent a material change in the coefficient of coupling between said inductors when their self-inductance is varied.

2. The invention as set forth in claim 1 wherein said separate means between said cores comprises a resilient member.

3. The invention as set forth in claim 1 wherein said separate means between said cores comprises a resilient member having a limit of compression corresponding to the desirable maximum inward movement of said cores.

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