

Feb. 10, 1948.

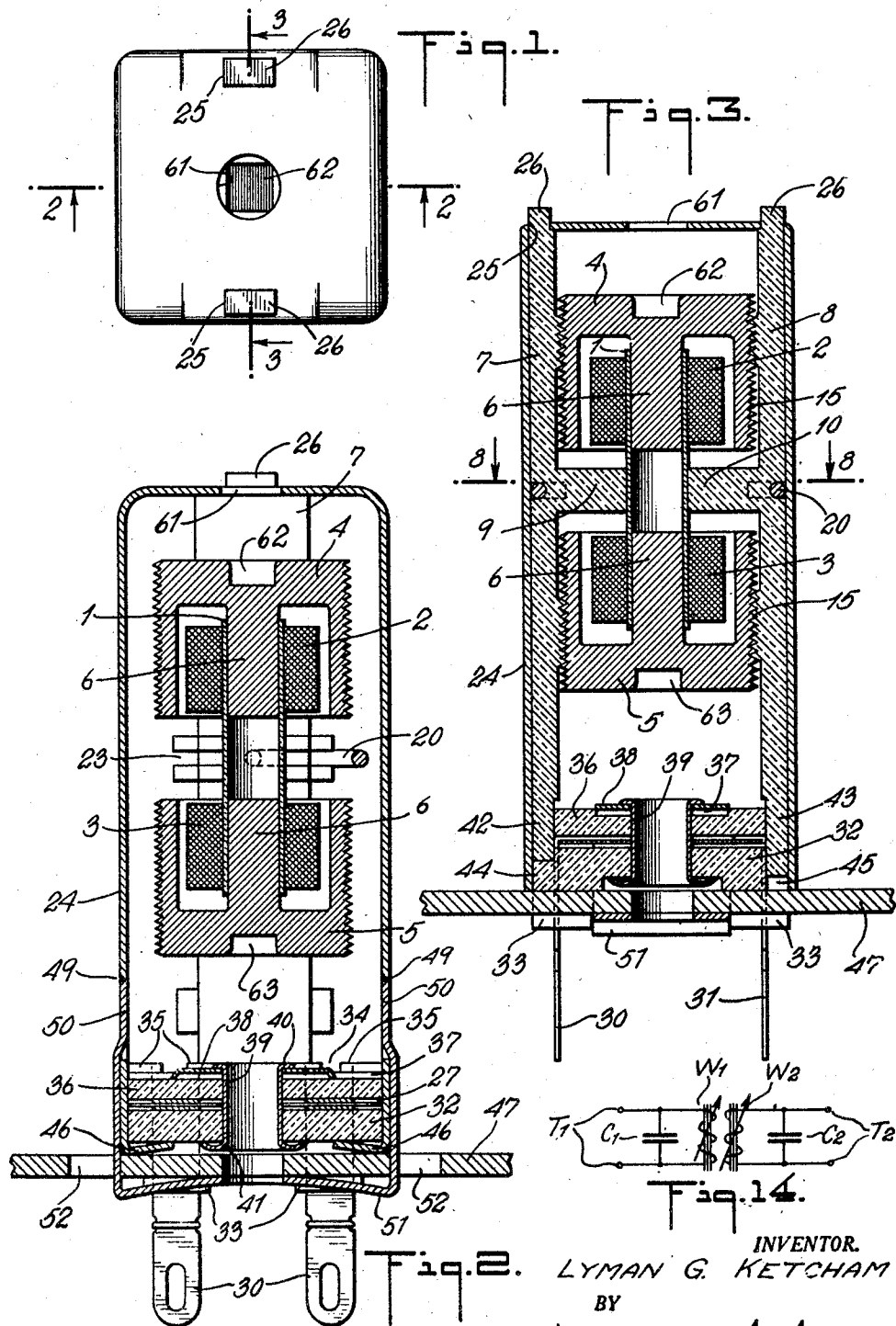
L. G. KETCHAM

2,435,630

TUNED TRANSFORMER ASSEMBLY

Filed June 2, 1945

3 Sheets-Sheet 1



INVENTOR.
 LYMAN G. KETCHAM
 BY
Hand, Cady & Wood
 ATTORNEYS

Feb. 10, 1948.

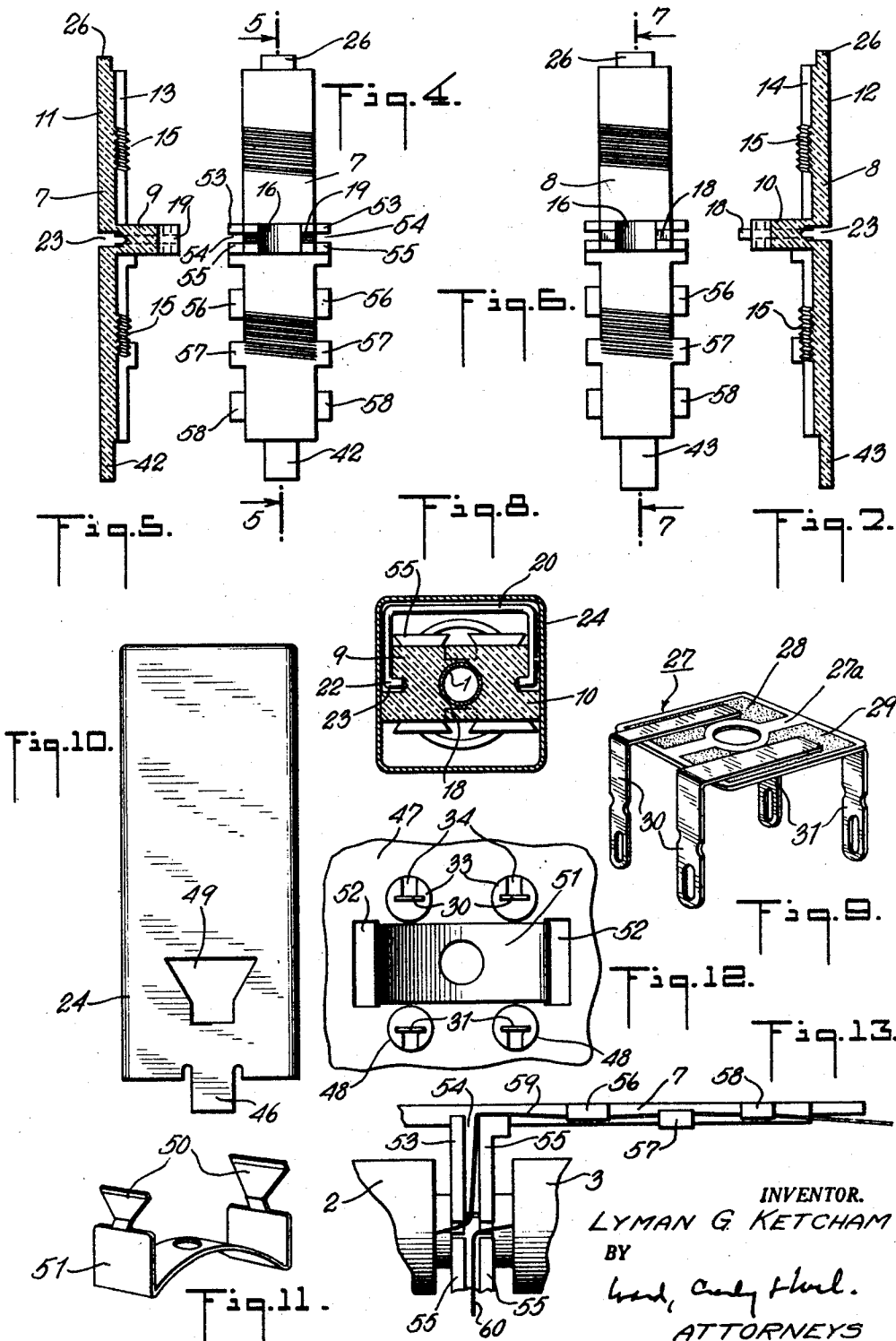
L. G. KETCHAM

2,435,630

TUNED TRANSFORMER ASSEMBLY

Filed June 2, 1945

3 Sheets-Sheet 2



Feb. 10, 1948.

L. G. KETCHAM

2,435,630

TUNED TRANSFORMER ASSEMBLY

Filed June 2, 1945

3 Sheets-Sheet 3

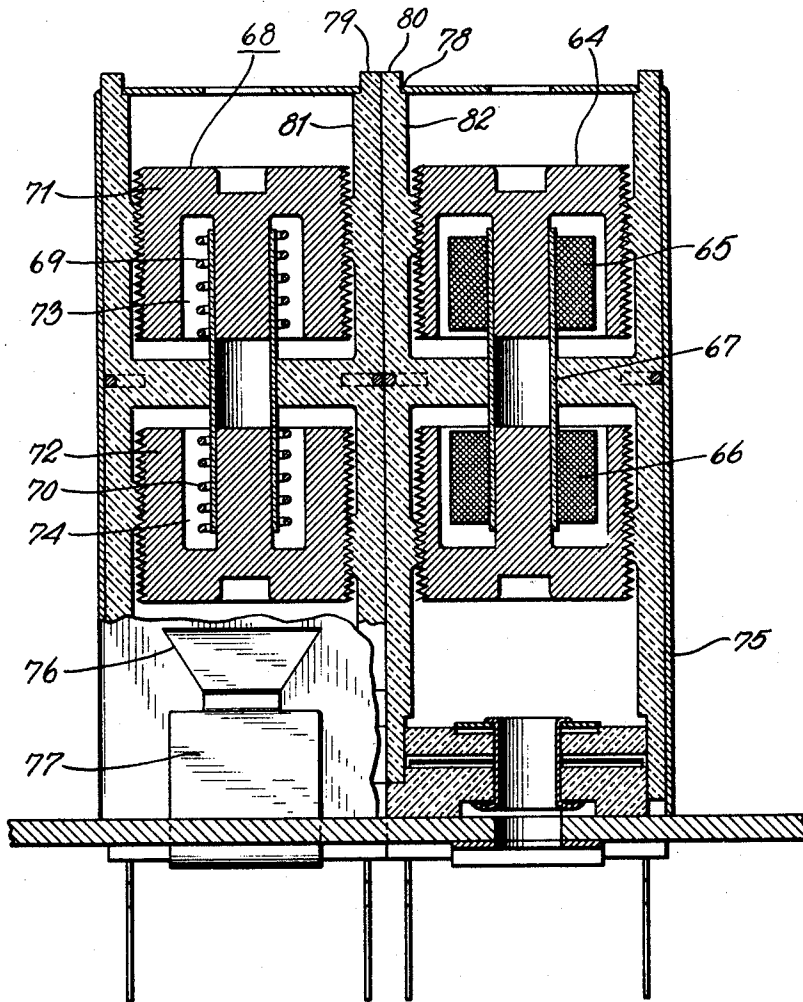


Fig. 15.

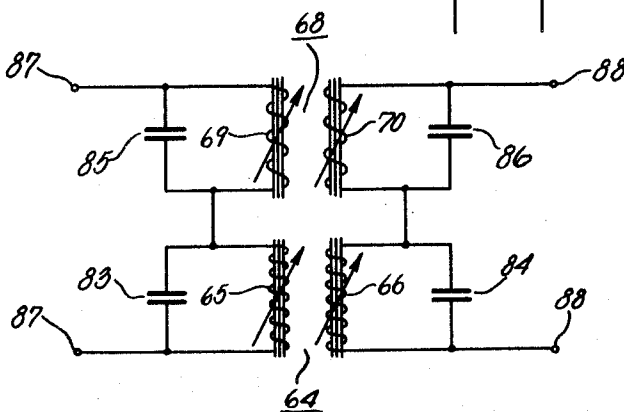


Fig. 16.

INVENTOR.
 LYMAN G. KETCHAM
 BY
Ward, Rudy & Ward
 ATTORNEYS

UNITED STATES PATENT OFFICE

2,435,630

TUNED TRANSFORMER ASSEMBLY

Lyman G. Ketcham, Kearny, N. J., assignor to
Automatic Manufacturing Corporation, East
Newark, N. J., a corporation of New Jersey

Application June 2, 1945, Serial No. 597,349

12 Claims. (Cl. 171-777)

1

This invention pertains to tuned, high frequency transformer assemblies and, more particularly, to such as are adapted for use in the intermediate frequency portion of superheterodyne radio receiving systems and the like, and such as are commonly referred to as intermediate frequency, or more simply as I. F., transformers.

Intermediate frequency or I. F. transformers, in general, consist of a pair of magnetically coupled coils constituting primary and secondary transformer windings, with tuning capacities connected in shunt to said coils respectively. The capacities tune the coils to the desired frequency range of transmission, and the coils are slightly over-optimum coupled, to provide band transmission throughout the desired transmission range with relatively sharp cut-off at the limiting transmission frequencies.

From the standpoint of tuning, I. F. transformers may be generally classified in either of two categories, i. e., those which employ capacity tuning and those which employ inductance tuning.

The conventional capacity tuned I. F. transformer consists of mica dielectric, compression type capacitors which are usually assembled on a ceramic base. The coil form on which the magnetically coupled coils or inductances are wound, is secured to the capacitors, and the entire unit is assembled in a metal shielding can. The external terminals are ordinarily in the form of flexible, insulated leads which can be soldered directly to the tube sockets. The major disadvantages of the capacity tuned transformers are: instability due to temperature and humidity changes; difficulties of precise tuning due to relatively large changes of capacity with small variations of the adjusting screw; and variations of capacity coupling due to changes in spacing of coil leads and external leads. Various means have been proposed for overcoming one or all of these objections, but, without entering into a detailed discussion thereof, suffice it to say that all entail more elaborate and expensive constructions.

In contrast to the above, the conventional inductance tuned I. F. transformer consists of silvered mica capacitors mounted on a terminal board to which the coil form is secured. This is usually accomplished by means of threaded bushings which also engage threaded metal studs molded in the powdered iron cores employed for inductance adjustments of the coils. The entire unit so constructed is assembled in a metal shield can. The external terminals are ordinarily in the form of lugs which extend through the radio chassis for wiring to the tube sockets.

2

The major disadvantage of the inductance or permeability-tuned transformers as heretofore constructed, is the variation of Q , i. e., the factor

$$\frac{2\pi f l}{R}$$

of the inductances with changes in iron-core positions. Variation of capacity-coupling is also present in this type of transformer, but not to the same extent as in the capacity tuned type.

Both of the capacity tuned and inductance-tuned types of transformers aforesaid are subject to considerable variation in mutual inductances due to mechanical variations of the parts, and are subject also to various other disadvantages which need not be recounted, because well understood to those skilled in the art.

The improved transformer of the present invention is of the permeability or inductance-tuned type. It is of extremely compact design such that it can be assembled in a three-fourths inch square shielding can; or in even smaller dimensions if desired.

The condenser assembly consists, in the preferred modification, of a single sheet of mica dielectric having on each side thereof, in opposed relation, two silvered areas forming the two capacitors. When higher capacity values are required, two or more of such silvered mica sheets may be stacked and resiliently clamped. Contact is made to the four silvered sections by four terminal lugs, which are compressed between an insulating base plate and an insulating clamp plate, by means of a single central eyelet. A spring plate is interposed between the eyelet and the clamp plate for providing a resiliently compressed, unitary assembly, in which the compression is maintained over a wide range of temperatures and repeated temperature cycles.

The coil assembly consists of a tubular coil form of suitable insulating material, such as laminated plastic, upon the opposite ends of which are wound the primary and secondary transformer coils or inductances. Two externally threaded, cup-like, powdered iron, shell cores having internally projecting central studs integral therewith, are assembled on opposite ends of the coil form, in such fashion that the central stud of each shell core fits into the tubular end of the coil form, and thus forms a magnetic core for the coil; while the outer cylindrical wall of the core fits over the coil in spaced relation thereto to form a shield. These two shell cores and the coil form are clamped between cooperating male and female frame members, of suitable insulating material, such as

laminated plastic, which cooperate thereby to provide a split-nut arrangement, having suitably threaded interior surface portions for threadedly engaging the shell cores, and which are also suitably provided with semi-circularly recessed portions fitting about the central portion of the coil form for supporting the same. The components as thus arranged are maintained in unitary assembly by means of a substantially U-shaped wire spring clip, which snaps into suitable recesses provided on opposite external surfaces of the male and female frame members respectively. Slippage of the coil form is prevented by cementing it within the socket provided by the semi-circular recesses in the frame members; or alternatively by providing a flange on the coil form or a pin through it and corresponding recesses in the sockets of the frame members for reception of the flange or pin.

The frame members are provided with grooves and tabs in a manner such that the four lead-out wires from the coils may be definitely positioned and insulated from each other and from other parts. Also one end of each frame member is provided with tabs and shoulders to properly position the assembly in rectangular slots provided in the top of a shielding can housing the assembly. The other end of each frame member is provided with tabs and shoulders adapted to fit into appropriate recesses provided in the capacitor base for this purpose. The entire transformer and capacitor base assembly is held within the shielding can by means of tabs provided at the base of the can, which, after assembly, are bent in under the capacitor base.

The shielding can is removably mounted on the chassis of the radio receiver or the like by means of a spring mounting clip which extends through suitable slots in the chassis and snaps into truncated cut-outs provided in opposite side walls of the shielding can.

Inductance adjustment of the upper coil is made by inserting a tool through an aperture provided in the top of the shielding can, and into a recess provided in the upper surface of the shell core, and thereby rotating the shell core to vertically adjust the same, upwardly or downwardly as desired, owing to the threaded mounting of the shell core between the frame members. In this way, the shell core is caused to variably penetrate and overlap the associated coil. Similar adjustment of the lower shell core is made through the aforesaid hollow eyelet in the capacitor assembly. In this way, the effective coil inductances, and the magnetic coupling between coils, may be varied as desired within the design limits of the equipment.

Having thus described generally the construction and arrangement of the transformer assembly in accordance with the inventions and the features thereof believed novel, reference is now made to the accompanying drawings for a more detailed description thereof wherein:

Fig. 1 is a plan view of a preferred form of tuned transformer assembly in accordance with the invention; while Figs. 2 and 3 are longitudinal sections thereof taken at 2—2 and 3—3 of Fig. 1 respectively.

Figs. 4 to 7 are views of the cooperating male and female frame members employed for supporting the coil form and for adjustably mounting the shell cores within the shielding can; Fig. 4 being a front elevation of the female frame member, and Fig. 5 a longitudinal section thereof at 5—5 of Fig. 4; while Fig. 6 is a front eleva-

tion of the corresponding male frame member, and Fig. 7 is a longitudinal section thereof taken at 7—7 of Fig. 6.

Fig. 8 is a transverse section of the transformer assembly taken at 8—8 of Fig. 3.

Fig. 9 is a perspective view of the condenser and terminal lug assembly.

Fig. 10 is a side elevation of the shielding can employed for housing the assembly; while Fig. 11 is a perspective view of the resilient mounting clip employed for detachably securing the can-encased transformer assembly to the chassis of a radio receiver or the like.

Fig. 12 is a plan view of a fragmentary showing of the chassis portion upon which the transformer assembly is mounted, this view showing the chassis apertures required for reception of the aforesaid mounting clip and for projection of the condenser terminal lugs therethrough.

Fig. 13 is a fragmentary detail of the transformer assembly showing the manner in which lead-out connections extend from the transformer coils to the terminal lugs.

Fig. 14 shows the basic circuit arrangement of the intermediate frequency transformer assembly of the invention.

Fig. 15 is a sectional view, similar to Fig. 3, but showing two tuned I. F. transformer assemblies mounted in a single shielding, for adapting a radio receiver for reception over two different frequency bands such as the broadcast band and the ultra-high frequency so-called "frequency modulation" band.

Fig. 16 shows the basic circuit arrangement of the Fig. 15 assembly.

Referring, for the moment, to Fig. 14 in the drawings, the intermediate frequency or I. F. transformer of the invention, consists essentially of a pair of magnetically coupled, high frequency, iron-core coils W_1 , W_2 , the inductances of which are adjustable as indicated, and across which are respectively bridged, tuning condensers C_1 and C_2 , each coil and its associated shunt condenser being connected between a pair of input or output terminals T_1 or T_2 .

Referring now to the remaining figures of the drawings, which show the constructional details of the assembly, and more particularly to Figs. 1 to 3 thereof, the transformer comprises a tubular insulating coil form 1, of laminated plastic or the like, mounting at its opposite ends a pair of multi-layer coils 2, 3. Each coil 2, 3 is housed within a cup-like shell core 4, 5, provided with a central stud, such as 6, fitting slidably within an end of the tubular coil form 1, as shown. The outer cylindrical surfaces of the shell cores 4, 5, are threaded as shown and threadedly engage threaded portions of the male and female frame members 7 and 8 of Figs. 4 to 7 inc., in assembled relation in the manner shown in Fig. 3 at 15. In addition, these frame members, which are described more in detail hereinafter, are provided, as shown in Figs. 3 and 8, with inwardly extending flanges 9 and 10, having semi-circular inner surfaces, which cooperate to surround and frictionally engage the coil form 1, thereby to support the same, as shown in Figs. 3 and 8. The shell cores 2, 3 are made of powdered iron admixed with a suitably powdered filler, such as a thermosetting resin and molded onto the configuration shown under heat and pressure.

Referring to Figs. 4 and 7 inc., the male and female frame members 7, 8 are of generally rectangular contour, viewed in elevation, as shown in Figs. 4 and 6, and are provided with plane ex-

terior surfaces 11, 12 and interior surfaces 13, 14 of arcuate contour containing, adjacent their upper and lower ends respectively, threaded portions, such as 15, for threadedly engaging the outer threaded surfaces of the shell cores 4, 5, as above noted in connection with Fig. 3. About midway of their elevations, these frame members are provided with the above-mentioned inwardly extending flanges 9, 10, having semi-circular inner surfaces 16 supporting the coil form 1, in the manner shown in Fig. 8. In order to provide an interlock for the frame members, at the point of support of the coil form 1, the flange 10 of the male frame member terminates at its inner end in projecting lugs 18, which engage corresponding slots 19 provided at the inner termination of flange 9 of the female frame member, as shown more particularly in Figs. 4 to 7 and 8.

Referring more particularly to Figs. 2, 3 and 8, the transformer 1, 2, 3, shell cores 4, 5 and frame members 7, 8 are held in integral assembly by means of a wire spring clip 20, of U-shaped configuration, bent at its opposite ends into inwardly projecting lugs, such as 22, engaging slotted recesses, such as 23, provided in the frame members 7, 8.

The transformer and frame member assembly as thus far described, is slidably housed within an open-ended metal shielding can 24, of generally rectangular, box-like contour, and provided at its upper end with oppositely disposed rectangular slots 25, Fig. 1, for reception of projecting lugs 26, provided at the upper ends of the frame members, thereby to position the transformer assembly within the shielding can as shown in Figs. 2 and 3.

The condensers C₁, C₂, for tuning the transformer coils W₁, W₂ of Fig. 14, or 2, 3 of Figs. 2 and 3, to the desired intermediate frequency range, are constructed in the unitary form shown in perspective in Fig. 9 and indicated generally by the numeral 27. This consists of a rectangular sheet of dielectric material 27a, such as mica, the upper and lower surfaces of which are provided in affixed relation, with spaced, silvered areas, such as 28, 29. Terminal lugs, such as 30, are mounted against the upper silvered areas respectively, and corresponding terminal lugs 31 are mounted against the corresponding lower silvered areas respectively.

The condenser assembly 27, as thus shown in the manner of Fig. 9, is mounted on an insulating base member 32, Figs. 2, 3, of, for example, laminated plastic material or the like. The base member 32 is of generally rectangular contour, corresponding to that of the condenser assembly 27, and is provided with downwardly projecting studs, such as 33, Figs. 2, 3 and 12, which are slotted as shown at 34, Fig. 12, and through the slots of which, extend the terminal lugs 30, 31, of the condenser assembly.

Viewed in end elevation, the upper portion of the base member 32 is of channel-like configuration, and provided with opposite upwardly extending side-wall portions, such as 35, Fig. 2, adapted to receive and center a rectangular clamp plate 36 of insulating material, such as laminated plastic or the like. The clamp plate 36 is slightly channeled on its upper surface, as shown at 37, Figs. 2 and 3, for reception of a spring plate 38 of slightly U-shaped configuration. The spring plate 38, clamp plate 36, condenser structure 27, terminal lugs 30, 31, and base member 32, are all centrally apertured, as shown, for reception of a metal eyelet 39, Figs. 2 and 3, which extends

through the apertures of the assembly and is bent, at its upper end, over the spring plate, as at 40, and, at its lower end, over the base plate, as at 41, for providing a unitary assembly of these elements, maintained under resilient compression by the action of the spring plate 38.

This unitary assembly, held together by eyelet 39, is slidably housed within the lower portion of the shielding can 24 below the frame members 7, 8, as shown in Figs. 2 and 3. For maintaining the frame 7, 8 assembly and the base 32, 27, 36 assembly in proper relation to each other, the upstanding side walls 35 of the base are longitudinally slotted for reception, as shown at 42, 43 of Fig. 3, of the downwardly extending tabs 42, 43, Figs. 4 to 7 inc., provided at the lower ends of the frame members 7, 8. It will be observed, in this connection, that tab 42 on the female frame member 7 is somewhat shorter than the corresponding stud 43 on the male frame member 8. The reason for this is shown in Fig. 3, wherein the slot provided in the side wall 35 on base 32 for reception of the female frame member stud 42, terminates abruptly as shown at 44, to provide a support for frame member 7; while the corresponding slot provided in the opposite side wall base, for reception of the male frame member stud 43, is cut through as shown at 45, Fig. 3, so that the entire support for the coil and frame member assembly, as integrated by the wire spring clamp 20, is provided on the shoulder 44 of the base member 32.

The shielding can 24 is provided initially with downwardly projecting tabs 46, Fig. 10, integral with the side walls thereof. These tabs are for the purpose of holding the frame and base assemblies in their assembled relation as shown in Figs. 2 and 3, to which end, after being so assembled, these tabs 46 are bent inwardly under the base plate 32, as shown in Fig. 2.

The entire assemblage, as thus housed within the shielding can, is mounted on the chassis 47, Figs. 2, 3 and 10, of a radio receiver or the like, the chassis being appropriately apertured, as at 48, Fig. 12, for projection therethrough of the base member studs 33, and the terminal lugs 30, 31 extending therein.

For securing the shielding can 24 to the chassis member 47, the shielding can is provided on its opposite side walls with truncated apertures, such as 49, Fig. 10, for reception of correspondingly shaped lugs 50 provided on a U-shaped spring clip 51, Fig. 11. The chassis member 47 is provided with appropriately spaced rectangular slots 52, Fig. 12, through which the lugs 50 of the spring clip 51 are pushed from the lower side of the chassis and the lugs 50 thereupon snapped into position in the can apertures 49, as shown in Fig. 2.

Referring to Figs. 4 to 8 and 13, the central flanges 9, 10 of the frame members 7, 8 are provided with laterally extending flanged and grooved portions 53, 54, 55; while the lower vertical portions of the frame members proper are provided with laterally projecting tabs, such as 56, 57, 58 for bringing out the lead-out wires, such as 59, 60, from the coils 2, 3, in the manner illustrated in Fig. 13. Thus, referring more particularly to Fig. 13, lead-out conductor 59 extending from the upper coil 2 is extended downwardly from the coil and looped under flange 53 on frame member 7, and is passed thence along the groove 54 and over the outer shoulder of flange 55, and laced thence under the first tab 56, over the second tab 57 and under the bottom tab 58,

these tabs 56, 57, 58 having surfaces contacting the lead-out conductors which are alternately beveled in opposite directions for maintaining the conductor in position as shown. The second lead-out from coil 2, not shown, is brought out on the opposite side of the coil, and similarly extended over the opposite flanges and grooves 53 to 58, Fig. 4. In the same manner, the lead-outs, such as 60, extending from the lower coil 3, are passed up and over the inner shoulder of flange 55, thence down over the outer shoulder thereof and laced through the tabs 56, 57, 58 in accordance with the showing of Fig. 13.

As above stated, the powdered iron shell cores 4, 5 are mounted in threaded engagement with the frame members 7, 8 as shown more particularly in Figs. 2 and 3. For vertically adjusting the upper shell core 4 in relation to its associated coil 2, an aperture 61 is provided in the upper end of the shielding can 24, and also a recess, for example, rectangular, hexagonal, etc., is provided in the upper surface of shell core 4. Adjustment is effected by inserting a suitable tool through the can aperture 61 into the shell core recess 62 and rotating the tool. Similarly, for vertically adjusting the lower shell core 5, a corresponding recess 63 is provided in the lower surface thereof, and the central eyelet 39 of the capacitor base provides an aperture for insertion of the adjusting tool through the eyelet and into the recess 63. In this way, the effective inductances of coils 2, 3, and the mutual inductance between these coils, may be adjusted as desired, within limits.

Figs. 15 and 16 show an I. F. transformer assembly and circuit arrangement for use in a receiver designed for reception over two distinct frequency bands, such, for example, as the usual broadcast band of about 535 to 1620 kilocycles employing amplitude modulation of signals; and the ultra-high frequency band of about 78 to 108 megacycles, employing frequency modulation. For this purpose, two tuned I. F. transformer assemblies are required, one designed for a relatively low intermediate frequency of about 455 kilocycles for reception over the broadcast band, and the other designed for a relatively high intermediate frequency range of about 12 to 16 megacycles for reception over the frequency modulation or FM band.

The low frequency transformer assembly is shown at the right in Fig. 15, and is designated generally by the numeral 64. The coils 65 and 66 are of the multi-layer type mounted on an insulating coil form 67 in the same manner as Fig. 3, this assembly being otherwise identical in all respects with that of Fig. 3 and hence requiring no further description.

The high frequency transformer assembly is shown at the left in Fig. 15, and is designated generally by the numeral 68. The transformer coils in this assembly are of the single layer type, each consisting of a relatively few spaced turns, as shown at 69, 70. In this case, of course, some redesign of the iron cores 71, 72 is required to provide proper spacing, as at 73, 74, between the central stud and the outer shell of the core, to adjust the air gap in conformity with the smaller coils employed; but in other respects the construction of the high frequency assembly 68 is generally the same as the low frequency assembly 64.

The two transformers are assembled side-by-side, as shown in Fig. 15, in a single shielding can 75, which is generally similar in construction to that shown and described in connection with Figs.

1 to 12 inc., with the exception that it is approximately twice as wide, is provided with two sets of cut-outs, such as 76, and associated attaching clips, such as 77, one for each transformer. Also, the upper surface of the can is provided, along its opposite edges, with a pair of enlarged central cut-outs, as at 78, for reception of the adjacent centering lugs, such as 79, 80, of the adjacent frame members 81, 82 of the high and low frequency transformers respectively.

Fig. 16 shows the basic circuit arrangement for the Fig. 15 assembly. The low frequency tuned transformer 64 comprises the magnetically coupled coils 65, 66 bridged respectively by condensers 83, 84. Similarly, the high frequency tuned transformer 68 comprises the inductively coupled coils 69, 70, bridged respectively by condensers 85, 86. The low and high frequency coils 65, 69 and 66, 70, with their associated condensers, are connected in series, respectively, between input and output terminals 87, 88, as shown. With this arrangement, and during reception of signals in the high frequency band, condensers 83, 84 act as by-pass condensers of negligible impedance across the low frequency coils 65, 66, so that the entire circuit operates as a high frequency tuned I. F. transformer. On the other hand, during reception of signals in the low frequency band, the high frequency coils 69, 70 offer negligible impedance so that the entire circuit functions as a low frequency tuned I. F. transformer.

In accordance with a further feature of the invention, the transformers may be so constructed as to compensate for variations in inductance, such as would otherwise result from temperature variations. For example, referring to Fig. 3, as the temperature increases, the radius of the transformer coils 2, 3 will increase slightly, thereby increasing the coil inductances. To compensate for this effect, the coil form 1 on the one hand, and the frame members 7, 8 on the other, may be made of materials having different coefficients of expansion and such that, for example, as the temperature increases, thereby to increase the effective inductance of coils 2, 3, the frame members will expand at such relative rates in relation to the expansion of coil form 1 as to back the shell cores 4, 5 slightly away from their associated coils 2, 3, thereby to reduce the effective coil inductances in substantially the same proportions as they tend to be increased by expansion of the coil diameters. For example, polystyrene synthetic resin has a higher coefficient of expansion than a phenol-formaldehyde resin. Accordingly, if coil form 1 is made of laminated plastic material employing a phenol-formaldehyde resin, while the frame members are made of polystyrene, and the dimensions from the point of support 9, 10 of the coil form 1 are properly proportioned, compensation of the above character may be obtained within a desired degree of precision. The above modification will give negative temperature compensation. By reversing the materials, i. e. by making the frame members 7, 8 of phenol-formaldehyde resin, and the coil form of polystyrene, a positive temperature compensation may be obtained, should such become desirable for a particular construction.

What is claimed is:

1. A coil assembly of the character described, including a coil form, a coil enclosing said coil form, a magnetic core having a portion enclosed by said coil form and coil and mounted to afford adjustment of the extent of its penetration with-

in the coil, said coil form projecting axially beyond one end of said coil, and a supporting frame having portions engaging the projecting portion of said coil form to hold said coil and coil form in position, said frame at least partially enclosing said coil and having portions engaging said core to position the latter with respect to said coil form and coil.

2. A coil assembly of the character described, including a coil form, a coil enclosing said coil form, a magnetic core having a portion enclosed by said coil form and coil and mounted to afford adjustment of the extent of its penetration within the coil, said coil form projecting axially beyond one end of said coil, and a supporting frame having portions engaging the projecting portion of said coil form to hold said coil and coil form in position, said core having a shell portion surrounding said coil, and said frame having portions disposed outwardly of and engaging said shell portion to position said core with respect to said coil form and coil.

3. A coil assembly of the character described, including a coil form, a coil enclosing said coil form, a magnetic core having a portion enclosed by said coil form and coil and mounted to afford adjustment of the extent of its penetration within the coil, said coil form projecting axially beyond one end of said coil, a sectional frame supporting said coil form, coil and core assembly, said frame having a plurality of sections each partially enclosing said coil and core and each of said sections having portions engaging the projecting portion of said coil form to hold said coil and coil form in position, said sections also having portions engaging said core to position the latter with respect to said coil form and coil.

4. A coil assembly of the character described including a coil form, coils enclosing said coil form in spaced relation to each other, magnetic cores each having a portion enclosed by said coil form and one of said coils, at least one of said cores being mounted to afford adjustment of the extent of its penetration within its corresponding coil, and a supporting frame having sections each extending partially around the peripheries of the coils, said sections having inwardly projecting portions gripping between them the portion of said coil form between said coils to hold said coils and coil form in position.

5. A coil assembly of the character described including a coil form, coils enclosing said coil form in spaced relation to each other, magnetic cores each having a portion enclosed by said coil form and one of said coils, each of said cores being mounted to afford adjustment of the extent of its penetration within its corresponding coil, each of said cores having a shell portion surrounding its corresponding coil, and a supporting frame having portions engaging the portion of said coil form between said coils to hold said coils and coil form in position, said frame also having portions engaging the shell portions of said cores to position the latter with respect to said coil forms and coils.

6. A coil assembly of the character described including a coil form, coils enclosing said coil form in spaced relation to each other, magnetic cores each having a portion enclosed by said coil form and one of said coils, each of said cores being mounted to afford adjustment of the extent of its penetration within its corresponding coil, each of said cores having a shell portion surrounding its corresponding coil, said shell portions of the cores being externally threaded, and

a sectional frame supporting said coil form, coil and core assembly, said frame having a plurality of sections each partially enclosing said coil and core, said sections having portions engaging the portion of the coil form which is between said coils to hold the said coils and coil form in position, said sections also having threaded portions engaging the aforesaid threaded portions of said cores.

7. A coil assembly of the character described, including a coil form, a coil enclosing said coil form, a magnetic core having a portion enclosed by said coil form and coil and mounted to afford adjustment of the extent of its penetration within the coil, said coil form projecting axially beyond one end of said coil, a sectional frame supporting said coil form, coil and core assembly, said frame having a plurality of sections each partially enclosing said coil and core, and means projecting inwardly from said sections and engaging the projecting portion of said coil form to hold said coil and coil form in position, and a spring clip embracing said frame sections to clamp them in position.

8. A coil assembly of the character described, including a coil form, a coil enclosing said coil form, a magnetic core having a portion enclosed by said coil form and coil and mounted to afford adjustment of the extent of its penetration within the coil, a frame supporting said coil and coil form in position, said frame having sections each extending partially around the periphery of said coil and core, said core also having portions extending outwardly into contact with said frame sections, said frame sections also engaging one of said coil and coil form elements, and means for urging said frame sections toward each other to hold said coil form, coil and core in position.

9. A coil assembly of the character described, including a coil form, a coil enclosing said coil form, a magnetic core having a portion enclosed by said coil form and coil and mounted to afford adjustment of the extent of its penetration within the coil, a frame supporting said coil and coil form in position, said frame having sections each partially enclosing said coil and core, and means for holding said frame sections in position, said frame sections having portions projecting endwise of said coil and engaging said core to hold the latter in position.

10. A coil assembly of the character described, including a coil form, a coil enclosing said coil form, a magnetic core having a portion enclosed by said coil form and coil and mounted to afford adjustment of the extent of its penetration within the coil, a frame supporting said coil and coil form in position, said frame having sections each partially enclosing said coil and core, and means for holding said frame sections in position, said frame sections having portions projecting endwise of said coil and engaging said core to hold the latter in position, said last mentioned portions of the frame being spaced outwards of said coil, and said core having a shell portion interposed between said last mentioned frame portions and the coil.

11. A coil assembly of the character described, including a coil form, a coil enclosing said coil form, a magnetic core having a portion enclosed by said coil form and coil and mounted to afford adjustment of the extent of its penetration within the coil, said coil form projecting axially beyond one end of said coil, and a supporting frame having sections each extending partially around the periphery of the coil, said sections having in-

wardly projecting portions gripping between them the projecting portion of said coil form to hold said coil and coil form in position, said frame also having portions spaced radially outwards of said coil, and said core having a shell portion interposed between said last mentioned frame portions and the coil.

12. A coil assembly of the character described, including a coil form, a coil enclosing said coil form, a magnetic core having a portion enclosed by said coil form and coil and also having a shell portion constructed to surround the coil, said core being movable axially with respect to said coil, a supporting frame at least partially enclosing said coil, the surface of said shell portion of the core adjustably engaging said supporting frame to position the core axially with respect to the coil.

LYMAN G. KETCHAM.

REFERENCES CITED

The following references are of record in the file of this patent:

5
10
15
20

Number
1,656,381
1,801,050
2,065,711
2,111,490
2,113,603
2,180,413
2,199,669
2,206,250
2,221,217
2,222,770
2,283,924
2,332,868
2,336,091
2,362,034
2,364,291
2,379,457
2,388,848

UNITED STATES PATENTS

Name	Date
Marvel	Jan. 17, 1928
London	Apr. 14, 1931
Ketcham	Dec. 29, 1936
Jacob	Mar. 15, 1938
Polydoroff	Apr. 12, 1938
Harvey	Nov. 21, 1939
Loughlin	May 7, 1940
Fill	July 2, 1940
Kirk	Nov. 12, 1940
Hartl	Nov. 26, 1940
Harvey	May 26, 1942
Nowak	Oct. 26, 1943
Gray	June 15, 1940
Stahl	Nov. 7, 1944
Harvey	Dec. 5, 1944
Ricker	July 3, 1945
Howe	Nov. 13, 1945

FOREIGN PATENTS

Country	Date
Great Britain	Oct. 10, 1940