March 25, 1930. R. C. DA COSTA 1,751,854

RADIO APPARATUS

Filed April 24, 1928

Fig. 1.

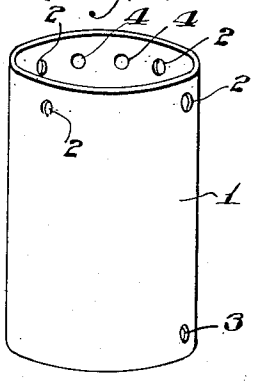


Fig. 2.

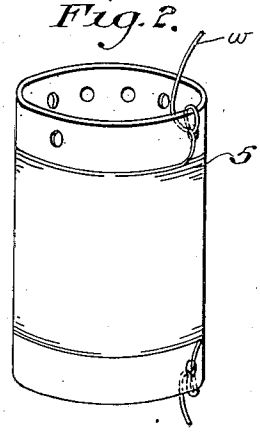


Fig. 3.

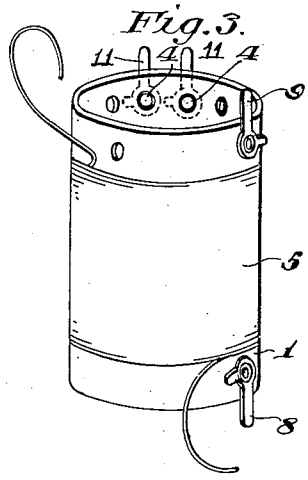


Fig. 4.

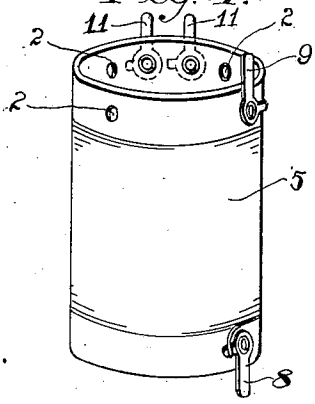


Fig. 5.

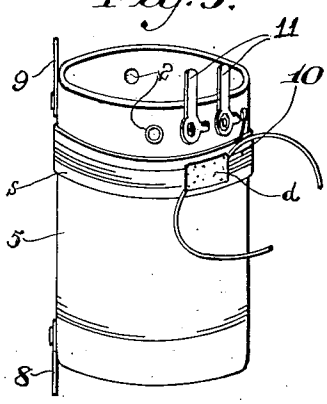


Fig. 6.

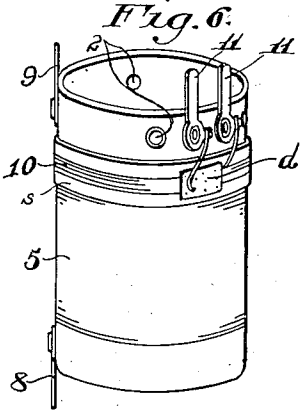


Fig. 7.

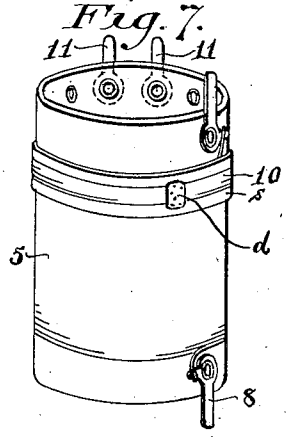


Fig. 8.

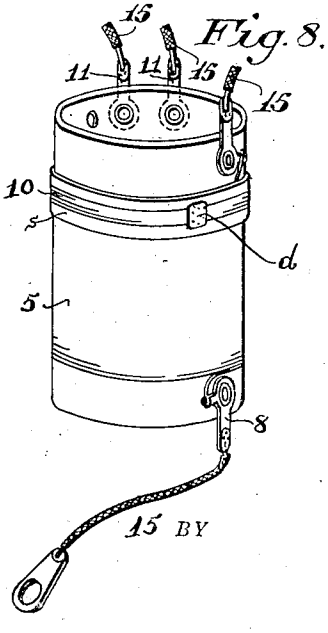
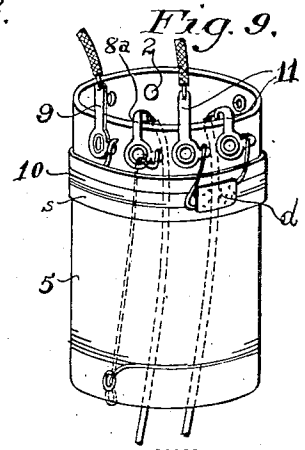


Fig. 9.



INVENTOR.
Robert C. DaCosta
BY
Cornelius L. Ehret
His ATTORNEY

Patented Mar. 25, 1930 1,751,854

UNITED STATES PATENT OFFICE

ROBERT C. DA COSTA, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO ATWATER KENT MANUFACTURING COMPANY, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA

RADIO APPARATUS

Application filed April 24, 1928. Serial No. 272,385.

My invention relates to radio frequency inductances, particularly as utilized in radio frequency amplifier stages of radio receiving apparatus, tunable to the same wave lengths throughout a range of wave lengths.

In quantity production of radio apparatus utilizing cascaded tuned circuits, particularly coupled by thermionic amplifier tubes, coupling transformers are classified according to their turn ratio, as determined by the circuit or stage for which they are constructed, and each class is divided into groups or sub-classes of coils having substantially the same electrical characteristics, as of inductance; the coils of the different classes and of the corresponding group or sub-class of each class being associated with substantially identical tuning devices, as for example, condensers, preferably of the striaght-line capacity type, having the same rate of change of capacity, to comprise circuits tunable from one wave length to another wave length solely by movement of the adjustable elements of the tuning devices to equal extents.

In accordance with my invention, to facilitate replenishment of groups of the classes, the forms or tubes upon which the coils are wound are each provided at one end with a plurality of holes, circumferentially spaced, at a selected one of which, during a winding operation is secured its conductor or wire, to determine within a fraction of a turn, the number of convolutions of a completed coil whose other end is secured to a fixed point, as provided by a single aperture, at the opposite end of the supporting form; more particularly and preferably, the forms, of suitable insulating material, are accurately machined, as by a grinding operation, to uniform diameter to limits of tolerance within which the transformers, when associated with substantially similar condensers comprise circuits tunable within a given range of wave lengths.

My invention further resides in the method and features of construction hereinafter described and claimed.

For the purposes of explanation, reference is to be had to the accompanying drawings, in which:

Figs. 1 to 8 inclusive illustrate the successive steps of constructing a transformer in accordance with my invention.

Fig. 9 is a completed, modified form of transformer.

Referring to Figs. 1 to 7, the coil forms 1, of suitable insulating material, as bakelite, fiber, or the like and preferably tubular in shape, are provided, at least at one end, with a plurality of circumferentially and preferably equally spaced holes 2, and at the other end with a single hole 3. Additional holes 4 are provided for purposes hereinafter referred to, Preferably, the coil forms 1 before or after punching of certain or all of the different holes are accurately machined, as by a grinding operation, to uniform diameter, the maximum variation between the diameters of separate forms being suitably narrow, as for example about .004 of an inch.

Starting at either end, a wire or conductor *w* is secured to the coil form 1 as by looping it through hole 3, or a selected one of the holes 2, and winding a predetermined number of complete turns upon the form, the fractional part of a turn being determined by the position of the selected hole 4 with respect to the hole 3 at the opposite end of the coil. After the winding operation, the coils are preferably given a coating of suitable material, for example collodion, as by a dipping or brushing operation, to retain the turns of the coil 5 in place. After the coating of retaining material has sufficiently set, terminal clips are secured as by riveting, to the coil of Fig. 3, in the holes 4, 4 and a hole 2, at the upper end of the coil form and to the hole 3 at the opposite end thereof. The ends of the winding 5 are scraped clean of insulation and temporarily secured to oppositely disposed clips, as terminal 8 secured in hole 3 and terminal 9 secured in a hole 2. The lower end of the wire *w* instead of being secured to a clip 8 at the lower end of the coil form may be anchored at the lower end by looping the wire through the hole 3 and thence to the upper end of the coil where it may be secured to a clip riveted in place in a manner similar to the other terminals, as in Fig. 9.

A strip *s* of suitable insulating material, as

varnished silk, may be wound on the coil 5 near the upper end thereof and a second coil 10 of relatively few turns is wound over the strip and retained by dabs *d* of a quick setting wax at points 180 degrees apart, preferably one of the dabs holds the free ends of the coil 10 in position and insulates the end which crosses over the wound coil. The ends of the coil 10 are then cleaned and connected respectively to the terminal tips 11 secured in the holes 4. The ends of the coils 5 and 10 are then soldered to the clips to which they are temporarily secured as above described. The completed coil is then dipped in a suitable compound, as lacquer, to protect the windings from mechanical abrasions and to render it moisture-proof. Thereafter flexible leads 15 of different colors for purposes of identification are soldered to the projecting ends of the terminal clips and these wires which are of predetermined lengths are formed to their final position ready for assembly in radio receiving apparatus.

In a complete radio receiving apparatus utilizing cascaded tuned circuits coupled by thermionic tubes, it is often necessary or desirable, as for example when inherent capacities are utilized to effect stability, that the primary windings 10 of the transformers connected in the anode circuits of the associated tubes be of a different number of turns while the secondary windings 5, which are associated with substantially similar condensers, are of substantially indentical electrical characteristics.

The completed transformers are classified first according to their number of primary turns which is determined by the stage of the completed amplifier with which they are to be associated. The coils of each class are then grouped according to the measured inductance of their respective coils 5. In the assembly of an apparatus, the radio frequency transformers, each of a required class, having the proper number of primary turns, and of the corresponding group of the classes, that is, having substantially the same inductance, are associated respectively with tuning condensers, having the same rate of change of capacity, and preferably of the straight-line capacity type.

The rotors of the tuning condensers may be and are preferably mechanically connected to effect simultaneous tuning of the cascaded circuits by a single control knob, drum or dial.

After assembly and wiring of the amplifier, and when single dial control of the tuning condensers is desired, the rotors or adjustable elements of the variable condensers are independently and relatively adjusted until all the tuned circuits are responsive to the same frequency or wave length. The several adjustable elements or condenser rotors are then positively and mechanically connected to effect their movement in unison. By constructing the transformers as above and associating selected groups thereof with tuning condensers as described, true single dial operation of radio receiving apparatus is effected, without the necessity of providing additional trimming condensers, or of modifying structurally the individual tuning condensers themselves.

In quantity production of apparatus, as the supply of coils of any group of a class approaches depletion, to replenish the same it is only necessary to specify that coils be wound terminating at a specified one of the holes 2 of the unwound coil forms.

It will be readily understood that all of the operations above described are not necessarily effected in the sequence recited or that all operations are necessary. For example, the coil 10 may be omitted, if it is desired to utilize a single inductance, for example as an auto transformer, and that the primary if used may lie in the plane of the coil or secondary 5 instead of being superimposed thereon. Further, the flexible leads 15 may be soldered to the terminal clips before riveting of the latter to the coil form, and all soldering may be done at one operation, that is, the ends of the coils 5 and 10 and the flexible leads may be soldered to the terminal clips without the intervention of the lacquering operation. It is also within the scope of my invention to omit the clips and leads and leave the ends of the coils secured in the holes in the coil form and of sufficient length to use them directly as leads, preferably with flexible tubes, of suitably different colors, and of insulating material slipped over the free ends.

What I claim is:

1. An air-core, radio frequency coil comprising a tubular form machined to uniform, predetermined diameter, a plurality of circumferentially spaced apertures at one end of said form and at least one aperture at the other end thereof, and conductor wound on said form between a selected aperture of said plurality of spaced apertures and said one aperture.

2. An air-core, radio frequency coil comprising a tubular form ground to uniform, predetermined diameter, a plurality of circumferentially spaced apertures at one end of said form and at least one aperture at the other end thereof, and a coil upon said form terminating at a selected aperture of said plurality of spaced apertures, and at said one aperture respectively.

3. An air-core, radio frequency transformer comprising a form having a series of circumferentially spaced apertures at one end thereof and at least one aperture at the other end, a coil terminating at a selected aperture of said series of apertures and said one aperture, and a second coil terminating at a pair of remaining apertures of said series.

4. An air-core, radio frequency transformer comprising a tubular form machined to uniform, predetermined diameter, a series of circumferentially spaced apertures at one end of said form and at least one aperture at the other end thereof, a secondary coil terminating at a selected aperture of said series and at said one aperture, and a primary coil terminating at a pair of remaining apertures of said series.

5. An air-core radio frequency coil comprising a form having a series of circumferentially spaced terminal points, and at least one other terminal point, and a conductor wound on said form between said one terminal point and such of said series of terminal points as to procure an inductance of standard magnitude.

6. An air-core radio frequency transformer comprising a form having a series of circumferentially spaced terminal points, and at least one other terminal point, a coil terminating at said one terminal point and at such of said series of terminal points as to procure an inductance of standard magnitude, and a second coil terminating at another terminal point of said series.

ROBERT C. DA COSTA.