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R. C. SHERMUND

1,898,792

RADIORECEIVER

Filed Oct. 26, 1929

Fig. 1

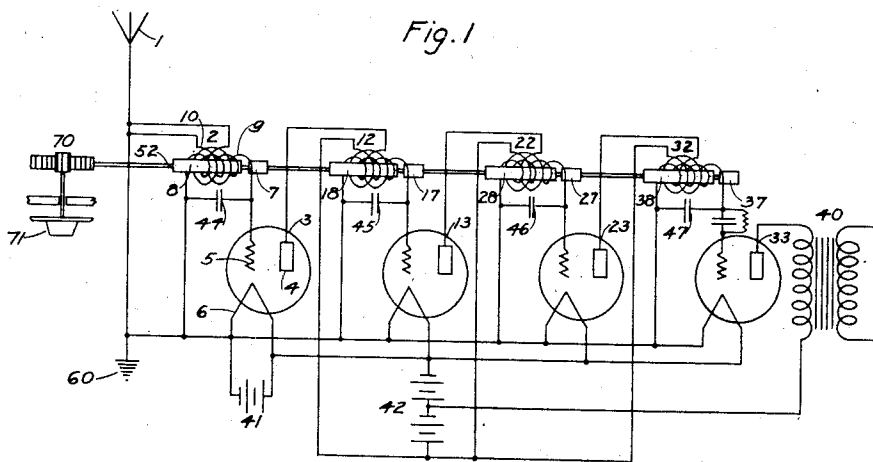


Fig. 2

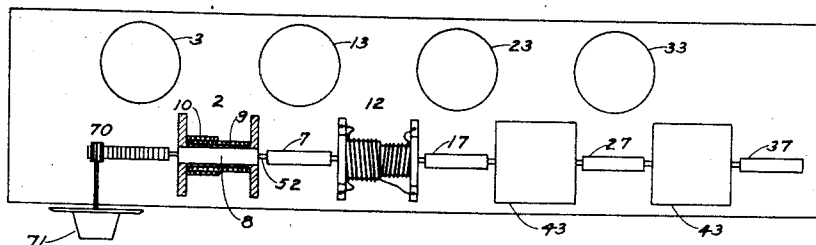


Fig. 3

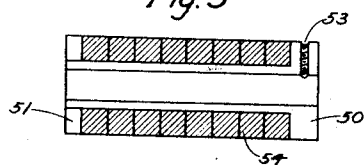


Fig. 4

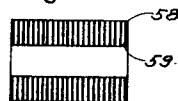


Fig. 5

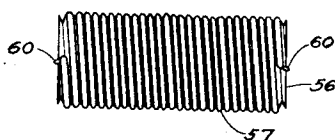
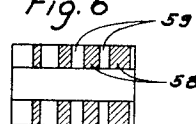


Fig. 6



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RADIORECEIVER

Application filed October 26, 1929. Serial No. 402,616.

This invention relates to radio receiving circuits and is directed more especially to improvements in tuned multi-stage radio frequency amplifiers.

It has been the common practice heretofore to tune multi-stage high frequency amplifiers by means of a plurality of variable tuning condensers, each of which is individual to and forms a part of one of the several inter-stage coupling systems. These tuning condensers—particularly in broadcast receivers—are now generally coupled together mechanically so as to be operable simultaneously—thus simplifying the tuning operation. The use of variable condensers as the sole tuning media in receivers intended to operate over a wide band of frequencies, such as the broadcast band, involves certain difficulties and inherent limitations which it is highly desirable to avoid. In the first place, it is difficult and costly to build gang condensers in which the units are precisely alike as to capacity at all settings of the dial. Secondly, the use of variable condensers in combination with constant inductances to cover a wide frequency band results in a marked disparity in the amplification obtainable between the higher and lower operating frequencies. To be more specific, where condensers are relied upon exclusively as the adjustable elements for tuning over a wide band, there is ordinarily involved a serious sacrifice of amplification at the lower frequencies in order to attain stability at the higher frequencies.

The objects of this invention are twofold in that it aims, first, to simplify and render more economical the necessary tuning provisions, second, to provide tunable coupling arrangements whereby the aforementioned sacrifice of amplification at the lower frequencies can be avoided.

It is proposed, in accordance with the present invention, to tune the respective stages of an amplifier by providing coupling transformers having both magnetic cores and nonmagnetic, short circuited cores, and to vary the inductance by simultaneously withdrawing the magnetic cores and inserting the short circuited cores, or vice versa.

The short circuited cores serve the dual purpose of further reducing the inductances of the transformers and introducing additional resistance to compensate for the increased tendency toward feedback at the higher frequencies.

Referring to the drawing:

Fig. 1 is a schematic circuit diagram of a radio receiving circuit in accordance with the invention.

Fig. 2 is a plan view showing the arrangement of the apparatus incorporated in the circuit of Fig. 1.

Fig. 3 is a detail section showing the construction of a magnetic core element used in the transformers shown in the circuit of Fig. 1 and

Figs. 4, 5, and 6 are detail drawings of three alternative short circuiting cores adapted for use in the circuit and apparatus disclosed in Figs. 1 and 2.

In Fig. 1 a radio receiving circuit is depicted which comprises three radio frequency amplifying tubes 3, 13 and 23, respectively, and a detector tube 33. The input circuit of tube 3 is connected to a source of signals comprising an antenna 1 and ground 60, through a radio frequency transformer 2 having a primary winding 10 and a secondary winding 9. The output circuit of tube 3 is coupled to the input circuit of tube 13 by a similar transformer 12. Likewise transformers 22 and 32, which are similar to transformers 2 and 12, couple the output circuit of tube 13 to the input circuit of tube 23 and the output circuit of tube 23 to the input circuit of detector tube 33, respectively. The output circuit of detector tube 33 may be coupled to an audio frequency amplifier (not shown) through an audio transformer 40. Sources of energy for energizing the cathode and anode circuits of the tubes are shown conventionally as batteries 41 and 42 respectively.

Each of the coupling transformers 2, 12, 22, and 32 consists of a primary and a secondary winding, surrounding a movable core. These transformers have their windings so proportioned as to be tuned to a

frequency within the range of frequencies to be received by virtue of their inductance and distributed capacity, together with the capacities of fixed condensers 44, 45, 46, and 47 and inter-electrode capacities of the tubes to which they are connected. Changes in the tuning are then effected by changing the inductances of the transformers. To this end the transformer windings are mounted about a common axis as disclosed in Fig. 2 and each transformer is provided with a movable core consisting of two sections, one section being composed of magnetic material and the other of electrically conductive material forming a closed electric circuit. Thus, transformer 2 has a core consisting of sections 8 and 7 respectively. Section 8 preferably consists of finely comminuted iron or other magnetic material mixed with mica as disclosed in my copending application, Serial No. 309,967, filed October 3, 1928. The mica serves to insulate the particles of magnetic material from each other so that eddy currents are substantially prevented. Element 7, on the other hand, may consist of solid metal such as copper, the resistance of which is so low that when inserted within the windings of the transformer it acts as a short circuited secondary winding. As shown in Fig. 2, the magnetic core 8 is entirely within the transformer windings 2 and under these conditions, because of the low reluctance of the magnetic core 8, the transformer windings have a high inductance and are tuned to a long wavelength. To change the tuning, the cores 7 and 8 are simultaneously moved to the left by means of the tuning control knob 71 and rack and pinion 70. Removing magnetic core from within the transformer reduces the inductance of the windings, but a greater reduction and consequently a greater change in tuning range is effected by the simultaneous movement of short circuiting core 7 into the magnetic field. This effect is obtained because the currents induced in conducting core 7 produce a field opposing that of the current in the primary winding 2.

As depicted in Fig. 2, the cores for all the inter-stage transformers are mounted on a common shaft 52 so that they may be shifted simultaneously to produce like variations in the tuning of all the transformers. This makes possible a very simple and effective construction since all the cores are rigidly attached together and must move in absolute unison.

To prevent stray fields and resultant undesired feed-back of energy from one transformer to another, the transformers are preferably enclosed in metal shield cans 43.

The magnetic cores 8, 18, 28, and 38, respectively, may be conveniently constructed as shown in Fig. 3, in which a plurality of

disks of magnetic material 54 are mounted on a spool of insulating material 50. A shoulder 51, which may be pressed on to the spool after the disks are in place, serves to fix them solidly in position, and the unit as a whole may be secured to shaft 52 by means of set screw 53.

The short circuiting elements 7, 17, 27, and 37 may be solid cylinders of copper or other conducting material drilled to fit shaft 52, or they may be constructed as disclosed in Figs. 4, 5, or 6.

Fig. 4 is a sectional view of a short circuiting element built up of copper disks 59 separated by insulating washers 58. The disks can be secured together by means of cement or other adhesive material. In this form of construction, the short circuiting effect of the core can be controlled within limits by increasing or decreasing the thickness of the conducting disks relative to the insulating disks.

Fig. 5 depicts a short circuiting core composed of heavy wire 57 wound about a grooved form 56 of insulating material. The ends of the conductor 57 are connected by a conductor 60 which passes through a hole in the form 56. The short circuiting effect of this type of core can be varied by varying the resistance of either conductor 57 or of conductor 60 or of both. The most satisfactory type of core is determined by the frequency range which is to be covered and can best be ascertained by experiment.

In some cases a more satisfactory rate of change of inductance may be obtained by tapering the short circuiting core. For instance, in the case of a core constructed as disclosed in Fig. 4 it may be desirable to make the copper disks relatively thick at one end of the core and gradually reduce the thickness toward the other end. Such a tapered core is disclosed in Fig. 6. However, in any case, as indicated above, the most satisfactory core for any particular condition can best be determined by experiment.

I claim:

1. The method of varying the inductance of a winding which comprises simultaneously varying the reluctance of the magnetic circuit of said winding and introducing in said magnetic circuit a magnetizing force opposing that of the winding.

2. In an amplifier, a plurality of stages of amplification, each stage comprising a tuned circuit containing a winding, all of said windings being positioned about a common axis, a magnetic shield and a core for each winding and means for securing said cores together whereby they can be shifted simultaneously along the axis of said windings.

3. In an amplifier, a plurality of tuning elements, each comprising a magnetically

shielded winding, all of which windings are mounted symmetrically about a common axis, a shaft extending through said coils and adapted to be moved longitudinally, and cores mounted on said shaft adapted to be moved therewith to simultaneously vary the inductances of said windings.

4. In an amplifier, a plurality of tuning elements disposed along a common axis, each comprising a winding in combination with a core movable to vary the tuning frequency of said winding, and means for moving all of said cores simultaneously with respect to said windings.

5. In a broadcast receiver, a plurality of amplifying tubes in cascade, tuned transformers having a common axis for intercoupling said tubes, each transformer having a core movable to vary the tuning of the circuit and common means rigidly fixing the relative positions of said cores whereby they may be all moved as a unit to equally change the tuning of all the transformers.

6. An amplifying network comprising a plurality of amplifying tubes in cascade, tuned transformers for intercoupling said tubes, each transformer being individually shielded and having a core movable to vary the tuning thereof, each core comprising a portion of magnetic material and a portion composed of a plurality of annular conductors separated by non-conductive spacers and providing an axial variation in conductivity with respect to a given cross-sectional area of the current-path in said conductors, and a unitary control means for simultaneously moving said cores to equally adjust the tuning of said transformers.

7. In an amplifier, a tuned circuit comprising a winding, a movable element of magnetic material, and a movable element of electrically conductive material, means for moving said elements simultaneously to vary the reluctance of the magnetic circuit of said winding and introducing in said magnetic circuit a magnetizing force opposing that of the winding.

In testimony whereof, I have hereunto set my hand.

RALPH C. SHERMUND.