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METHOD AND MEANS OF EXTENDING FREQUENCY RANGE OF RADIO APPARATUS

Filed May 13, 1931 2 Sheets-Sheet 1

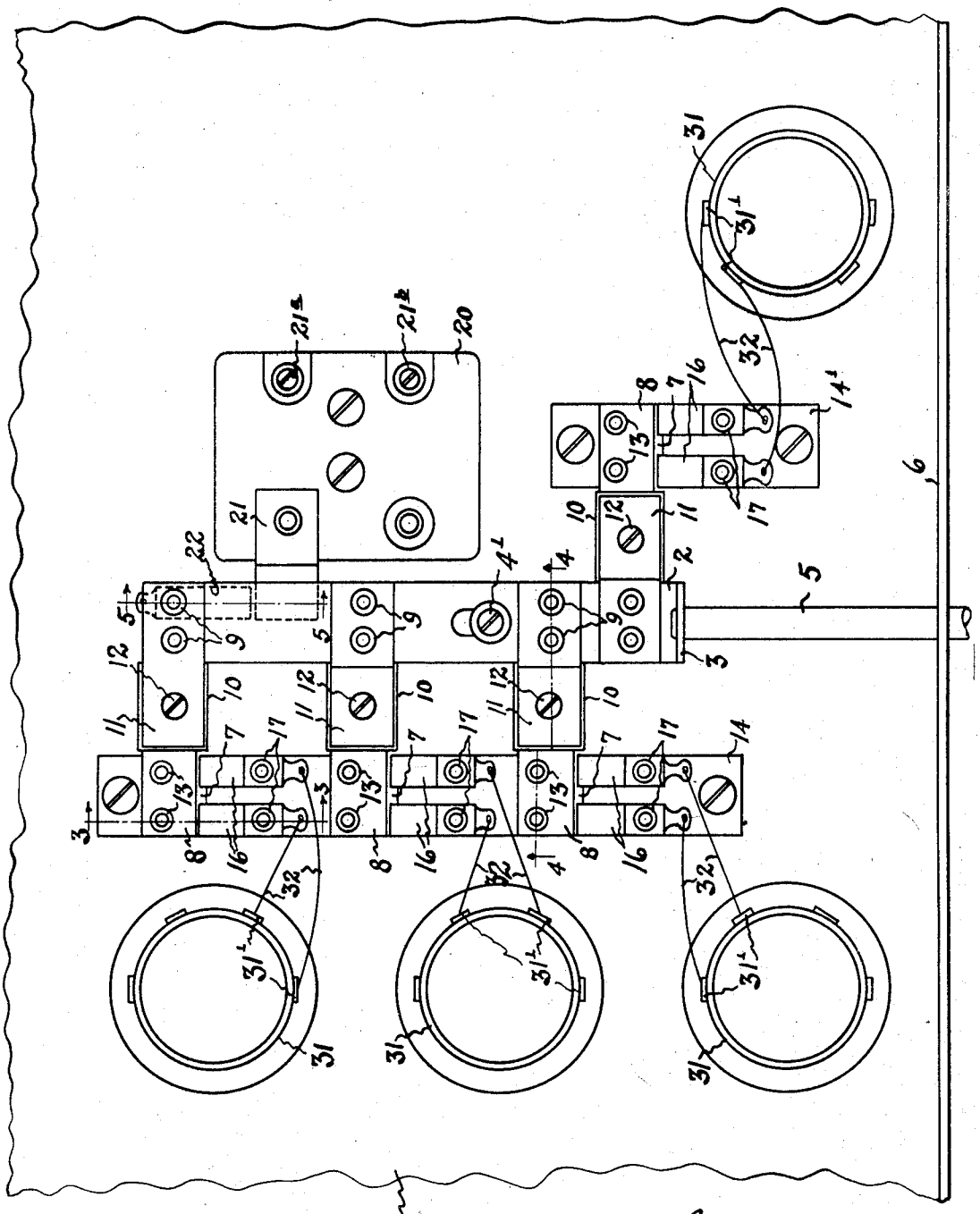


Fig. 1.

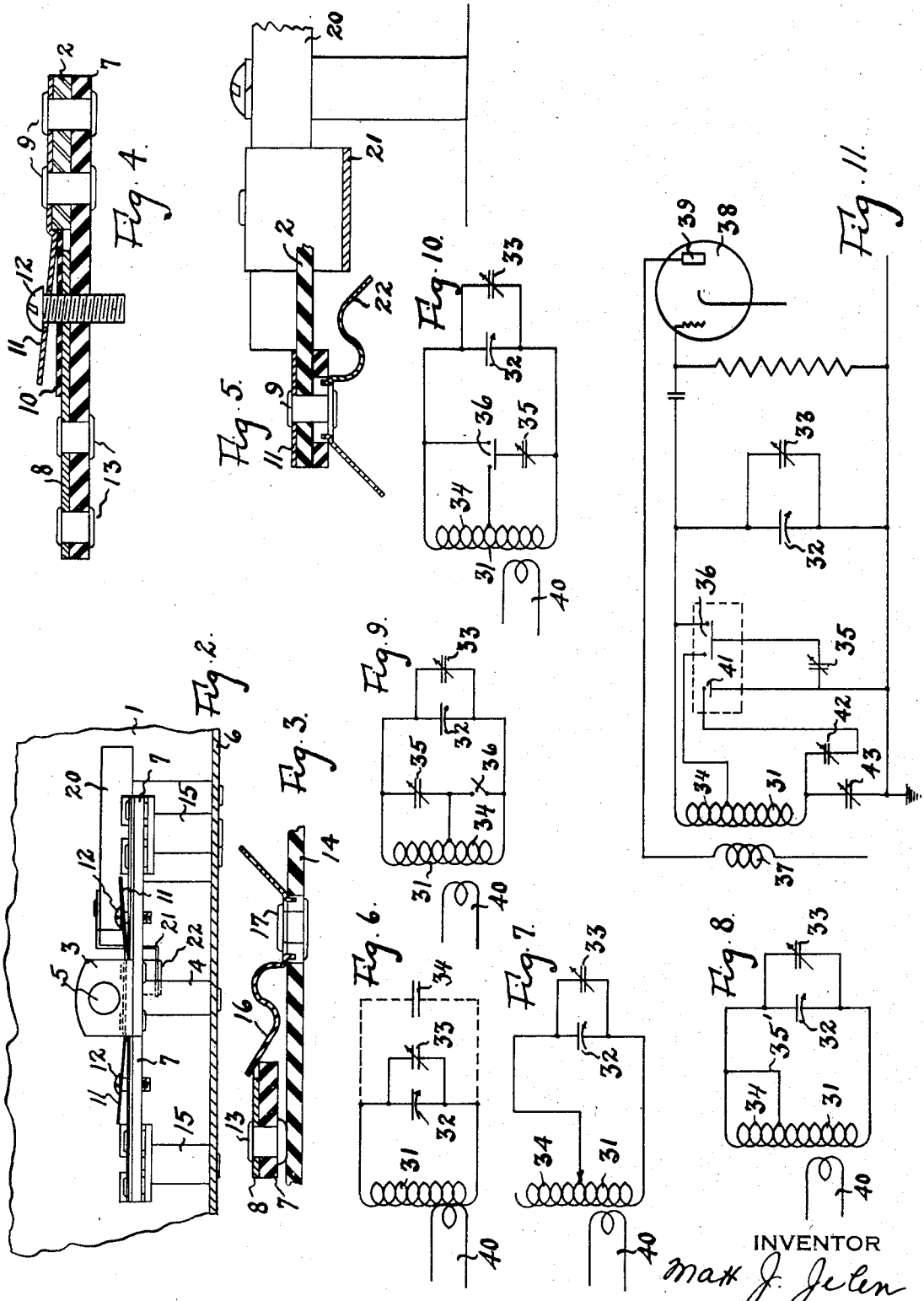
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UNITED STATES PATENT OFFICE

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METHOD AND MEANS OF EXTENDING FREQUENCY RANGE OF RADIO APPARATUS

Application filed May 13, 1931. Serial No. 536,993.

This invention relates to method and apparatus by means of which the frequency range of radio circuits and especially radio receiving circuits may be extended either above or below their normal frequency range.

One of the objects of this invention involves a method and the apparatus by means of which particularly radio receiving sets designed to normally operate on the so-called broadcast range may be simply and quickly adjusted so as to extend the frequency range either above or below the normal range.

A further object involves an apparatus of this type more particularly a device by means of which the frequency range of a receiving set may be extended above its normal range.

A still further object of this invention is to provide a switching device which will permit by a single operation of the adjustment of the receiver from its normal receiving range with regard to frequency to a higher frequency range.

A still further object of this invention is the provision of a switching device of this nature arranged for use in radio receiving apparatus involving a number of coupled stages each of which is tuned by a separate tuning device, all of which, however, are operated by a single control means.

Another object of this invention is the provision of a switching device for use in circuits of this type which short-circuits a portion of the secondary coil in each of the stages and by the same operation includes "trimming" condensers in the various stages without in any manner disturbing the setting of the conventional "trimming" condensers permanently connected in the stages with the tuning condensers.

This invention is also applicable to the superheterodyne type of receivers in which the same operations are carried out in connection with the amplifiers and the oscillator to extend the range thereof above their normal range.

These and many other objects as will appear from the following disclosure are secured by means of this invention.

This invention resides substantially in the combination, construction, arrangement, relative location of parts, steps and series of steps, all as will be set forth in considerable detail in conjunction with the drawings.

Referring to the drawings—

Figure 1 is a top plan view of the elements of this invention;

Fig. 2 is a front elevational view thereof;

Fig. 3 is an enlarged cross-sectional view taken on the line 3—3 of Fig. 1;

Fig. 4 is an enlarged cross-sectional view taken on the line 4—4 of Fig. 1;

Fig. 5 is an enlarged cross-sectional view taken on the line 5—5 of Fig. 1;

Figs. 6 to 11 inclusive, are diagrammatic illustrations of the principles involved in this invention.

Modern radio signalling apparatus is more and more involving a larger portion of the radio frequency spectrum. The broadcasting of intelligence, speech, music and pictures is requiring that receiving sets be operable over a wider frequency band. Thus wireless telegraphy as well as telephony is involving transmission on low and high frequencies and television transmission is involving transmission at high frequencies. A radio receiver which is designed to operate on the normal broadcast frequency band is not well adapted for receiving signals on frequencies higher and lower than this band. Although apparatus could be designed to operate over a wider band it becomes relatively more expensive and complicated and, even at best, does not operate at full efficiency over the expanded frequency band. It is the general purpose of this invention to provide a relatively simple adjunct for radio receivers designed for operation on the normal broadcast band by means of which the reception band of the receiver may be expanded particularly in a direction adapted for operation on higher frequencies such as are used, for example, in television transmission. The present practice involves apparatus constructed so that the radio frequency coupling coils are interchangeable to adapt the receiver for operation on different bands.

Present day receivers employ fixed in-

ductances and variable capacitances in the various stages for securing frequency selection. Of course this apparatus involves several joined stages which are coupled together and in each stage of which is provided a variable capacitance for tuning it. The capacitances are in the form of variable condensers all of which are commonly operated by a single control. For the most efficient operation of these circuits it is necessary that the rate of change in resonant frequency of the tuned circuits be uniform. This is accomplished by making the effective inductances in each stage equal to each other, using similar tuning condensers and providing small fixed condensers known as "trimmers" which are adjustable for the purposes of adjusting the circuits to make them as uniform as possible.

The principles of this invention have been applied to apparatus of this type and the nature of the invention will be best understood by reference in detail to the drawings.

It is believed that the principles of operation of the invention will best be understood by reference first to Figs. 6 to 11 inclusive. Fig. 6 illustrates diagrammatically one stage of a radio frequency amplifier. The primary circuit of the radio frequency transformer is shown at 40 inductively coupled to the secondary 31 of the radio frequency transformer. This inductance 31 is shunted by the variable condenser by means of which the circuit is tuned for frequency selection. Shunted around the variable condenser 32 is a small fixed adjustable condenser 33 known as a "trimmer". The capacity 34 illustrates the equivalent capacity of the circuit and the vacuum tube which is normally connected to the circuit. This circuit is tuned for frequency selection by means of the variable condenser 32 and the condenser 33 is provided to adjust the fixed circuit and tube capacities of that stage to render the circuit electrically similar to the other stages which would be coupled thereto in cascade in accordance with well known practice. The frequency range of this circuit may be extended above or below its normal range by adding to or reducing the inductance of the coil 31. From here on the description of the apparatus will relate to the extension of the frequency range of the apparatus above its normal range to adapt the apparatus for operation at higher frequencies and lower wave lengths. It will be apparent that the principles of the invention apply in an obvious manner to the extension of the frequency range below the normal range of the apparatus.

The frequency range of such a circuit as shown in Fig. 6 may be extended above its normal range by using a tapped coil 31, in Fig. 7, or, more desirably, by short-circuiting a part of the coil as indicated in Fig. 8. In Fig. 7 one of the leads from the coil is made adjustable in accordance with well known practice so that a number of turns as indicated at 34 are cut out of circuit. In Fig. 8 a number of turns of the coil 31 as indicated at 34 are short-circuited by the wire 35'. By these arrangements the frequency range of the circuit may be increased. One difficulty with the arrangements of these figures is that the "trimming" condenser 33 must be readjusted for the new frequency conditions. Since this cannot be done conveniently it is desirable to provide another "trimming" condenser to line up the oscillator and pre-selector circuits to a difference in frequency equal to that of the intermediate amplifier when the receiver is to be operated on the extended portion of the frequency band.

Such an arrangement is illustrated in Fig. 9 in which arrangement in extending the frequency range provision for "trimming" in both frequency bands is made. The extension in the frequency range of the circuit is accomplished by short-circuiting a portion of the inductance 31 as indicated at 34 by means of switch 36. The additional "trimming" of the circuit is provided by the adjustable fixed condenser 35. The disadvantage of this arrangement is that the adjustment of either "trimming" condenser 35 or 33 will necessitate readjustment of the other.

This difficulty is overcome by the arrangement shown in Fig. 10 wherein when switch 36 is closed the portion 34 of coil 31 is short-circuited and at the same time the "trimming" condenser 35 is connected in circuit without disturbing the "trimming" condenser 33. With such an arrangement incorporated into all the tuned circuits in a superheterodyne receiver it is possible to make a receiver having a greater tuning range.

In a superheterodyne receiver it is desirable to provide additional "trimming" condensers to adapt the oscillator for operation of the receiver on the extended range. This circuit is illustrated in Fig. 11 where the "trimming" condenser 35 and the switch 36 for cutting it in circuit and short-circuiting the turns 34 are shown. In addition, another switch 41 is provided for cutting in at the same time a "trimmer" 42 to adjust the frequency of the oscillator at the low frequency end of the extended range. The "trimming" condenser 43 is used to adjust the frequency of the oscillator at the low frequency end of the normal range of the receiver. "Trimmer" 35 is used to adjust the frequency of the oscillator at the high frequency end of the extended range of the receiver. "Trimmer" 33 is used to adjust the frequency of the oscillator at the high frequency end of the normal range of the receiver.

The structure by means of which the neces-

sary switching operations for a superheterodyne receiver can be easily made is shown in detail in Figs. 1 to 5 inclusive. At 1 is a suitable support such as the base of the receiver which is provided with the front panel 6. Supported for longitudinal movement on a post 4 by means of the screw 4′ is a metal strip 2 which is provided with the right angle extension 3 to which the operating rod 5 is connected. This rod extends through the front panel 6 and may be provided with a suitable operating handle. Extending transversely from the strip 2 and secured thereto by the rivets 9 are the arms 7 made of insulating material. There are four of these arms, 3 of them extend to the left as shown in Fig. 1 and one extends to the right. Secured on the upper surface of the strips 7 as shown more clearly in Fig. 4 by means of the rivets 13 are the conducting strips 8. Also secured to this structure by the rivets 9 are the metal plates 11 of suitable size which overlie thin strips of insulating material 10 as shown. The screws 12 are provided for adjusting the position of the strips 11 with respect to the strips 8. It will be apparent that the strips 8 and 11 supported by the insulating plate 10 provides small fixed adjustable condensers the capacities of which may be adjusted by the screws 12. Mounted on the standards 15 as shown in Fig. 2 are the strips of insulating material 14 and 14′. These strips are mounted so as to lie below the ends of the transverse arms 7 as is clear in Fig. 3. Mounted on strip 14 are three pairs of contact fingers 16 which are secured thereto by the rivets 17. In a similar manner a pair of contact fingers 16 are secured by rivets 17 to the insulating strip 14′.

At 20 is a casing or support for two additional small fixed adjustable condensers which are mounted therein and which may be adjusted in their capacity by means of the screws 21^a and 21^b. Mounted on this casing is a contact finger 21 which is supported so as to be engageable by the contact finger 22 which is secured to the under surface of the metal strip 2. This arrangement is shown in more detail in Fig. 5. The inductance coils are shown at 31 and are provided with terminals 31′ by means of which they are connected to their corresponding spring fingers 16 by means of the wires 32. These four inductances are the input coils corresponding to the inductance 31 of the circuits for three stages of radio frequency selection and for the input to the oscillator. The coil in the upper left hand corner of Fig. 1 is the input coil of the oscillator. The four fixed adjustable condensers on the movable strip 2 correspond to the "trimming" condensers 35. The two condensers in casing 20 correspond to the "trimming" condensers 42 and 43 and the switch comprising the contacts 21 and 22 corresponds to switch 41 for cutting condenser 42 in and out of circuit. Condenser 43 is, of course, always in circuit as is condenser 33.

In the operation of the device the change over from normal frequency range to extended frequency range is accomplished by simply pulling on rod 5. With the part in the position shown in Fig. 1 the circuits are arranged for operation on the normal frequency band with all the turns of the inductances 31 in circuit. When rod 5 is pulled contact strips 8 move under the contact fingers 16 in all cases to short-circuit the number of turns of the coils 31 connected between the terminals 31′ on these coils. At the same time the condensers 35 are cut into circuit as well as condenser 42 because this movement of the device interconnects contacts 21 and 22. The apparatus by this simple operation is then set for operation on the extended range which, in this case, would be a frequency range above the normal range since a portion of the coils 31 have been short-circuited. To return the set back to operation on its normal frequency range it is only necessary to push on rod 5 to return the apparatus to the position shown in the figure. The switch as illustrated is for use with a superheterodyne receiver. It would, of course, be considerably simplified when applied to a tuned radio frequency receiver in which no oscillator is used. In this case the device would not include the condensers in casing 20 and the switch comprising the parts 21 and 22, nor would it use the upper left hand coil 31 and the switch and condenser associated with it. In other words, the apparatus would be simplified to the form illustrated in Fig. 10 and duplicated as to that structure for as many radio frequency stages as are employed.

From the foregoing disclosure it will be apparent that my invention resides in certain principles of construction and operation which may be embodied in other physical forms. I do not, therefore, desire to be strictly limited to the disclosure as given for purposes of illustration but rather to the scope of the appended claims.

What I seek to secure by United States Letters Patent is:

1. The method of extending the normal frequency range of a tuned circuit including an inductance coil and a condenser comprising the steps of changing the inductance of the inductance coil and introducing a trimming condenser into the circuit.

2. The method of extending the normal frequency range of a tuned circuit including an inductance coil and a condenser comprising the steps of simultaneously changing the inductance of the inductance coil and introducing a trimming condenser into the circuit.

3. The method of raising the normal frequency range of a frequency selective circuit including a coil and a tuning condenser comprising the steps cutting out a predetermined

number of turns of the coil and connecting a trimming condenser to the remaining turns.

4. The method of raising the normal frequency range of a frequency selective circuit including a coil and a tuning condenser comprising the steps cutting out a predetermined number of turns of the coil and shunting a trimming condenser across the remaining turns of the coil.

5. The method of raising the normal frequency range of a frequency selective circuit including a coil and a tuning condenser comprising the steps of simultaneously cutting out a predetermined number of turns of the coil and connecting a trimming condenser in shunt across the remaining turns of the coil.

6. The method of raising the normal frequency range of a frequency selective circuit including a coil and a tuning condenser comprising the steps of simultaneously short-circuiting a number of turns of the coil and shunting a trimming condenser across the remaining turns.

7. The method of raising the normal frequency range of a frequency selective circuit including a coil and a condenser comprising the steps of short-circuiting a number of turns of the coil, connecting a trimming condenser across the remaining turns of the coil and connecting a trimming condenser in series with said remaining turns of the coil.

8. The method of raising the normal frequency range of a cascaded multi-stage radio frequency amplifier each of which stages includes a coil and a condenser for tuning it which comprises simultaneously cutting out of circuit a number of turns of each coil and connecting a trimming condenser to the remaining turns of each coil.

9. The method of raising the normal frequency range of a cascaded multi-stage radio frequency amplifier each of which stages includes a coil and a condenser for tuning it which comprises simultaneously short-circuiting a number of turns of each coil and connecting trimming condensers in shunt with the remaining turns of each coil.

10. The method of raising the normal frequency range of a cascaded multi-stage radio frequency amplifier each of which stages includes a coil and a condenser for tuning it which comprises effectively removing a number of turns of each coil from the circuit and connecting trimming condensers in circuit with the remaining turns of each coil.

11. In an apparatus of the type described the combination comprising an inductance, a condenser connected to said inductance for tuning it, means for cutting a number of turns of the inductance out of circuit, and means for connecting a condenser in circuit with the remaining turns of the inductance.

12. In an apparatus of the type described the combination comprising an inductance coil and a variable condenser connected to provide a frequency selective circuit, a trimming condenser and means for simultaneously effectively removing a number of turns of the coil from circuit and connecting the trimming condenser in circuit with the remaining turns of the coil.

13. In an apparatus of the type described the combination comprising an inductance coil, a vacuum tube having a grid and cathode connected to the inductance coil, a tuning condenser connected to the inductance coil to provide therefor a frequency selective circuit, means for short-circuiting a number of turns of the inductance coil and a trimming condenser connected across the remaining turns of the coil.

14. A radio frequency amplifier circuit including a vacuum tube having a grid and cathode, an input inductance connected between the grid and cathode, a variable condenser connected across the inductance to provide a frequency selective input circuit, and means for simultaneously short-circuiting a pre-determined number of turns of the inductance and connecting a trimming condenser across the remaining turns of the inductance.

15. The combination with an inductance coil, of means for short-circuiting a predetermined number of turns of the inductance coil, and means for simultaneously connecting a fixed condenser across the remaining turns of the inductance coil.

16. In an apparatus of the type described, the combination comprising a plurality of inductance coils, simultaneously operable means for short-circuiting a predetermined number of turns of each of the coils, and means operable with said first means for simultaneously connecting condensers in circuit with the remaining turns of each of said coils.

17. The combination as described comprising a vacuum tube having a cathode, an anode and a grid, an input circuit connected to the grid and cathode including a tuned inductance coil, an output circuit connected to the anode and cathode of said tube and associated with said input circuit, means for short-circuiting a predetermined number of turns of the input inductance, and means operable at the same time for connecting a condenser across the remaining turns of the coil.

18. The combination as described comprising a vacuum tube having a cathode, an anode and a grid, an input circuit connected to the grid and cathode including a tuned inductance coil, an output circuit connected to the anode and cathode of said tube and associated with said input circuit, means for short-circuiting a predetermined number of turns of the input inductance, and means for connecting a condenser in shunt across the remaining turns of the coil and a second con-

denser in series with the remaining turns of the coil.

19. In an oscillator circuit of the type described the combination comprising a vacuum tube having a grid, a cathode and an anode, a tuned input circuit including an inductance connected to the vacuum tube and an output circuit connected to the vacuum tube and associated with the input circuit, a condenser in series with the inductance in the input circuit, means for short-circuiting a number of turns of the inductance in the input circuit, means for connecting a condenser across the remaining turns of the inductance coil, and means for connecting a condenser in shunt with the condenser in series with the inductance coil.

In testimony whereof I have hereunto set my hand on this 25th day of April, A. D. 1931.

MATT J. JELEN.