Oct. 16, 1934. P. O. FARNHAM 1,977,435

METHOD OF ALIGNING BAND PASS CIRCUITS

Filed March 23, 1931

Fig. 1.

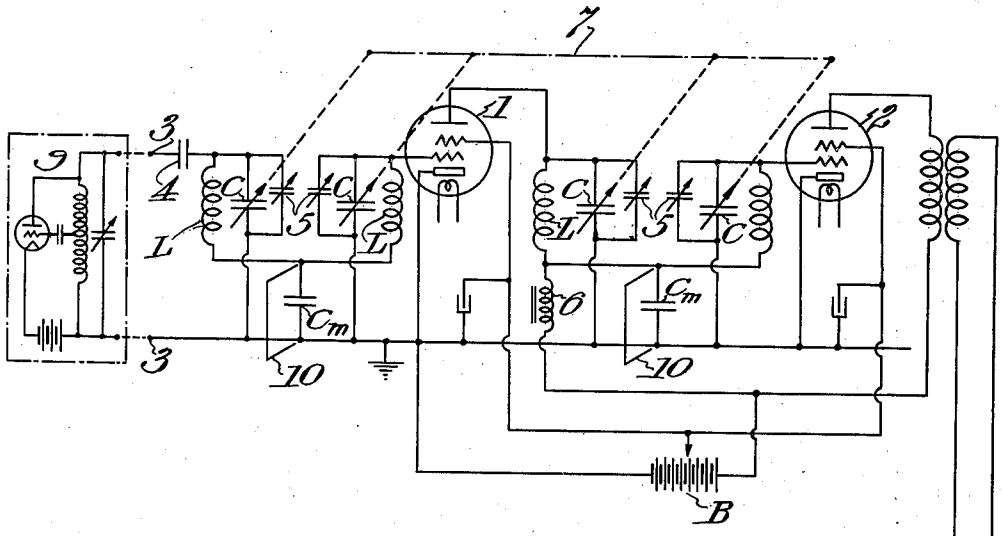
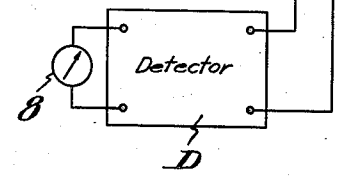
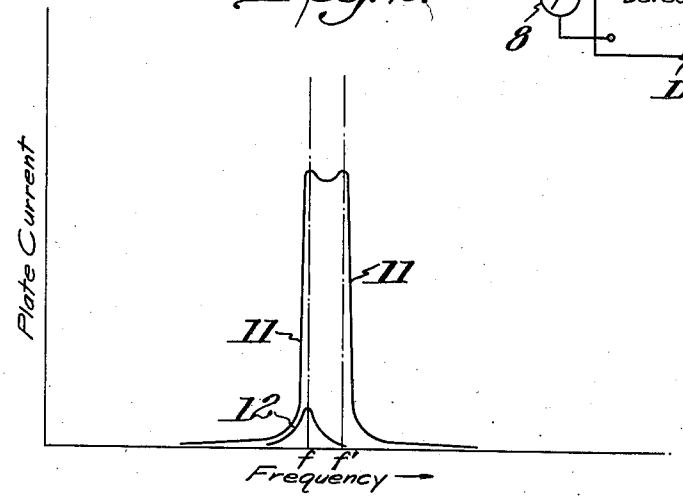


Fig. 2.





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METHOD OF ALIGNING BAND-PASS CIRCUITS

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4 Claims. (Cl. 178—44)

This invention relates to tuned circuits and particularly to methods of aligning tuned circuits of the band-pass type.

It has been proposed to secure substantially equal transmission for all frequencies within a narrow band and sharp attenuation for frequencies outside of that band by the use of tuned circuits coupled with somewhat in excess of critical coupling. The resonance curve for such a system of coupled circuits is characterized by two resonance peaks and, when one or more band-pass circuits of this type are included in a transmission system in which tuning is effected by a single control element, it is difficult so to align the adjustable elements of the system as to bring all of the tuned circuits into resonance at the same frequency.

An object of the present invention is to provide a simple and effective method for aligning the two tuned circuits of a band-pass system with each other and/or with other tuned circuits. More particularly, an object is to provide a method of adjusting the resonant frequency band of a band-pass circuit by first eliminating or substantially eliminating the coupling between the tuned circuits of a band-pass unit, and then tuning each circuit to the same frequency.

These and other objects of the invention will be apparent from the following specification when taken with the accompanying drawing, in which

Fig. 1 is a circuit diagram illustrative of the invention, and

Fig. 2 is a curve sheet showing resonance curves indicative of the results obtained during the adjusting operation.

As shown diagrammatically in Fig. 1, tuned band-pass circuits constitute the input system associated with the first amplifier tube 1, and the interstage coupling between that and the succeeding amplifier tube 2. For purposes of illustration, these stages may be considered to be tuned radio frequency amplifier stages of a radio receiver, but it will be apparent that the invention is generally applicable to the aligning of the coupled circuits of a band-pass unit, either tunable over a range of frequency or not tunable, irrespective of the particular apparatus or circuit arrangement in which the unit is to be incorporated.

As shown in Fig. 1, one of the input terminals 3 of the amplifier is connected to ground and the other is connected to the high potential terminal of inductance L through a condenser 4. The high potential terminal of a similar inductance L is connected to the control grid of tube 1, and the low potential terminals of the inductances are connected to ground through the coupling impedance C_m. Tuning condensers C are connected from the high potential terminals of each inductance to ground and small vernier or aligning condensers 5 are preferably shunted across each tuning condenser C.

The interstage coupling system is of the same general form as the input system for the first tube, the inductance L of the first tuned circuit being connected, in series with a radio frequency choke 6, between the plate of tube 1 and an appropriate source B of plate current. As indicated by the broken lines extending from the several tuning condensers C to the control bar 7, the adjustable elements of all of the tuning condensers are preferably connected mechanically to provide a single control for all of the tuned circuits.

To effect the desired alignment of the stages, the output circuit of the second amplifier stage is coupled, through a detector D, to a milliammeter 8 and a signal generator of adjustable frequency, indicated diagrammatically by the tuned oscillator 9, is connected across the input terminals 3. This use of a signal generator and meter in testing or adjusting an amplifier is well known but, as stated above, considerable difficulty has been experienced in adjusting the trimming condensers to insure alignment when one or more band-pass circuits are included in the amplifier.

In accordance with the invention, the coupling impedances C_m of the band-pass circuits are then short-circuited out by low resistance shunts 10, and the several trimming condensers 5 are adjusted to give a maximum current flow in the output circuit of the second stage, i. e., a maximum current flow as indicated by the meter 8.

Referring now to Fig. 2, the curve 11 is a typical resonance curve for a band-pass circuit of the type including two tuned circuits having a small impedance in common. The curve 11 is characterized by the presence of two resonance peaks, at frequencies f and f', and the width of the band is determined by the degree of coupling provided by the common impedance which, in the illustrated circuit, is capacitive. In the absence of the coupling impedance C_m, the tuned circuits are resonant at the lower frequency f, and I have discovered that, in practical constructions, there is an appreciable residual transmission of alternating currents of the frequency f

when the coupling condensers C_m are short circuited.

The aligning process may therefore be carried out by impressing upon the input terminals 3 an oscillatory voltage of a frequency corresponding to the mean of frequencies f and f', and adjusting the tuning condensers C to give a maximum or approximately maximum alternating current flow in the output circuit of the second stage, as indicated by the reading of the meter 8. If necessary, the connection between the main control shaft and the condensers C is adjusted to bring the scale reading of the control shaft into agreement with the frequency of the impressed voltage, which frequency is indicated by the adjustment of the signal generator 9. This frequency corresponds to the mean of the frequencies f and f' of the resonance curve 11. The shunts 10 are then applied to short circuit the coupling condensers C_m, and the signal generator is adjusted to the frequency f. As indicated by resonance curve 12 of Fig. 2, the transmission through the amplifier is substantially reduced by the short-circuiting of the condensers C_m, but the resonance peak is easily recognized. The several tuned circuits are aligned, by adjustment of the trimming condensers 5, to give a maximum current flow through the milliammeter 8.

By thus aligning the several LC circuits, the band-pass circuit is properly aligned, i. e., its resonance curve is substantially symmetrical about the desired mean frequency, when the shunts 10 are removed. When the amplifier includes more than one band-pass circuit all of the circuits are properly aligned and, if the same circuit constants are employed in all of the band-pass circuits, the several resonance bands are all of the same width.

When the amplifier also includes one or more stages tuned by simple resonant circuits, the band-pass or the single resonance peaks are, of course, separately adjusted. In the case of the single tuned circuit couplings, the generator 9 is adjusted, in the usual manner, to supply a voltage of the mean frequency, i. e. the frequency as indicated by the receiver scale graduations, when the single tuned circuits are to be aligned.

While the invention has been described in connection with band-pass circuits of one type now employed in tuned radio frequency amplifiers, it is apparent that the method is generally applicable to various types of band-pass circuits. For example, when the coupling impedance is inductive, the tuned circuits are resonant at the higher frequency f' of the band.

I claim:

1. The method of adjusting a band-pass circuit of the type intended to afford substantially uniform transmission of all frequencies lying within a band defined by two limiting frequencies at opposite sides of a desired carrier frequency, said circuit comprising two tuned circuits coupled by a capacitive impedance, and each of said circuits including inductances of substantially equal magnitude shunted by mechanically interconnected variable condensers of substantially identical construction and by trimming condensers; which method comprises impressing upon the band-pass circuit a voltage of the desired carrier frequency, adjusting said variable condensers to bring the band-pass circuit into resonance at approximately the carrier frequency, short-circuiting the coupling impedances, impressing upon the band-pass circuit a voltage of the frequency of the lower limit of the transmission band, and adjusting said trimming condensers to secure a maximum transmission of said lower limit frequency by said band-pass circuit, and then removing the short circuits.

2. The method of adjusting a band pass circuit of the type intended to afford substantially uniform transmission of all frequencies lying within a band defined by two limiting frequencies at opposite sides of a desired carrier frequency, said circuit comprising at least two tuned circuits coupled by an impedance, and each of said circuits including mechanically interconnected variable tuning elements of substantially identical construction and trimming tuning elements; which method comprises impressing upon the band pass circuit a voltage of the desired carrier frequency, adjusting said variable tuning elements to bring the band pass circuit into resonance at approximately the carrier frequency, short circuiting the coupling impedance, impressing upon the band pass circuit a voltage of the frequency of the lower limit of the transmission band and adjusting said trimming elements to secure a maximum transmission of said lower limit frequency by said band pass circuit and then removing the short circuits.

3. In the operation of a band pass circuit of the type including two tuned circuits coupled by a capacitive impedance which is common to said circuits each of said tuned circuits including an inductance shunted by a variable condenser and a trimming condenser, the steps in a method of aligning said band pass circuit so as to afford substantially uniform transmission of all frequencies lying within a band defined by two limiting frequencies at opposite sides of a desired carrier frequency which comprise adjusting said variable condensers of each of the tuned circuits so as to produce maximum response in said circuits at the desired carrier frequency, short-circuiting the coupling impedance and adjusting said trimming condensers to bring both tuned circuits into resonance at the frequency of the lower peak of the resonance curve of the band pass circuit and subsequently removing the short circuit.

4. The method of adjusting a band pass circuit of the type intended to afford substantially uniform transmission of all frequencies lying within a band of frequencies defined by two limiting frequencies at opposite sides of a desired carrier frequency, said circuit comprising at least two tuned circuits coupled by an impedance and each of said circuits including mechanically interconnected variable tuning elements; which method comprises, impressing upon the band pass circuit a voltage of the desired carrier frequency, adjusting said variable tuning elements so as to produce approximately maximum response at the desired carrier frequency, decreasing to a substantial degree the coupling between the two coupled circuits, impressing upon the band pass circuit a voltage of approximately the frequency of one of said two limiting frequencies of the transmission band and adjusting said trimming elements to secure substantially maximum transmission of the last impressed frequency by said band pass circuit and then increasing the degree of coupling between the circuits to its normal value.

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