Aug. 20, 1935. A. T. WITTS 2,012,030

BAND PASS TUNER

Filed March 3, 1933

Fig. 1

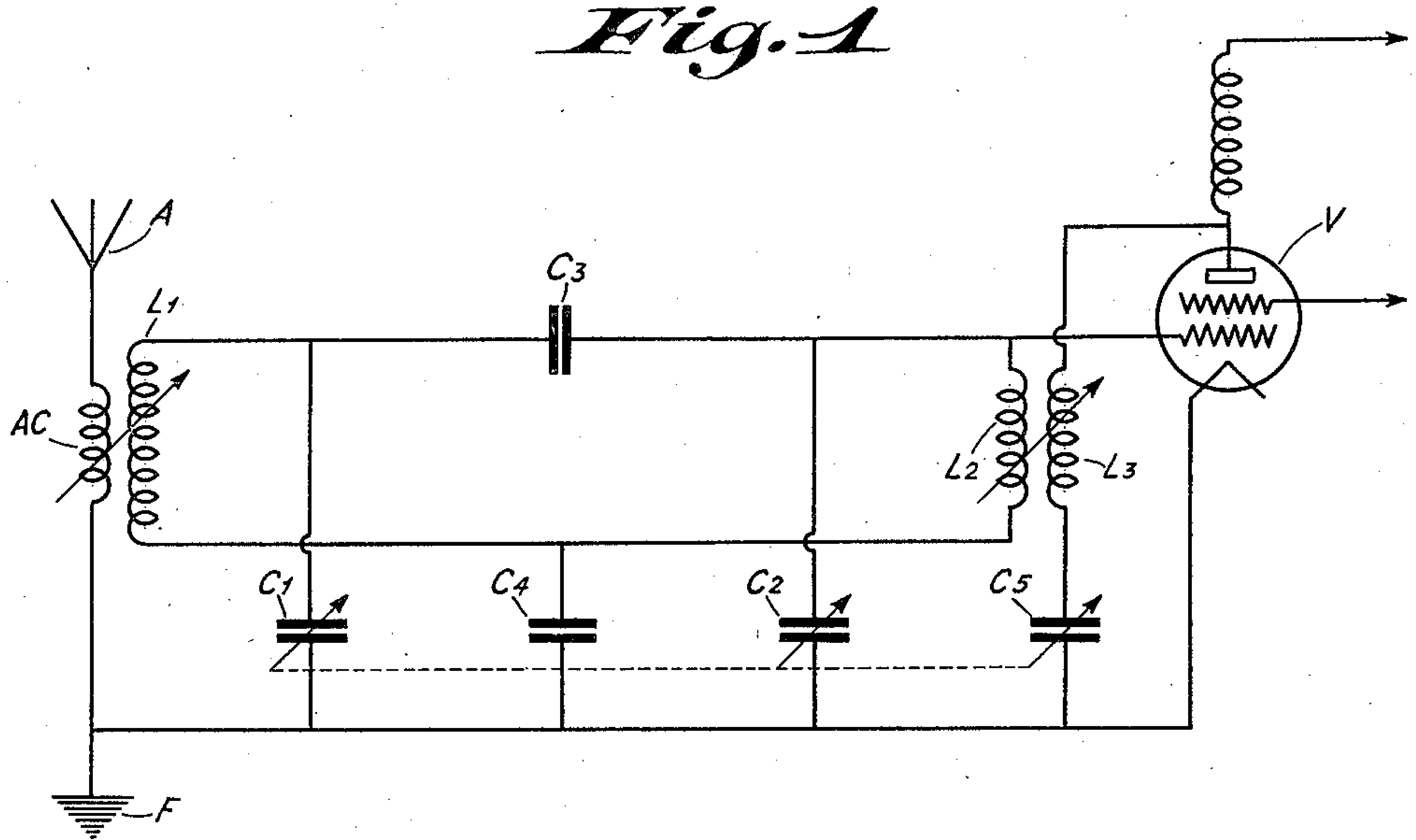
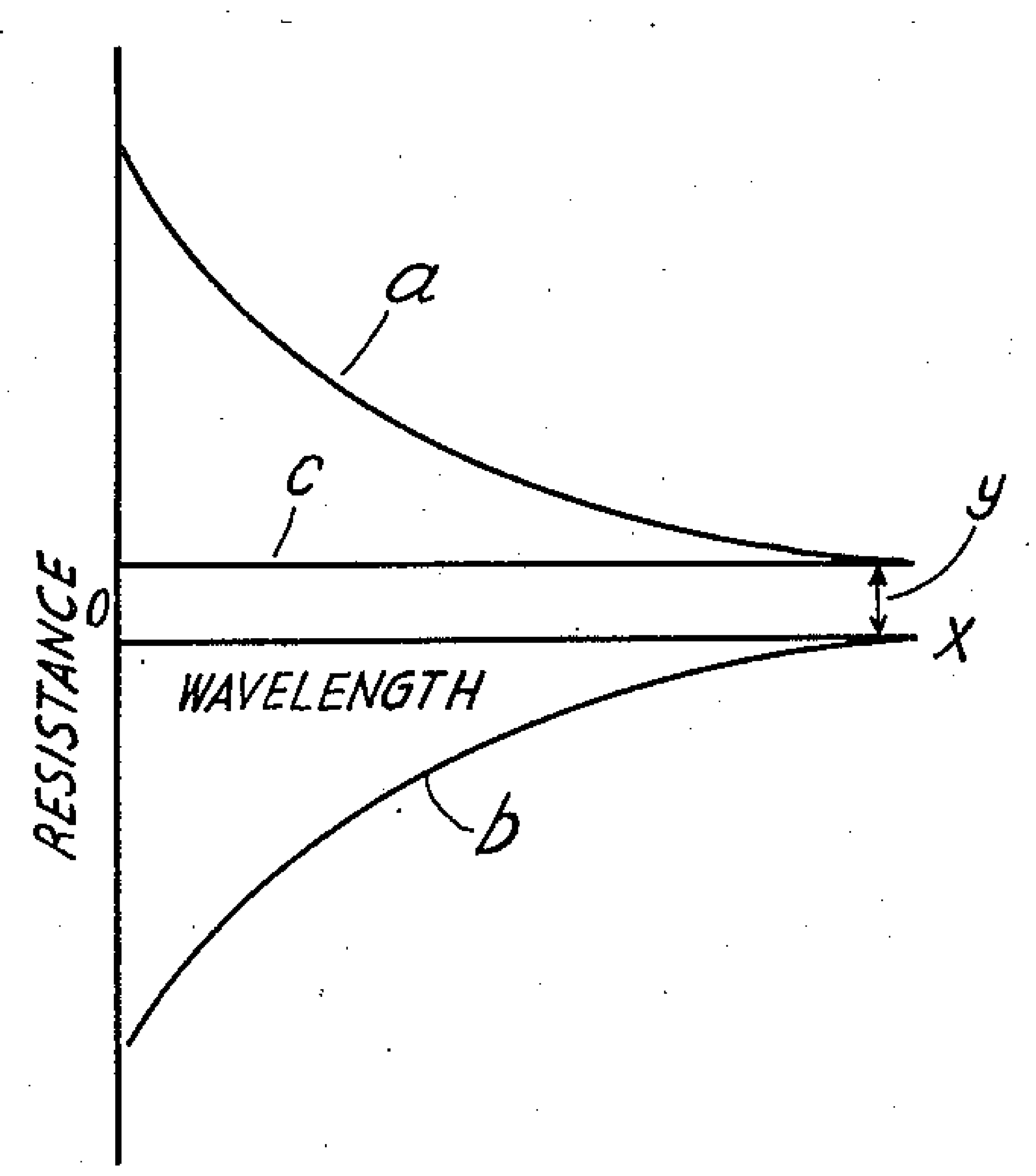


Fig. 2



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BAND PASS TUNER

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4 Claims. (Cl. 178—44)

This invention relates to frequency selection means for use in high frequency electrical circuits and although not limited to its application thereto, is particularly suitable for use in connection with the tuning of broadcast radio receivers.

As is well known it is very desirable in a broadcast radio receiver to be able to tune said receiver to receive, and substantially uniformly to amplify, all the frequencies in a strictly limited band of frequencies of width corresponding to the width of the modulation side bands of a broadcast transmitting station and to be able to move this band up and down within the tunable range of the receiver. In other words it is very desirable that a radio receiver shall have what is generally termed band pass tuning, i. e. shall be such that no matter what station the receiver is tuned to, it will receive the full modulation width of the said station (say about 10,000 cycles) but shall reject all frequencies outside this band. It is, therefore, common to provide radio receivers with so-called tunable band pass filters, and, although these are fairly satisfactory in practice, known forms of band pass filters present the serious disadvantage that their resistance is not constant over the wide range of wave lengths normally required for broadcast reception. This disadvantage is well known and various proposals have been made to obviate it, but all the proposals so far made have offered more or less serious disadvantages and have not been entirely successful in practice, it being generally the case that at some part of the frequency spectrum the choice has to be made between reduced amplification ratio or increased width of the accepted frequency bond.

The present invention has for its object to provid a tunable band pass filter arrangement which shall accept substantially the same width of band of frequencies at all positions of tuning.

According to this invention a tunable band pass filter arrangement comprises means controlled simultaneously with the normally provideded means for varying the tuning of the filter for injecting negative resistance into said filter, the means for injecting negative resistance being such that the amount of negative resistance injected is sufficient to compensate for the variations in resistance of the filter itself.

The invention is illustrated in Fig. 1 of the drawing which shows schematically one arrangement in accordance therewith, while Fig. 2 is an explanatory graph. Referring to the said Fig. 1, which represents the first stage of amplification of a radio receiver, an aerial A, which is earthed at F through the usual aerial coil AC, is coupled to an inductance L_1 in a band pass filter comprising two tuned circuits L_1C_1, L_2C_2 which are coupled to one another by condensers C_3C_4. The variable condensers C_1C_2 are ganged together, i. e. arranged for simultaneous adjustment, the filter as so far described being of a kind well known per se. The output of the filter is applied between the control grid and cathode of an amplifier valve V (shown as of the screen grid type) and, negative resistance is injected into the filter by a circuit including a coil L_3 and a variable condenser C_5, coil L_3 being coupled to the coil L_2 in the band pass filter proper. The amount of negative resistance injected is controlled by the condenser C_5 which, as is shown, is gang-controlled with the condensers C_1 and C_2, the condenser C_5 being so constructed, i. e. having such a law of capacity-setting, that at all positions of tuning given by the condensers C_1 and C_2 the total resistance, i. e. the resistance presented by the filter proper plus the negative resistance, is constant.

If desired the coil L_3 may be coupled to the coils L_1 and L_2 instead of, as shown, to the coil L_2 only. As will be appreciated it may be necessary to change the valve V from time to time, e. g. when it wears out to replace it by a new valve, and the new valve may not be of precisely the same constants and characteristics of the valve it replaces. Such changing of the valve V might result therefore in upsetting the "ganging" of the tuning arrangement and in order to provide for an adjustment to take care of this possibility the condenser C_5 is preferably provided with a so-called "trimming" condenser which may be adjusted for the purpose of imparting the necessary compensation.

The shape of the condenser plates of condenser C_5 is such that the control of the negative resistance injected into the band pass filter from its minimum value must be substantially of the same order of magnitude as the increase in positive resistance of the band pass filter. Consequently the actual shape will vary according to the positive resistance characteristic of the band filter, but the standard types of variable condenser plates may be used for this purpose.

In the example shown in the drawing the resistance frequency curve is given in Fig. 2. In order to get a negative resistance variation similar to curve *b* an ordinary straight line frequency condenser suffices; the condenser may have the usual adjustable split end plates. Such a condenser is in common use for effecting satisfactory tracking of ganged circuit tuning condensers. As the maximum value of negative resistance is required at the highest frequency to which the filter is tuned, the setting of C_5 must be a maximum at that point. Therefore, the ganging of C_5 with the tuning condensers C_1 and C_2 must give maximum value of C_5 when the setting of C_1 and C_2 is a minimum.

For other types of band pass filters with positive resistance frequency curves different from that shown in Fig. 2, the various standard types of condenser plates can be used; for example, with square law and logarithmic capacity variation with angle of rotation. The desired modification to bring the negative resistance curve into substantial agreement with the positive resistance curve of each particular type of filter can be effected by adjustment of the split end plate.

As regards the low end of capacity setting, this need not be of any specified value so long as the control exercised on the negative resistance enables any increase in positive resistance of the filter to be compensated. The amount of negative resistance injected must be zero at the lowest point of the resistance frequency curve corresponding to the particular band pass filter employed.

Referring to Fig. 2 of the drawing the curve *a* represents the resistance of a normal so-called double-capacity-coupled filter, i. e. a filter as shown in Fig. 1 but without the negative resistance provision. As will be seen the resistance falls with increasing wave length. The requirement to be met is that of maintaining the overall resistance constant at the value which it has at the highest wave length in the tuning range, i. e. at the value "*y*". To put the matter in another way, the straight line *c* is the resistance characteristic which is required. This characteristic *c* is obtained by so designing the circuit for injecting negative resistance that the amount of negative resistance injected is as given by the curve *b*, the curve *b* being such that the ordinate at any point along the abscissa line OX is equal and opposite to the ordinate of the curve *a* minus the ordinate of the curve *c* at that point.

The invention is, of course, of general application to all forms of band pass filters and various methods of injecting negative resistance may be resorted to. For example, a dynatron may be coupled to the filter in place of the reactive winding L_3 of Fig. 1, the potential of the third electrode of the dynatron being operated about a suitable point on the operating curve by means of a potentiometer or equivalent arrangement which is uni-controlled with the tuning means for the filter proper. Alternatively the potentials applied to the dynatron may be constant and the coupling between said dynatron and the filter proper varied by means uni-controlled with the filter tuning means.

In yet a further modification, use is made of the negative resistance characteristic of a specially provided screen grid valve. In this arrangement means uni-controlled with the filter tuning means are provided for altering the potential of the anode or the potential of the control grid, or the potentials of the screen grid and anode together and in this way the required amount of negative resistance is injected into the band pass filter proper at each position of tuning.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. A tuning circuit arrangement suitable for use in radio receivers and for like purposes, and comprising in combination a tunable band pass filter arrangement and means, controlled simultaneously with the normally provided means for varying the tuning of said filter, for injecting negative resistance into said filter, the means for injecting negative resistance being such that the amount of negative resistance injected substantially compensates for variations in resistance of the filter proper as the said filter is tuned.

2. A radio or like modulated carrier wave receiver comprising a tuning circuit arrangement as claimed in claim 1, and wherein the negative resistance for injection into the filter is obtained from the output of a normally provided valve in the receiver.

3. A radio receiver comprising an aerial circuit, a band-pass filter including a plurality of coupled gang-controlled tuned circuits for coupling said aerial circuit to the input circuit of an amplifier valve, an inductance in series with an adjustable condenser connected in circuit between the plate and cathode of said amplifier valve, said inductance being coupled to an inductance in the band-pass filter, and means for uni-controlling said adjustable condenser with tuning condensers provided for varying the tuning of the band-pass filter to maintain a constant resistance characteristic over the receiver tuning range.

4. In combination with a radio frequency band pass network of the type including a pair of tuned circuits, both resonant to a common signal frequency, and both circuits being coupled by at least one untuned reactance to provide a band pass characteristic, each of said tuned circuits including a variable tuning condenser, means for uni-controlling both condensers to tune said band pass network over a desired signal range, a signal source coupled to one of said tuned circuits, an electron discharge tube having its input electrodes coupled to the other tuned circuit, a regenerative feed back path coupling the anode circuit of said tube to the input circuit thereof and including an element coupling said path to the said band pass network, said path including a variable condenser mechanically coupled with said uni-controlled tuning means whereby sufficient negative resistance is injected into said network as said tuning means is varied to maintain the resistance of said network substantially constant over said tuning range.

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