

May 27, 1941.

K. R. STURLEY

2,243,401

SELECTIVITY CONTROL CIRCUITS

Filed Feb. 15, 1939

2 Sheets-Sheet 1

Fig. 1

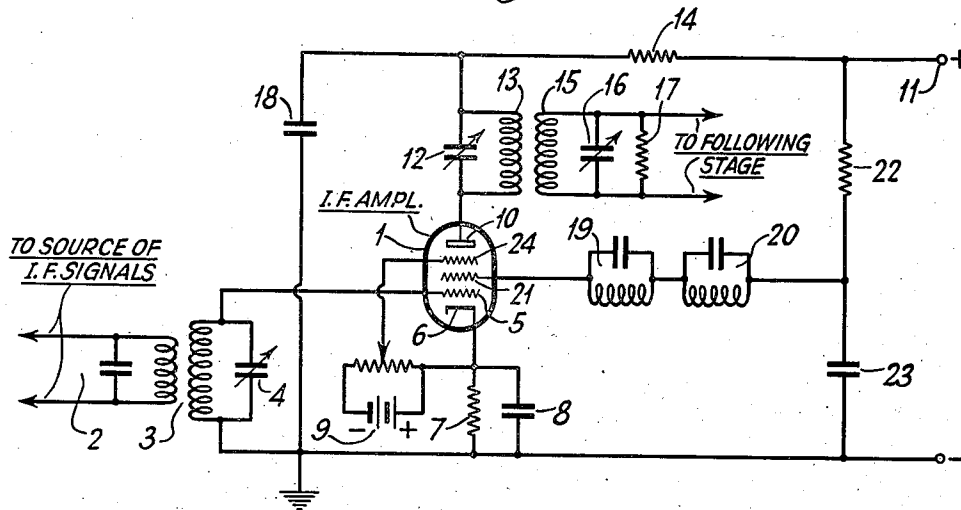
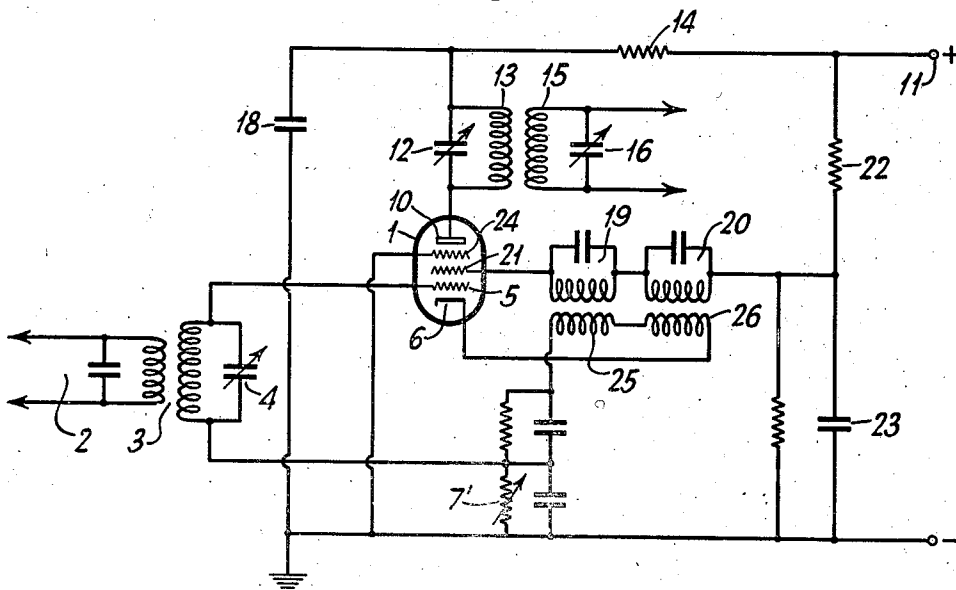


Fig. 2



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Fig. 3a

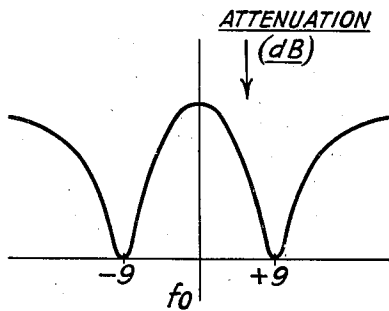


Fig. 3b

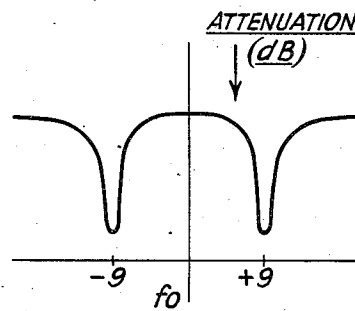
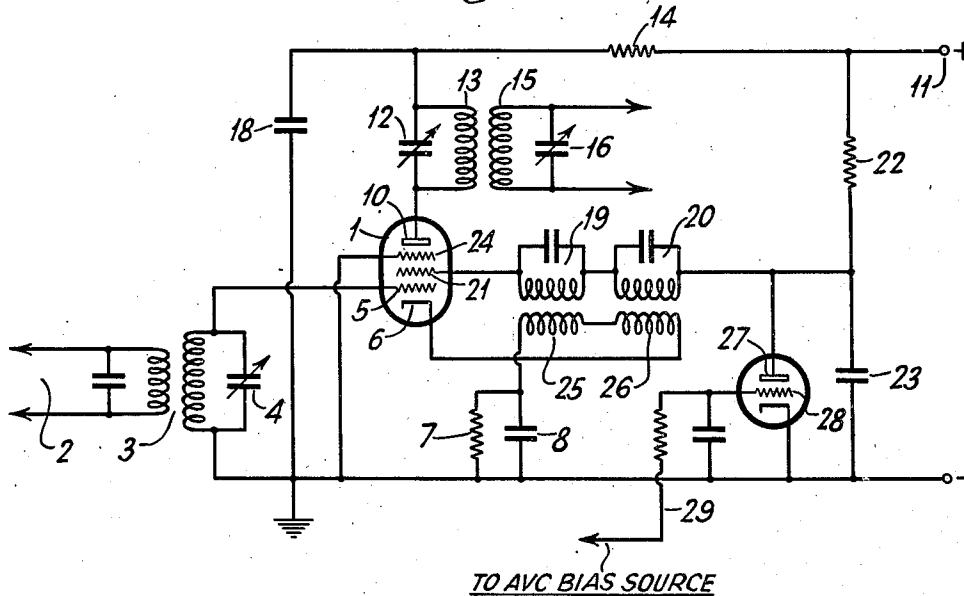


Fig. 4



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SELECTIVITY CONTROL CIRCUITS

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Application February 15, 1939, Serial No. 256,447
 In Great Britain April 14, 1938

11 Claims. (Cl. 179-171)

This invention relates to thermionic valve amplifiers, and more particularly to frequency selective thermionic valve amplifiers in which improved selectivity is obtained by a frequency selective feedback circuit, or circuits, between the output electrode and one or more control, or grid, electrodes of the valve.

The invention, though not limited to its application thereto, is particularly well suited to, and primarily intended for incorporation in, the intermediate frequency amplifiers of superheterodyne receivers. By means of the invention an intermediate frequency amplifier of bandpass characteristics, with sharply defined cut-off frequencies and a substantially uniform response over the pass range, can be obtained; the characteristic having steep "sides" and a substantially flat "top" without the usual pronounced "peaks" common to most known bandpass amplifiers. Further, the gain obtainable is rather better than is obtainable with known bandpass amplifiers of comparable selectivity and generally comparable design.

According to this invention a frequency selective thermionic valve amplifier comprises a valve having at least a control grid and a screen grid, in addition to a cathode and an anode, and is characterized in that at least one frequency selective feedback circuit is included between the anode and the screen grid of the said valve.

In the drawings—

Fig. 1 shows one embodiment of the invention, Fig. 2 illustrates a modification,

Fig. 3a graphically shows a characteristic secured with low screen voltage,

Fig. 3b illustrates the characteristic with high screen voltage,

Fig. 4 shows still another modification.

Referring first to Fig. 1, which shows one embodiment of the invention as applied to an intermediate frequency bandpass amplifier, the valve employed is a pentode 1. The signals to be amplified are applied at 2 and through a tuned intermediate frequency transformer 3, whose secondary coil is tuned by a condenser 4, between the control grid 5 and ground; the cathode 6 being connected to ground through the usual capacity shunted self-bias resistance combination 7, 8. The suppressor grid 24 may be connected directly to the cathode 6, or, as indicated, may be connected thereto through a source 9 (which may be adjustable) of negative bias potential. The anode 10 is connected at 11 to the positive terminal of a source (not shown) of anode potential through the usual intermediate frequency

parallel tuned circuit 12, 13, and the usual decoupling resistance 14 in series; said tuned circuit being inductively coupled to a second intermediate frequency tuned circuit 15, 16, (which may, if desired, be shunted by a damping resistance 17) which feeds into the next stage (not shown).

A condenser 18 is connected between ground and the junction point of the decoupling resistance to the tuned circuit 12, 13. The two tuned circuits 12-13 and 15-16, are employed as in the usual way to obtain a bandpass effect. In order to improve the selectivity and obtain a bandpass characteristic with a flatter "top" and deeper, steeper sides, a feedback circuit comprising two further tuned circuits 19 and 20 is, in accordance with this invention, connected to the screen grid 21. More specifically, the screen grid 21 is connected to a suitable positive potential source, preferably the positive terminal 11 of the anode potential source, through the two tuned circuits 19 and 20 in series with one another and with a decoupling resistance 22, the said resistance being connected at one end to the terminal 11 and at the other end to the terminal of the tuned circuit path, 19-20 remote from the screen grid 21. A condenser 23 is connected between ground and the junction point of the decoupling resistance 22 with the tuned circuit 20. For the case of a broadcast receiver for present day broadcast practice the circuits 19 and 20, will preferably be chosen to resonate one a 9 kc. above and the other 9 kc. below, the intermediate frequency.

The main difference between the circuit shown in Fig. 2 and the circuit of Fig. 1 is that in Fig. 2 the inductances in the two tuned circuits 19 and 20 are coupled each to a further coil 25 or 26, and the two said further coils are included in series with one another in the cathode leg circuit. These further coils are connected in such manner as to oppose regeneration which might lead to oscillation between the screen grid and cathode circuits. In this circuit, as will be appreciated, feedback in the screen grid circuit, and, also, cathode feedback are obtained. In practice, the turns ratio of each coil 25, or 26, to the coil to which it is coupled may be of the order of 1:10. As in Fig. 1 the tuned circuits 19 and 20 are tuned on either side of the midband frequency to be passed, and serve in effect to steepen the sides of the characteristic, deepen the cut-off "valleys" and flatten the "top." The two tuned circuits 19, 20 in the embodiment of Fig. 1 may be replaced by a double tuned trans-

former, the primary and secondary of which are tuned to the mid-band frequency, the primary being inserted in the screen grid circuit and the secondary being free. The position of the "valleys" may be controlled by variation of mutual inductance between the primary and secondary.

In either Fig. 1 or Fig. 2 control of the feedback may be obtained by control of the suppressor grid bias potential, but a certain amount of control is also obtainable by varying the control grid bias. If desired, control of both these biases may be provided. Further, if desired, and as shown in Fig. 2, control of suppressor grid potential may be obtained by means of a variable resistance r' in the cathode leg circuit.

Variation of feedback over the pass region may be obtained by variation of screen grid voltage. A change in screen grid voltage changes the frequency response over the pass region from a broad flat curve to a peaked response. Thus Fig. 3a shows in conventional manner the peaked type of curve obtained with a low screen grid voltage, and Fig. 3b represents the flat topped type of curve obtainable with a high screen grid voltage. In Figs. 3a and 3b, which represent the frequency characteristic due to the feedback circuits only, f_0 represents the mid-frequency of the band to be passed (the I. F. frequency), and the cut-off points are marked $+9$ and -9 to indicate that, in general, they will be at frequencies of (f_0+9) kc. and (f_0-9) kc. Variable selectivity may thus be obtained by varying the screen grid voltage. This may be effected manually, e. g. by means of a potentiometer connected between the positive terminal 11 and ground, the center point being taken to the screen grid through the tuned circuits.

It may, however, as shown in Fig. 4, be obtained automatically by connecting the screen decoupling resistance 22 to the anode 27 of another valve 28, the grid bias for which is derived from a source (not shown) of automatic volume control voltage which is applied over lead 29.

What is claimed is:

1. In a wave transmission system, a tube of the screen grid type having wave input and output circuits tuned to a common wave frequency, degenerative feedback means operatively associated with the screen grid of said tube and comprising at least two resonant circuits coupled to said screen grid, said two resonant circuits being oppositely mistuned by equal frequency values with respect to said common wave frequency.

2. In a wave transmission system, a tube of the screen grid type having wave input and output circuits tuned to a common wave frequency, degenerative feedback means operatively associated with the screen grid of said tube and comprising at least two resonant circuits coupled to said screen grid, said two resonant circuits being oppositely mistuned by equal frequency values with respect to said common wave frequency, and means for varying the direct current potential of said screen grid to adjust the magnitude of feedback voltage and thereby to regulate the shape of the resonance curve of the said tube circuits.

3. In a wave transmission system, a tube of the screen grid type having wave input and output circuits tuned to a common wave frequency, degenerative feedback means operatively associated with the screen grid of said tube and comprising at least two resonant circuits coupled to said screen grid, said two resonant circuits being oppositely mistuned by equal frequency values

with respect to said common wave frequency, and means for controlling the gain of said tube thereby to control the magnitude of feedback voltage.

4. In a wave transmission system, a tube of the screen grid type having wave input and output circuits tuned to a common wave frequency, degenerative feedback means operatively associated with the screen grid of said tube and comprising at least two resonant circuits coupled to said screen grid, said two resonant circuits being oppositely mistuned by equal frequency values with respect to said common wave frequency, and means responsive to wave amplitude for automatically regulating the potential of said screen grid.

5. In combination, in a bandpass amplifier network of the type comprising a tube having at least a cathode, signal grid, screen grid and anode, a signal input circuit connected to said signal grid and cathode, a signal output circuit connected to the anode and cathode, at least two resonant circuits included in circuit with said screen grid, said two resonant circuits being oppositely mistuned by equal frequency values with respect to the operating signal frequency of said input and output circuits.

6. In combination, in a bandpass amplifier network of the type comprising a tube having at least a cathode, signal grid, screen grid and anode, a signal input circuit connected to said signal grid and cathode, a signal output circuit connected to the anode and cathode, at least two resonant circuits included in circuit with said screen grid, said two resonant circuits being arranged in series with each other and being oppositely mistuned by equal frequency values with respect to the operating signal frequency of said input and output circuits.

7. In combination, in a bandpass amplifier network of the type comprising a tube having at least a cathode, signal grid, screen grid and anode, a signal input circuit connected to said signal grid and cathode, a signal output circuit connected to the anode and cathode, at least two resonant circuits included in circuit with said screen grid, said two resonant circuits being oppositely mistuned by equal frequency values with respect to the operating signal frequency of said input and output circuits, and means responsive to signal amplitude variation for adjusting the gain of said tube.

8. In combination, in a bandpass amplifier network of the type comprising a tube having at least a cathode, signal grid, screen grid and anode, a signal input circuit connected to said signal grid and cathode, a signal output circuit connected to the anode and cathode, at least two resonant circuits included in circuit with said screen grid, said two resonant circuits being oppositely mistuned with respect to the operating signal frequency of said input and output circuits, and means reactively coupling each of said two resonant circuits to said signal input circuit.

9. In an intermediate frequency amplifier network of the type employing a screen grid tube provided with intermediate frequency input and output circuits; the improvement which comprises at least two resonant circuits electrically connected in circuit with the screen grid of said tube, said two resonant circuits being oppositely mistuned by a common frequency value with respect to said intermediate frequency whereby the resonance curve characteristic of said network has steep sides and a substantially flat top.

10. In an intermediate frequency amplifier network of the type employing a screen grid tube provided with intermediate frequency input and output circuits; the improvement which comprises at least two resonant circuits electrically connected in circuit with the screen grid of said tube, said two resonant circuits being oppositely mistuned by a common frequency value with respect to said intermediate frequency whereby the resonance curve characteristic of said network has steep sides and a substantially flat top, and means for varying the positive potential of the screen grid thereby to adjust the shape of said resonance curve.

11. In an intermediate frequency amplifier network of the type employing a screen grid tube provided with intermediate frequency input and output circuits; the improvement which comprises at least two resonant circuits electrically connected in circuit with the screen grid of said tube, said two resonant circuits being oppositely mistuned by a common frequency value with respect to said intermediate frequency whereby the resonance curve characteristic of said network has steep sides and a substantially flat top, and means reactively coupling each of said resonant circuits to said input circuit.

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