Dec. 19, 1939. G. L. GRUNDMANN 2,183,741

RADIO RECEIVING SYSTEM

Filed Aug. 21, 1937 2 Sheets-Sheet 1

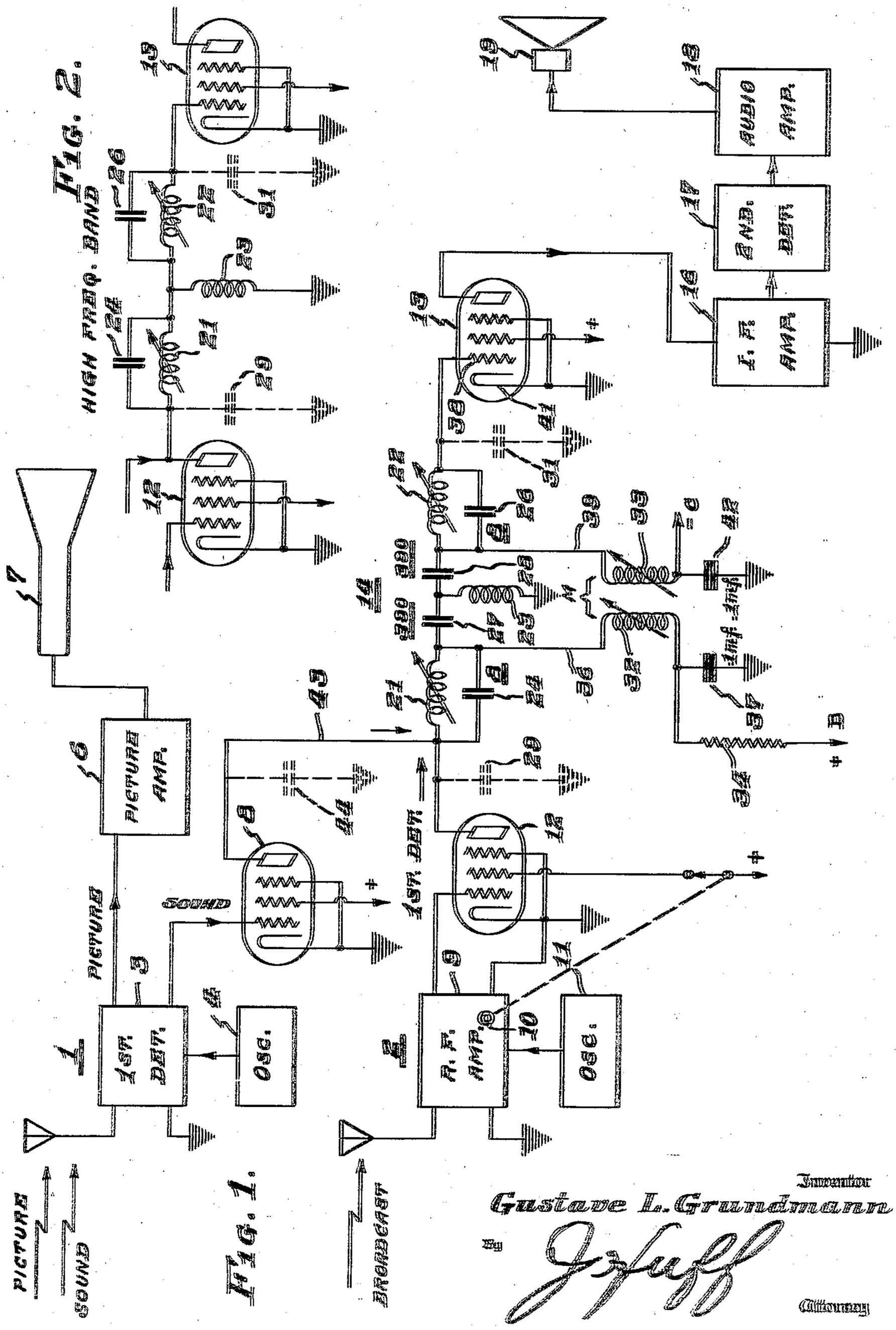

FIG. 1.

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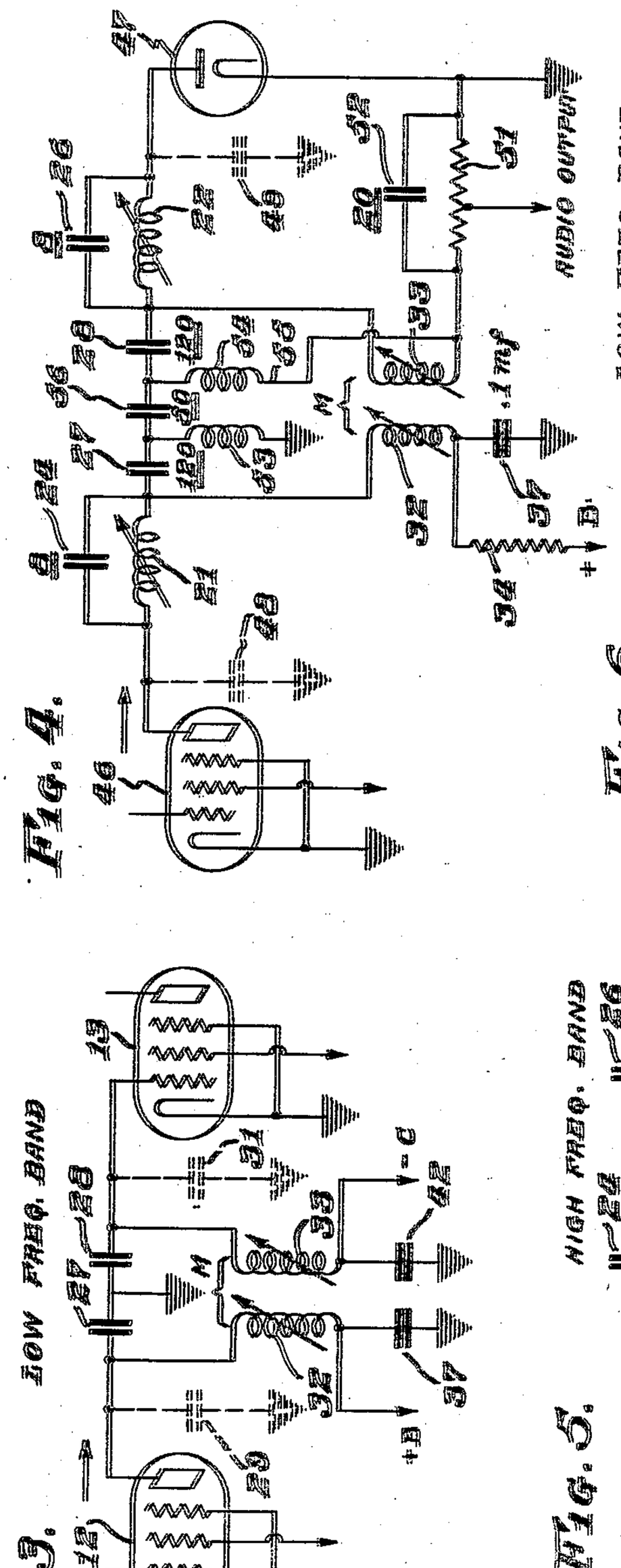

Fig. 4.

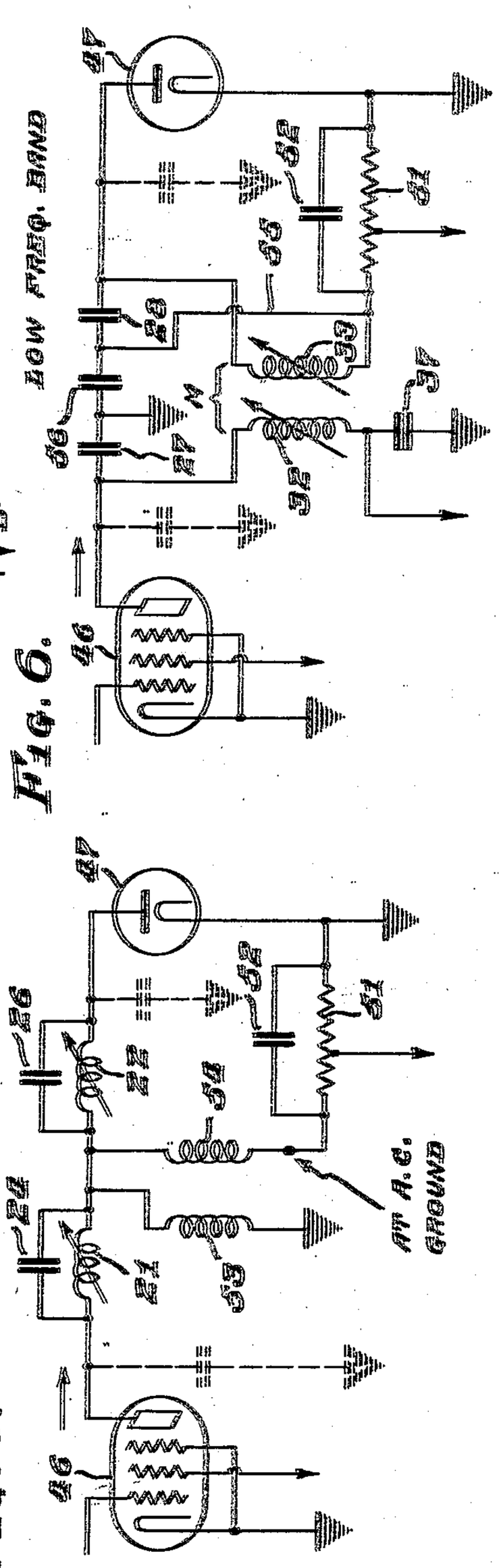

Fig. 6.

Fig. 3.

Fig. 5.

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RADIO RECEIVING SYSTEM

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7 Claims. (Cl. 250—20)

My invention relates to television receivers or the like wherein it is desired to amplify signals in a plurality of frequency bands. Specifically I have applied my invention to a combination television receiver and broadcast receiver in which the sound signals accompanying the picture are in a high frequency band such as a 9.75 megacycle band and in which the sound signals from broadcast transmitters are in a comparatively low frequency band such as a 460 kilocycle band.

It has previously been the practice in designing combination receivers of the above-mentioned type to employ two separate intermediate frequency amplifiers for the television sound signals and the broadcast sound signals. These two amplifiers had a common audio amplifier to which they could be connected selectively by means of suitable switches. For various reasons the feature of switching the two I. F. amplifiers to the audio amplifier was undesirable. Furthermore, a large number of amplifier tubes was required for the two separate I. F. amplifiers.

It is accordingly an object of my invention to provide an improved combination receiver of the above-mentioned type which does not require that the audio amplifier be switched to the desired amplifier channel.

It is a further object of my invention to provide a simplified combination receiver of the above-mentioned type.

It is a still further object of my invention to provide an improved amplifier in which one amplifier tube selectively amplifies signals in a plurality of frequency bands.

It is a still further object of my invention to provide an improved coupling network for connecting amplifier tubes in cascade relation.

In a preferred embodiment of my invention as applied to a combined television and broadcast receiver, I supply the television sound signals and the broadcast sound signals to a common I. F. amplifier comprising amplifier tubes which are connected in cascade, each tube being coupled to the succeeding tube through two I. F. transformers, one transformer being designed to pass the high frequency television sound signals and having the primary and secondary coupled through a common coupling coil and the other transformer being designed to pass the comparatively low frequency broadcast sound signals.

The receiver is provided with switching means whereby either television sound signals or broadcast sound signals are supplied to the common I. F. amplifier as desired. The two I. F. transformers in each amplifier stage are so coupled and designed that each one is effectively out of the circuit for signals of the frequency that the other transformer is designed to pass.

The invention will be better understood from the following description taken in connection with the accompanying drawings in which

Figure 1 is a circuit diagram of a combined television receiver and broadcast receiver embodying my invention.

Figures 2 and 3 are circuit diagrams which are referred to in explaining the operation of the receiver shown in Figure 1,

Figure 4 is a circuit diagram of another embodiment of my invention, and

Figures 5 and 6 are circuit diagrams which are referred to in explaining the operation of the circuit shown in Figure 4.

Referring to Fig. 1, the combined receiver includes two superheterodyne receiver sections 1 and 2, receiver section 1 being designed for receiving picture signals and the accompanying sound signals on very high frequency carrier waves (40 to 80 megacycles, for example), and receiver section 2 being designed for receiving sound signals in the ordinary broadcast band (550 to 1500 k. c., for example).

Receiver section 1 includes a first detector 3, a tunable oscillator 4, and a picture amplifier 6 through which picture signals are supplied to a cathode ray tube 7. The usual deflecting circuits are not illustrated as they form no part of the present invention.

The television sound signals are supplied to an amplifier 8 having its output circuit connected to an I. F. amplifier which is to amplify both television and broadcast sound signals as will be explained hereinafter.

The receiver section 1 may me similar to the corresponding section of the receiver described in Carlson Patent 1,975,056.

The broadcast receiver section 2 includes a radio frequency amplifier 9, a tunable oscillator 11 and a first detector 12. The I. F. broadcast sound signals are supplied from the output circuit of detector 12 to the first I. F. amplifier tube 13 through a coupling circuit 14 designed in accordance with my invention. The other I. F. amplifier stages indicated at 16 which supply the I. F. signal to the second detector 17 are the same as the preceding stage 13—14.

The output circuit of the second detector 17 is connected to an audio amplifier 18 which supplies either television sound signals or broadcast sound signals to a loudspeaker 19, depending

upon whether sound signals are supplied from the receiver 1 or from the receiver 2.

Referring now to the design of the I. F. amplifier 13—14, the high frequency tuned transformer or band pass filter includes a primary coil 21, a secondary coil 22 and a coupling coil 23. The coils 21 and 22 are shunted by tuning condensers 24 and 26, respectively, the exact tuning of the primary and secondary circuits being done by means of movable magnetic cores in the coils 21 and 22. This high frequency transformer is of the type described and claimed in application Serial No. 129,804, filed March 9, 1937, as a joint invention of H. C. Allen and G. L. Grundmann, and assigned to the Radio Corporation of America.

For reasons which will appear later, two condensers 27 and 28 of comparatively large capacity are connected in series between coils 21 and 22 and the coupling coil 23 is connected between the junction point of the two condensers and ground. The condensers 27 and 28 have such large capacity that at the high frequency sound band their effect in the circuit is negligible.

It will be seen that the output capacity of detector 12 indicated at 29 is across both the primary coil 21 and the coupling coil 23. Likewise the input capacity of ampliler tube 13 indicated at 31 is across both the secondary coil 22 and the coupling coil 23. Thus the capacities 29 and 31 form part of the tuning capacity of the primary circuit and the secondary circuit, respectively. Since the inductance of the coupling coil 23 is small compared with the inductance of primary coil 21 and secondary coil 22, the fact that condensers 24 and 26 are not across all the inductance in the primary and secondary circuits, respectively, is not of importance. As to the relative values of coils 21, 22 and 23, coils 21 and 22 may have approximately 25 turns each and coil 23 may have 5 turns. It may be noted that in some receiver designs the condensers 24 and 26 may be omitted and the coils 21 and 22 tuned entirely by the tube capacities 29 and 31.

Referring now to the low frequency tuned transformer or band pass filter, it includes a primary coil 32 and a secondary coil 33 which are spaced apart the correct amount to give the desired inductive coupling indicated by the letter M. Plate voltage is supplied to the detector 12 through a filter resistor 34, the primary coil 32, a conductor 36 and the primary coil 21. A filter condenser 37 is connected between the high potential end of filter resistor 34 and ground.

The high potential end of secondary coil 33 is connected to the control grid 38 of amplifier tube 13 through a conductor 39 and through the secondary coil 22. The other end of coil 33 is connected to the cathode 41 of amplifier tube 13 through a suitable biasing source (not shown). A filter condenser 42 is connected between the low potential end of coil 33 and ground.

The primary coil 32 and the secondary coil 33 are effectively shunted by condensers 27 and 28, respectively, at frequencies in the low frequency band whereby the primary and secondary circuits are tuned to provide the desired band pass characteristic. This results from the fact that the coupling coil 23 presents substantially no impedance to signals in the low frequency band. Also the filter condensers 37 and 42 are of such capacity as to present a low impedance to these signals.

The operation of the coupling circuit 14 will be more clearly understood by referring to Figs. 2 and 3. In these figures parts corresponding to like parts in Fig. 1 are indicated by the same reference numerals.

Referring first to Fig. 2, there is shown the portion of circuit 14 which is effective as a band pass filter for signals in the high frequency band. The coils 32 and 33 of the low frequency transformer present such high impedances to signals in the high frequency band that they are effectively out of the high frequency band circuit. Also, condensers 27 and 28 are effectively out of the high frequency circuit because of their low impedance. Therefore, at the high frequency band, the primary circuit comprises coils 21 and 22 tuned by capacities 24 and 29 while the secondary circuit comprises coils 22 and 23 tuned by capacities 26 and 31. The coupling between the primary and secondary circuits is provided by the coil 23 which is common to the two circuits.

Referring next to Fig. 3, the effective circuit for signals in the low frequency band is as indicated because the coils 21, 22 and 23 present substantially no impedance to these lower frequencies. It will be seen that tuning condenser 27 is connected across coil 32 through filter condenser 37 and that tuning condenser 28 is connected across coil 33 through filter condenser 42. The tube capacities 29 and 31 are in parallel with tuning condensers 27 and 28, respectively.

From the foregoing description it will be apparent that the coupling network 14 functions as a band pass filter for either the high frequency sound band or for the low frequency sound band.

If a picture and the accompanying sound are to be received, the voltage supply is switched off the broadcast receiver section 2 by means of an on-off switch 10 thus taking voltage off the screen grid of detector 12 whereby it cannot pass signals. Television sound signals are supplied through amplifier 8 and a conductor 43 to the input end of coupling network 14. They then pass through the portion of the circuit shown in Fig. 2 to the tube 13, and then through similar I.F. stages to the second detector 17.

It will be noted that plate voltage is supplied to tube 8 through the same circuit supplying it to detector 12. Since the output capacity of tube 8, indicated at 44, is in parallel with the tube capacity 29 it, of course, functions as part of the tuning capacity in the primary circuit of the high frequency band pass portion of the coupling network.

If the broadcast sound is to be received, the voltage supply is taken off receiver 1 whereby there is no voltage on the screen grid of tube 8 and no signals are passed by it. The broadcast sound signals appearing in the output circuit of detector 12 pass through the portion of the coupling network shown in Fig. 3 and through similar network portions to the second detector 17.

It will be evident that my invention permits a saving in the number of amplifier tubes and that it eliminates the switching of the audio amplifier that would be necessary if two distinct sound I.F. amplifiers were employed.

In Fig. 1 the capacities of condensers 24, 26, 27 and 28 have been indicated in micro-microfarads by way of example. These values are for a receiver in which the mean frequency of the high frequency pass band is 9.75 megacycles and in which the mean frequency of the low frequency pass band is 460 kilocycles.

In Fig. 4 there is shown an embodiment of my invention in which the I. F. amplifier feeds into a second detector of the diode type. If the second

detector is a triode or the like, the circuit just preceding it may be the same as the coupling network 14 shown in Fig. 1. However, if a diode detector is employed certain changes are desirable.

In Fig. 4 parts corresponding to those in Fig. 1 are indicated by the same reference numerals. In this figure I have shown a coupling network between the final I. F. amplifier tube 46 and the second detector 47 of the diode type. The output and input capacities for tubes 46 and 47 are indicated at 48 and 49, respectively.

The diode detector 47 requires the usual resistor 51 and shunting condenser 52 connected between the diode cathode and the low potential end of the secondary coil 33. The audio signal is taken from the resistor 51 as indicated.

It will be seen that if a single coupling coil 23 were employed as in Fig. 1, the condenser 52 and the condenser 28 would be connected in series across the secondary 33. This would not be satisfactory because condenser 52 cannot be given a capacity large enough to make its impedance negligible at the low intermediate frequency. In order to avoid this difficulty I employ coupling coils 53 and 54 in place of the single coupling coil 23 shown in Fig. 1.

Each of the coils 53 and 54 has twice the inductance of coil 23. Since they are effectively in parallel for signals in the high frequency band, as will be shown in the following paragraphs, their combined inductance and coupling action is the same as that of the single coil 23.

An additional condenser 56 is connected between tuning condensers 27 and 28. Coupling coil 53 is connected between ground and the junction point of condensers 27 and 56 while coupling coil 54 is connected between the low potential end of secondary 33 and the junction point of condensers 28 and 56 through a conductor 55.

Since condenser 52 has negligible impedance to signals in the high frequency band, the low potential end of secondary 33 is at ground for these signals. Condenser 56 also has negligible impedance for these signals. Therefore, coupling coils 53 and 54 are in parallel at the high frequencies. This is illustrated in Fig. 5 where the effective circuit for the high frequency band is shown. Obviously, this circuit functions the same as the circuit shown in Fig. 2.

In Fig. 6, there is shown the circuit which is effective at the low frequency band. The tuning condenser 27 is connected across coil 32 the same as shown in Fig. 3. The tuning condenser 28 is connected across the coil 33 through the conductor 55, the coil 54, like the coil 53, being effectively out of the circuit at the lower frequency.

It will be noted that in the low frequency band the condenser 56 is in parallel with the by-pass condenser 52 of the diode circuit.

From the foregoing description it will be apparent that the second embodiment of my invention functions in the same way as the first described embodiment. A receiver having a second detector of the diode type will ordinarily employ a coupling network such as the network 14 in Fig. 1 for the I. F. stages up to the last I. F. stage, only the final I. F. coupling network being of the type shown in Fig. 4.

In Fig. 4 the capacities of condensers 24, 26, 27, 28, 56, and 52 are indicated in micro-microfarads, by way of example, for a network designed to pass the 9.75 megacycle and 460 kilocycle bands.

It will be apparent that I have provided a combined television and broadcast receiver of simplified design. Also, it will be seen that I have provided a coupling network comprising I. F. transformers for passing different frequency bands, the high frequency transformer being of a preferred design which includes a coupling coil common to the primary and secondary circuits and the low frequency transformer being of the inductively coupled type.

I claim as my invention:

1. An amplifier for passing signals in a comparatively high frequency band and for passing signals in a comparatively low frequency band, said amplifier comprising a plurality of amplifier tubes connected in cascade through coupling networks,each tube having a plate circuit and a grid circuit, each of said networks including a band pass filter for passing only the signals in said high frequency band and a band pass filter for passing only the signals in said low frequency band, said band pass filters being of the tuned transformer type each having a tuned primary and a tuned secondary, the primaries being connected in series with the plate circuit of one amplifier tube and the secondaries being connected in series with the grid circuit of the succeeding amplifier tube.

2. An amplifier for passing signals in a high frequency band and for passing signals in a low frequency band, said amplifier comprising an electric discharge tube having a plate circuit and an electric discharge tube having an input circuit, a network for coupling said tubes, said network comprising a primary coil of comparatively high inductance and a primary coil of comparatively low inductance connected in series with each other and in series with said plate circuit, a secondary coil of comparatively high inductance and a secondary coil of comparatively low inductance connected in series with each other and in series with said input circuit, said high inductance primary and said high inductance secondary being inductively coupled, two tuning condensers connected in series and connected between the junction point of said primaries and the junction point of said secondaries, a comparatively low inductance coupling coil connected between ground and the junction point of said tuning condensers for coupling said low inductance primary and said low inductance secondary, said tuning condensers being of sufficient capacity to tune the high inductance primary and the high inductance secondary to pass signals in said low frequency band, said low inductance primary and said low inductance secondary each being tuned by capacity to pass signals in said high frequency band, said two frequency bands differing so widely in frequency that said low inductance coils present substantially no impedance to signals in the low frequency band and that said tuning condensers present substantially no impedance to signals in the high frequency band.

3. In a combined television and broadcast receiver, means for converting the sound signals accompanying picture signals into intermediate frequency signals having a comparatively high frequency, means for converting the sound signals in the broadcast band into intermediate frequency signals having a comparatively low frequency, an intermediate frequency amplifier comprising a plurality of amplifier tubes connected in cascade, a second detector, means for supplying both bands of intermediate frequency

signals to said second detector through said intermediate frequency amplifier, and an audio amplifier connected to said second detector, the tubes in said intermediate frequency amplifier being connected through networks each of which includes a band pass circuit for the high frequency band and a band pass circuit for the low frequency band, said band pass circuits being so designed that the characteristics of one are substantially independent of the characteristics of the other.

4. A coupling circuit for coupling two electric discharge tubes in cascade, each of said tubes having an input circuit and an output circuit said coupling circuit comprising a primary coil connected to the output circuit of one of said tubes to form a primary circuit and a secondary coil connected to the input circuit of another of said tubes to form a secondary circuit, said coils being coupled by means of an inductance coil common to the primary and secondary circuits, said primary and secondary coils each having a capacity thereacross to tune them to pass a band of frequencies at a comparatively high frequency, a transformer having primary and secondary coils which are highly inductive as compared with said first mentioned primary and secondary coils and said coupling coil, said primary coils being connected in series in said output circuit and said secondary coils being connected in series in said input circuit, a tuning condenser connected between said first primary coil and said coupling coil for tuning said second primary coil, and a tuning condenser connected between said first secondary coil and said coupling coil for tuning said second secondary coil, said tuning condensers having such capacity that said transformer is tuned to pass a band of frequencies at a comparatively low frequency.

5. A circuit for coupling two electric discharge tubes, said circuit comprising a primary circuit which includes a primary coil and a coupling coil in series and means for tuning said primary circuit, a secondary circuit including a secondary coil and said coupling coil in series and means for tuning said secondary circuit, said primary and secondary circuits being so tuned and coupled as to pass a band of frequencies having a comparatively high frequency, a tuning condenser connected between said primary coil and said coupling coil, a second tuning condenser connected between said secondary coil and said coupling coil, a highly inductive primary coil connected to the junction point of said first primary coil and said first tuning condenser and in series with said first primary coil, and a highly inductive secondary coil connected to the junction point of said first secondary coil and said second tuning condenser and in series with said first secondary coil, said highly inductive primary and secondary coils being so inductively coupled and being so tuned by said tuning condensers as to pass a band of frequencies having a comparatively low frequency.

6. A coupling network for passing signals in a high frequency band and in a low frequency band, said network comprising a high frequency band pass circuit having a tuned primary circuit including a primary coil and a tuned secondary circuit including a secondary coil, at least one inductance coil common to said circuits and coupling them the correct amount to give them a band pass characteristic, and a low frequency band pass transformer having inductively coupled primary and secondary coils, said primary coils being connected in series and said secondary coils being connected in series, and means for so tuning said low frequency transformer as to give it a band pass characteristic without disturbing the action of said high frequency band pass circuit in said high frequency band.

7. A coupling circuit for coupling two electric discharge tubes in cascade, each of said tubes having an input circuit and an output circuit said coupling circuit comprising a primary coil connected to the output circuit of one of said tubes to form a primary circuit and a secondary coil connected to the input circuit of another of said tubes to form a secondary circuit, said coils being coupled by means of a pair of inductance coils in parallel with each other at high frequencies and common to the primary and secondary circuits, said primary and secondary coils each having a capacity thereacross to tune them to pass a band of frequencies at a comparatively high frequency, a transformer having primary and secondary coils which are highly inductive as compared with said first mentioned primary and secondary coils and said coupling coil, said primary coils being connected in series in said output circuit and said secondary coils being connected in series in said input circuit, a tuning condenser connected between said first primary coil and one of said coupling coils for tuning said second primary coil, a tuning condenser connected between said first secondary coil and the other of said coupling coils for tuning said second secondary coil, said tuning condensers having such capacity that said transformer is tuned to pass a band of frequencies at a comparatively low frequency, a blocking condenser connected in series with said tuning condensers and between the high potential ends of said coupling coils, a diode and a resistor connected in series with each other and in series with said secondaries, and a condenser connected across said resistor, one of said coupling coils having its high potential end connected to the junction point of said blocking condenser and said second tuning condenser and having its low potential end connected to the junction point of said resistor and said second secondary coil.

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