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ELECTRICAL SIGNAL SEPARATING CIRCUIT

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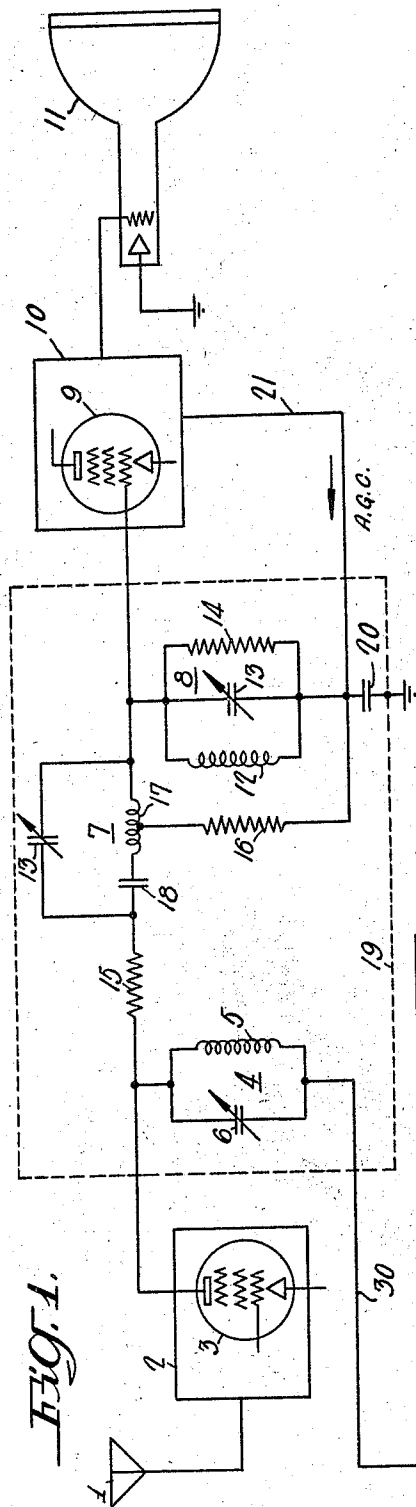


Fig. 1.

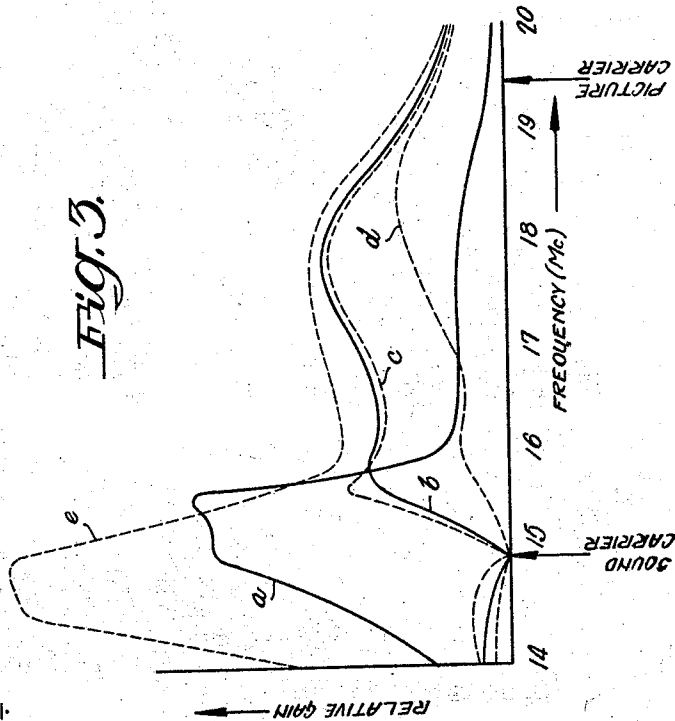


Fig. 3.

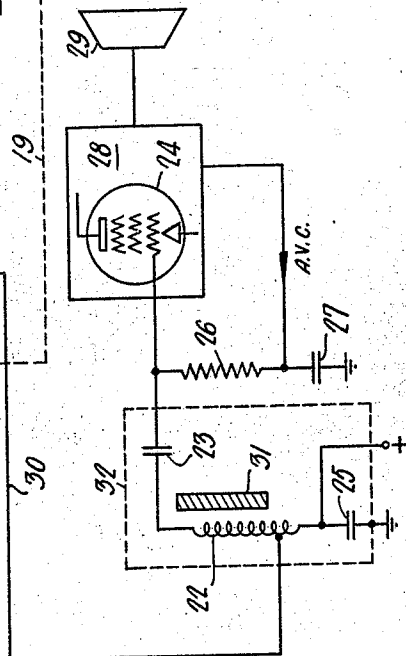


Fig. 2.

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ELECTRICAL SIGNAL SEPARATING
CIRCUITS

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6 Claims. (Cl. 178—5.8)

This invention relates to an electrical signaling system for use in the separation of a plurality of electrical signals of different frequencies or of a plurality of different signals each comprising frequency components within different frequency ranges.

In an electrical system wherein a plurality of electrical signals are present simultaneously in a single signal channel, it is frequently desirable to provide separate outputs for each of the signals to separate signal channels, each adapted to utilize the particular signal supplied to it. This is particularly the case in a television receiver wherein picture and sound modulated carrier signals are received and amplified in a common signal channel, are translated to correspondingly different intermediate frequencies by means of a common first detector, are partially amplified by means of a common intermediate frequency amplifier, and then are supplied respectively to separate picture and sound channels. Each of these channels may be adapted to amplify with maximum efficiency the particular signal supplied to it and subsequently to utilize the signal, in the case of the picture channel, in the reproduction of a television image and, in the case of the sound channel, in the reproduction of the accompanying sound.

Heretofore considerable difficulty has been experienced in providing suitable circuits whereby the two signals may be separated efficiently and supplied to their respective channels. One such difficulty arises from the necessity of providing a relatively long connection from the point in the common signal channel from which the separate signals are derived to the channel adapted for the transmission and utilization of the sound signal. Such a lead, because of its length, tends to pick up energy radiated from the circuits of the picture signal channel to such an extent that regeneration may result in this channel.

The principal object of the present invention is to provide an improved signal separating circuit whereby this difficulty may be avoided. Briefly, this object is attained by providing in the signal channel in which both picture and sound signals are simultaneously present, a space discharge device whose output circuit includes a resonant circuit tuned to a frequency within the range of frequency components comprising the picture intermediate frequency signal. From this resonant circuit there is derived a signal which is supplied to the picture signal channel. A second resonant circuit is provided which is tuned to a frequency within the range of frequency components comprising the sound intermediate frequency signal. There is provided a low impedance connection between the low alternating potential side of the first resonant

circuit and ground, which connection includes a relatively small part of the inductance forming a part of the second resonant circuit. By means of this connection, energy from the output circuit of the space discharge device is supplied to the second resonant circuit and from the latter there is derived a signal which is supplied to the sound signal channel. Since the connection between the low potential terminal of the first resonant circuit and the tap point on the inductance of the second resonant circuit is electrically separated from ground by a low impedance path including only a small part of the inductance in the second tuned circuit, there will be very little pick-up by this connection of energy radiated from the picture signal channel and thus the occurrence of regeneration in the picture signal channel may be effectively prevented.

It may also be observed that in a circuit constructed in accordance with the invention the connection between the output of the common picture and sound channel is such that there is very little interaction between the picture and sound channels whereby the frequency response characteristic of one channel is not appreciably modified by the presence of the other channel. For this reason it is possible to adjust the circuits of one channel to produce therein a desired frequency response characteristic without appreciably changing the frequency response characteristic in the other channel, which is a decided advantage from the point of view of the practical construction and adjustment of the television receiver circuits.

Although the novel features of the invention will be pointed out in detail in the appended claims, the invention itself both as to its organization and mode of operation, will best be understood by reference to the following description and the accompanying drawings which show certain embodiments of the invention. However it will be understood that the invention is susceptible of embodiment in other physical forms which will occur to those skilled in the art upon reading the following description.

In the drawing:

Fig. 1 is a diagrammatic illustration of a television receiver embodying the invention;

Fig. 2 illustrates a modification; and

Fig. 3 is an explanatory diagram which will be used in setting forth the mode of operation and method of adjusting the circuits in accordance with the invention.

Referring first to Fig. 1, the antenna 1 is adapted to intercept both television picture and sound modulated carrier waves to supply them to the circuits conventionally represented by the rectangle 2. These circuits may include the conventional radio frequency amplifier stages, a first

detector stage, and may also include if desired one or more intermediate frequency amplifier stages. The space discharge device 3 included in these circuits may be either the first detector tube or the ultimate amplifier stage in case intermediate frequency amplifier stages are included in the circuits represented by the rectangle 2. In the output circuit of the space discharge device 3 there is connected a resonant circuit 4 comprising an inductance 5 and a condenser 6 which is tuned to a frequency within the range of frequency components comprising the picture modulated intermediate frequency signal. The circuit 4 in conjunction with the circuits 7 and 8 form a coupling network adapted to supply the picture modulated intermediate frequency signal to the grid of the space discharge device 9 contained within the rectangle 10. Within this rectangle there may be included all of the conventional circuits contained in the picture signal channel of a television receiver, for example, picture intermediate frequency amplifier stages, second detector and video frequency amplifier stages. The output signal from these circuits may be supplied to the grid of the cathode ray picture reproducing device 11 which is adapted to reproduce from the detected picture signal a television image in accordance with the intelligence contained therein.

Considering in detail the circuits of the coupling network between the circuits of rectangle 2 and those of rectangle 10, they will be seen to comprise the two shunt-connected parallel resonant circuits 4 and 8 and the serially-connected parallel resonant circuit 7. The circuits 4 and 8 may each be tuned to substantially the same frequency within the range of frequency components comprising the picture modulated intermediate frequency signal. The circuit 7 may be tuned to give a point of minimum response for the sound modulated intermediate frequency which may be located either above or below the said range. In addition to the response peak corresponding to the resonance of circuits 4 and 8, a peak may be obtained corresponding to series resonance in the circuit comprising all three of the simple resonant circuits 4, 7, and 8, and by properly adjusting the frequencies at which these circuits are individually resonant, this peak may be made to fall within the range of components comprising the video intermediate frequency signal.

In the illustrated embodiment of the invention, the circuit 7 may be tuned to a frequency below the range of picture frequency components so as to reject the sound modulated intermediate frequency signal which in this instance may be situated below this range. The resonant circuit 8 comprises the inductance 12 and the condenser 13 and is adjustable to the proper frequency by means of the condenser. There may also be provided in shunt with this resonant circuit, a resistor 14 for the purpose of damping the circuit to give the desired frequency response.

There is also provided a resistor 15 connected between the high alternating potential terminal of the resonant circuit 4 and one terminal of the resonant circuit 7. This resistor is adapted to damp the series resonance taking place in the circuit comprising the three resonant circuits 4, 7, and 8 in series, whereby it is effective in a similar manner to modify the frequency response characteristic of the entire coupling circuit.

Still another resistor 16 may be connected between a center tap on the inductance 17 of the resonant circuit 7 and the low alternating potential terminal of the resonant circuit 8. This re-

sistor is for the purpose of improving the rejection of the sound modulated intermediate frequency signal by the resonant circuit 7. This rejection is slightly impaired by dissipation in the resonant circuit which, however, may be compensated for by adjusting the resistor 16 until maximum rejection is obtained. A blocking condenser 18 may be connected in series with the inductance 17 for the obvious purpose of preventing the transfer of D. C. from the anode voltage supply of the tube 3 to the grid of the tube 9.

Preferably all of the circuits of the intermediate frequency coupling circuit just described are included within a grounded electric shield designated in the drawing by the dotted line 19 surrounding these circuits. The low alternating potential terminal of the resonant circuit 8 is grounded for A. C. through by-pass condenser 20 across which automatic gain control voltage may be supplied from the circuits in rectangle 10 to the grid of the tube 9 via the lead 21. It should be noted that, although there may be some mutual coupling between the inductances 5 and 12 in the resonant circuits 4 and 8 respectively, this is not essential. Such coupling will merely change the required value of the inductance 17.

According to one embodiment, the coupling network to the sound channel may comprise a resonant circuit consisting of an inductance 22 and a condenser 23 serially connected between the grid of the tube 24 and ground through the by-pass condenser 25. There may also be provided a grid leak resistor 26, the lower terminal of which is connected to ground through a condenser 27 across which is developed automatic volume control voltage derived from the sound channel circuits contained within the rectangle designated 28. Within this rectangle there may be included intermediate frequency amplifier stages, a second detector and audio frequency amplifier stages from which an output signal is derived to be supplied to the sound reproducing device 29. A connection 30 extends from the low alternating potential terminal of the resonant circuit 4 to a tap on the inductance 22. The tap is so located that only a small portion of the total inductance is included between the tap and the ground connection through the by-pass condenser 25. For example, in the one embodiment in which the coil 22 comprised 20 turns, the tap was made at a point one turn from the lower end. Thus, as has already been pointed out, the lead 30 from the output of the tube 3 to the tap point on the coil 22 is electrically separated from ground by a very small impedance so that there is very little pick-up by the lead 30 of energy radiated from the video channel circuits 10. Since in a conventional television receiver the lead 30 may be of considerable length and since it is therefore the principal source of feedback from the subsequent video circuits to the input of such circuits, it is possible by this expedient effectively to eliminate undesired regeneration in the picture circuits.

It will be noted that a movable core 31 is provided in association with the inductance 22 whereby the resonant circuit comprising the inductance 22 and the input capacitance of the tube 24 may be tuned to a suitable frequency located within the range of frequency components comprising the sound modulated intermediate frequency signal. Preferably the sound intermediate frequency coupling circuits just described are enclosed within an electric shield

designated by the dotted line 32. As indicated in Fig. 1, it is due to the fact that the lead 30 cannot conveniently be included within the shields 19 and 32 that it cannot thus be prevented from picking up radiated energy from the circuits of the picture signal channel.

According to a modification of the sound intermediate frequency coupling circuits shown in Fig. 2, there is provided a resonant circuit 33 comprising the inductance 34 and the condenser 35. This circuit is inductively coupled through the inductance 36 to the grid of a tube 37 included in the circuits of the sound channel 38. The resonant circuit 33 is tunable by means of a movable core 39 whereby it may be tuned to a frequency within the range of the frequency components comprising the sound modulated intermediate frequency signal. A connection 40 is provided to the sound channel from the output of the common picture and sound channel. As in the case of the embodiment first described, the tap point on the inductance 34 is such that only a small part of the total inductance is included between the lead 40 and the ground connection through the by-pass condenser 41. As in the case of the sound circuit first described, the inductance 34 may comprise a coil of 20 turns with the tap located a single turn from the lower terminal thereof.

The operation of this circuit is substantially the same as that of the first-described circuit, with the result that no appreciable feedback obtains between the circuits of the sound channel and the connecting lead 40. Again, as in the case of the embodiment first described, it is desirable to surround all of the sound channel coupling circuits by a grounded electric shield 42 in the manner shown.

At this point it will be well to point out the procedure which should be followed in adjusting the above described circuits for operation in the manner contemplated by the invention. For this purpose it will be convenient to refer to the explanatory diagram of Fig. 3 which shows various gain vs. frequency characteristics in both the picture and sound intermediate frequency coupling networks. The curves *a* and *b* show respectively the response characteristics measured at the output circuits of the sound and video coupling networks just described when properly adjusted in accordance with the principles of the invention for the separation of sound and picture intermediate frequency signals whose carrier frequencies correspond to 15 and 19.5 mc. respectively. It will be noted that the sound channel coupling network is adjusted to give maximum response in the vicinity of 15 mc. The picture coupling network is adjusted to give maximum response at a frequency within the range of the frequency components comprising the picture modulated intermediate frequency signal and to give minimum response at a frequency of 15 mc. corresponding to the sound intermediate frequency. The response to the picture frequency components is not uniform throughout the range of frequency components comprising the picture intermediate frequency but is somewhat lower at the low frequency end. This response was advisedly produced by adjustment of the circuits in this particular instance in order to compensate for the non-uniform response in the subsequent circuits of the video channel. In other words, it was intended that the overall response of the entire video channel should be as nearly uniform

as possible and for this purpose the circuits were adjusted to yield a response corresponding to that represented by the curve *b*. However, it will be understood that this response may be varied at will by adjustment of the resonant circuits, 4, 7 and 8 to obtain any desired response subject only to practical limitations.

The sound and picture response curves shown at *a* and *b* were obtained with the sound coupling network first described above employing an inductance 22 consisting of a coil of 20 turns tapped one turn from the bottom. In determining the tap point, the connection was made at various points along the inductance 22 until a point was found at which the picture coupling network response was substantially the same irrespective of whether or not the sound circuit was connected through the lead 30 to the low alternating potential terminal of the resonant circuit 4. Thus, for example, it was discovered that by locating a tap point three turns from the lower end of the coil 22 an appreciable alteration was produced in the picture coupling network response depending upon whether or not the sound circuit was connected. With the tap in this position and the sound circuit connected, a picture coupling network response characteristic was obtained corresponding to that designated at *d* in Fig. 3 and a sound coupling network response characteristic corresponding to that designated by *e* in Fig. 3. When the sound circuit was disconnected a picture coupling network response characteristic corresponding to that designated at *c* was obtained. However when the tap point was moved to a point one turn from the end of the coil the two curves coincided substantially as shown by the curves *b* and *c*. It was discovered that when no appreciable alteration in the picture coupling circuit response was produced by the connection and disconnection of the sound channel, no appreciable pick-up obtained in the connecting lead 30 and no undesired regeneration was produced in the picture signal channel. Thus the absence of such alteration serves as a criterion for the determination of the proper tap point on the inductance in the sound intermediate frequency coupling circuit.

Although it has been described with reference to certain embodiments, it should be clearly understood that the invention is not restricted to these particular forms. For example, although there has been illustrated a picture intermediate frequency coupling network comprising two shunt branches and one series branch which has been found to be particularly suitable for the purpose, it is possible to use coupling networks of many other forms such as will occur to those skilled in the art. All such variations are regarded as being within the scope of the invention defined by the appended claims.

I claim:

1. In an electrical signalling system, a signal channel adapted to transmit signals in at least two distinct frequency ranges, a space discharge device having an input circuit and an output circuit included in said channel, a first resonant circuit tuned to a frequency within one of said ranges connected in the output circuit of said space discharge device, a second resonant circuit tuned to a frequency within the other of said ranges and including an inductance having one terminal grounded, a low-impedance connection from the low alternating potential terminal of said first resonant circuit to a tap on said in-

ductance, said tap being so located that the portion of said inductance included in the connection between said first resonant circuit and ground is of such small impedance as not appreciably to alter the response of said first resonant circuit obtained when its low potential terminal is connected directly to ground, and separate means for utilizing the signals developed in said respective resonant circuits.

2. In an electrical signalling system, a signal channel adapted to transmit signals in at least two distinct frequency ranges, a space discharge device having an input circuit and an output circuit included in said channel, a first resonant circuit tuned to a frequency within one of said ranges connected in the output circuit of said space discharge device, means for deriving a signal from said resonant circuit, electrical circuit means for amplifying said derived signal, a second resonant circuit tuned to a frequency within the other of said ranges and including an inductance having one terminal grounded, a low-impedance connection from the low alternating potential terminal of said first resonant circuit to a tap on said inductance, said tap being so located that the portion of said inductance included in the connection between said first resonant circuit and ground is of such small impedance as not appreciably to alter the response of said first resonant circuit obtained when its low potential terminal is connected directly to ground, whereby the pick-up by said connection of energy radiated by said amplifier is maintained at a level to prevent regeneration in said system, and means for deriving a signal from said second resonant circuit.

3. In an electrical signalling system, a common signal channel adapted to transmit signals in at least two distinct frequency ranges, separate signal channels each adapted to utilize one of said signals, circuit means providing a connection between said common signal channel and one of said separate signal channels for transferring one of said signals from said common signal channel to said one channel, a grounded electric shield enclosing said circuit means, a resonant circuit tuned to a frequency within the range including said other signal, said circuit including an inductance having one terminal grounded, a grounded electric shield enclosing said resonant circuit, a low-impedance connection from a low alternating potential point of said circuit means to a tap on said inductance, at least a part of said connection being external to said grounded electric shields and subject to pick-up of energy radiated by said one signal channel, said tap being so located that the portion of said inductance included in the connection between said circuit means and ground is of such small impedance as not appreciably to alter the response of said circuit means obtained when said low potential point is connected directly to ground, and means for deriving a signal from said resonant circuit and for supplying it to the other of said separate signal channels.

4. In an electrical signalling system, a common signal channel adapted to transmit signals in at least two distinct frequency ranges, separate signal channels each adapted to utilize one of said signals, a coupling network connecting the said common signal channel to one of said separate signal channels, said network compris-

ing at least one serially connected branch and at least two shunt connected branches, said series branch including a resonant circuit tuned to reject one of said signals, and said shunt branches each including a parallel resonant circuit tuned for maximum response at a frequency within the range of said other signal, an additional resonant circuit tuned to a frequency within the range of said one signal, said circuit including an inductance, a part of said inductance being included in one of said shunt connected branches, the impedance of said included part being of such magnitude that it does not appreciably alter the response of said network obtained when said part is excluded from said shunt connected branch, and means for deriving a signal from said additional resonant circuit and for supplying it to the other of said separate signal channels.

5. In an electrical signalling system, a signal channel adapted to transmit signals in at least two distinct frequency ranges, a first resonant circuit connected to said channel to receive the output thereof and tuned to a frequency within one of said frequency ranges, said resonant circuit having high and low alternating potential terminals, a signal channel coupled to the high alternating potential terminal of said resonant circuit for receiving the signal in said one range, a second resonant circuit tuned to a frequency within the other frequency range and having high and low alternating potential terminals, a low-impedance connection from the low potential terminal of said first resonant circuit to a point of said second resonant circuit, said point being so electrically positioned that the impedance from said point to the low potential terminal of said second resonant circuit is so small as not appreciably to alter the response of said first resonant circuit obtained when its low potential terminal is maintained at the same potential as that of said second resonant circuit, and a signal channel coupled to the high potential terminal of said second resonant circuit for receiving the signal in said other frequency range.

6. In a picture-sound signal receiving system, a signal channel adapted to transmit both picture and sound signals in different frequency ranges, a first resonant circuit connected to said channel to receive the output thereof and tuned to a frequency within the picture signal range, a picture signal channel coupled to a high alternating potential point of said resonant circuit, a second resonant circuit tuned to a frequency within the sound signal frequency range and having high and low alternating potential terminals, a low-impedance connection from the low potential terminal of said first resonant circuit to a point of said second resonant circuit, said point being so electrically positioned that the impedance from said point to the low potential terminal of said second resonant circuit is so small as not appreciably to alter the response of said first resonant circuit obtained when its low potential terminal is maintained at the same potential as that of said second resonant circuit, and a sound signal channel coupled to a high alternating potential point of said second resonant circuit.

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