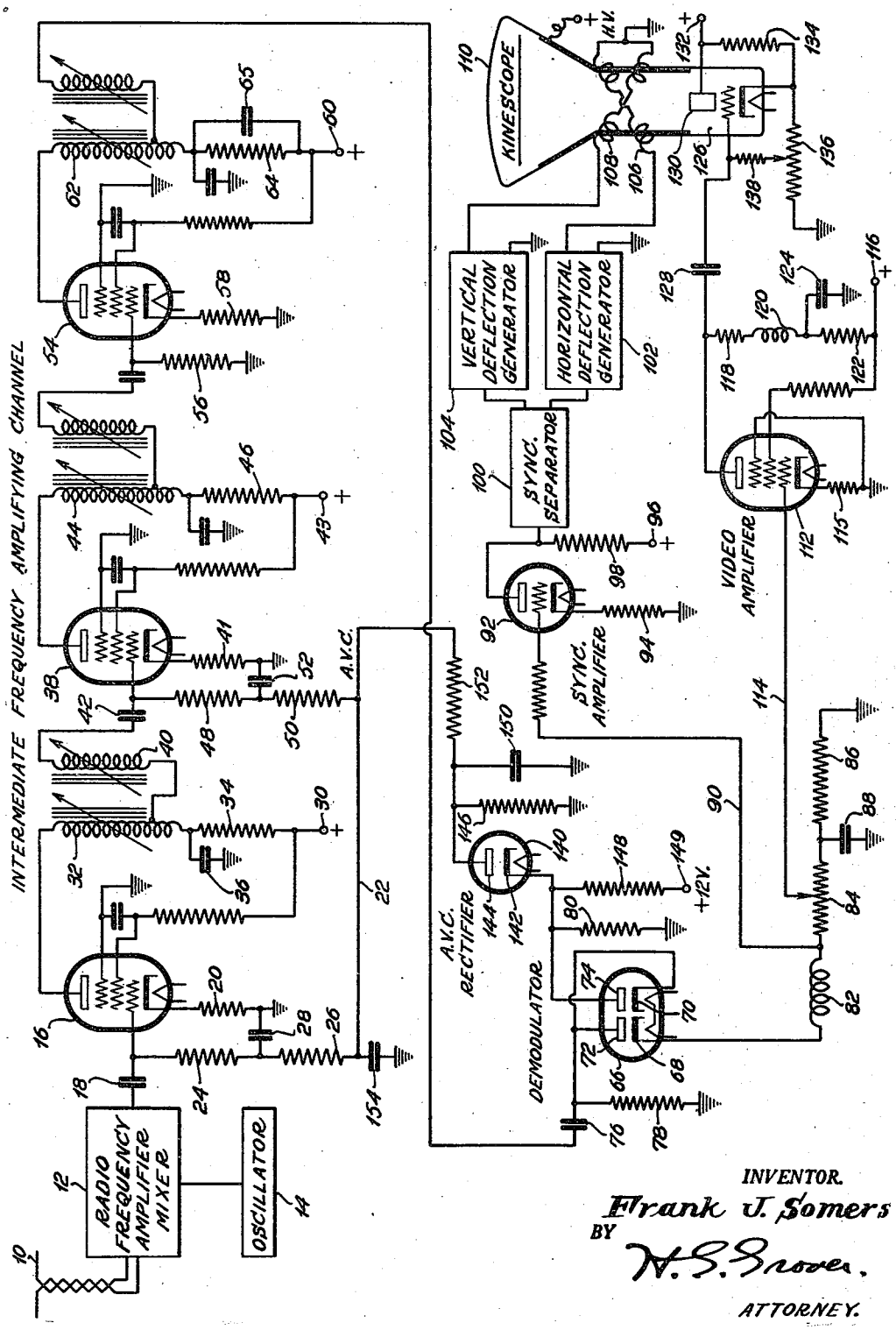
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CONTROL CIRCUIT

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CONTROL CIRCUIT

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This invention relates to an improvement in television receivers, and more particularly to receivers that may be used for telemetering or for similar purposes, and wherein relatively low deflection frequencies are employed.

In a conventional television system for the transmission of television programs, the line and field deflection frequencies are chosen relatively high in order that the produced image will not appear to flicker or vary in brilliance, and in order that relatively fast moving objects may be satisfactorily reproduced at the television receiver. In such systems, particularly where high fidelity and good detail are desired, the band width of the transmitted television signals must be quite wide, and in order to transmit such images without requiring an excessively wide transmission channel, it is common practice to suppress at least a portion of one side band of the modulated carrier. Such systems necessarily require relatively wide band intermediate frequency amplifying channels and video signal amplifying channels in order that none of the video signals will be attenuated during the transmission.

In the present system, however, it is contemplated that television be used for transmitting information obtained from a meter or a series of meters (or similar information) from one location to another. In the application of television to this or similar purposes, it is not necessary that the field deflection frequency or the line deflection frequency be as great as in the transmission of television images for entertainment purposes since the rate of movement to be observed will not be excessively rapid.

Accordingly, for illustrative purposes, in the present invention the field or frame deflection frequency has been chosen to be of the order of 10 cycles per second, with the line deflection at approximately 3000 cycles per second. In such a system both side bands are transmitted, with the result that the radio frequency transmission channel occupies approximately 750 kilocycles while the video band width is approximately 375 kilocycles. Furthermore, in the present system no interlacing is employed, as is usually the case in the transmission of television images for entertainment purposes.

In order that the produced image on the screen or target of the image producing television tube will not flicker an appreciable amount, an image producing tube having a relatively long persistence screen should be used, and by proper choice of an automatic volume control circuit any objectionable flicker may be substantially removed. Inasmuch as the apparatus is to be used near other electrical or mechanical equipment, it is possible that, in some instances, such equipment may introduce radio frequency carrier modulations which would cause objectionable brightness changes on the screen of the television image producing tube. The automatic volume control circuit proposed in the present invention is also so designed to eliminate such brightness variations, and is sufficiently effective that the television transmitter may be located in an airplane without resulting in any objectionable changes in image or picture brightness at a remotely located television receiver.

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Since the present invention is to be used for telemetering or for similar purposes, maintenance of proper background level is not particularly critical and, in fact, the average brilliance of the reproduced image may be maintained substantially constant regardless of the particular subject matter. Provision naturally is made for varying the contrast range of the produced image. Accordingly, the automatic volume control circuit used in the present invention need not be responsive solely to the intensity of the carrier during synchronizing intervals, as is the case in conventional television used for entertainment purposes as is well known to those skilled in the art, but instead the automatic volume control circuit may be responsive to the entire video signal envelope which may be considered as including both the video or image signals and the synchronizing signals.

Accordingly, the present invention provides, after suitable intermediate frequency amplification, a demodulating device for producing the video signal series, this series of signals being subsequently applied to an automatic volume control rectifier where the desired automatic volume control potential is developed. By proper choice of the time constants associated with the automatic volume control circuit, the desired maintenance of signal strength may be accomplished and an image may be produced which is relatively free from any objectionable effects of rapid signal strength variations.

It is therefore a purpose of the present invention to provide in a television receiver an automatic volume control circuit which may be effectively used to eliminate the effects of rapid signal variations in a television system wherein relatively low field and line deflection frequencies are employed.

Another purpose of the present invention relates to an improvement in a television receiver for use in telemetering or similar purposes wherein an automatic volume control circuit is provided which is responsive to the entire video signal series for producing the desired control action.

Still another purpose of the present invention resides in the provision of an automatic volume control circuit in a television receiver for use in a telemetering or similar service wherein the

time constants associated with the automatic volume control are such as will produce the desired results.

Still other purposes and advantages of the present invention will become more apparent to those skilled in the art from the following detailed description, particularly when considered in connection with the drawing wherein:

The figure shows a preferred form of the present invention.

Referring now to the drawing, the transmitted signals from an appropriate television transmitter, such as referred to above, are received by suitable antenna element 10 and are impressed upon a radio frequency amplifier 12. An oscillator 14 is also provided and energy from the oscillator is supplied to a mixer tube where these oscillations, operating in conjunction with the received radio frequency carrier, produce an intermediate frequency carrier. In the actual operation of the system, it has been found desirable to use a relatively high frequency intermediate frequency carrier in order to eliminate disturbances, even though the band of frequencies to be transmitted through the receiver is relatively narrow. Naturally, any desired radio frequency carrier and intermediate frequency carrier may be used, but, by way of example, it has been found convenient to use a radio frequency carrier of the order of 72.7 megacycles and to operate the receiver oscillator at 96.2 megacycles. With the choice of these two frequencies, an intermediate frequency carrier of the order of 23.5 megacycles is produced.

The intermediate frequency carrier available from the radio frequency amplifier and mixer 12 is then impressed upon the control electrode of an intermediate frequency amplifier tube 16 which includes, in addition to the control electrode, at least a cathode and an anode. The intermediate frequency carrier is applied to the control electrode of tube 16 by way of coupling condenser 18. The cathode of tube 16 is connected to ground by way of cathode resistance 20, while the control electrode of the amplifier tube is connected to an automatic volume control conductor 22 by way of grid resistance 24 and isolating resistance 26. A relatively small condenser 28 is connected between the junction of these two resistances and ground in order to provide an appropriate carrier frequency path.

The anode of tube 16 is connected to positive terminal 30 by way of tunable inductance 32 and resistance 34, these elements being connected in series. The condenser 36 is connected between the junction of these elements and ground. The coupling between the first intermediate frequency amplifier tube 16 and the next succeeding intermediate frequency amplifier tube 38 includes, in addition, tunable inductance 40 and coupling condenser 42, inductance 40 being tapped into inductance 32 so as to provide a suitable mutual inductance between coils 32 and 40 to obtain a suitable band-pass transformer characteristic.

The intermediate frequency amplifier tube 38 also includes a cathode and an anode. The cathode is connected to grond by way of resistance 41, while the anode is connected to positive terminal 43 by way of tunable inductance 44 and resistance 46. The control electrode of tube 38 is connected to the automatic volume control conductor 22 by way of series resistances 48 and 50, and the junction of these resistances is connected to ground by way of a relatively small condenser 52.

The amplified intermediate frequency carrier obtainable from the anode of tube 38 is impressed upon the control electrode of a third intermediate frequency amplifying tube 54, the coupling arrangement between tubes 38 and 54 being similar to the coupling arrangement between tubes 16 and 38. The control electrode of tube 54, however, as indicated in the drawing, is not connected to the automatic volume control conductor but instead is connected to ground by way of grid resistor 56. The cathode of tube 54 is also connected to ground by cathode resistor 58. The anode of tube 54 is connected to positive terminal 60 by tunable inductance 62 and resistance 64. A condenser 65 is connected in parallel with resistance 64 for filtering purposes.

The coupling elements between the final intermediate frequency amplifying tube 54 and a demodulator tube 66 are similar to the coupling arrangement used between the preceding stages of intermediate frequency amplification.

The demodulator comprises a pair of diodes including cathodes 68 and 70 and anodes 72 and 74. The cathode 70 of one diode is connected to the anode 72 of the other diode, and the amplified intermediate frequency carrier is applied to these elements by way of coupling condenser 76. The cathode 70 and the anode 72 are also connected to ground by way of resistance 78.

As is well known to those skilled in the art, a conventional television transmitting system for entertainment purposes employs vestigial side band suppression with the result that one complete set of side bands is transmitted, whereas only a portion of the other set of side bands is permitted to leave the transmitter. In the present system, however, both side bands are transmitted, with the result that the amplified intermediate frequency carrier envelope is substantially symmetrical about an alternating current axis.

Separate load circuits are provided for the two diodes contained within the demodulator 66, the load circuit for cathode 70 and anode 74 being resistance 80, while the load circuit for cathode 68 and anode 72 is inductance 82, resistance element of potentiometer 84 and a further series resistance 86. A relatively large condenser 88 is connected between ground and the junction of resistance 86 and potentiometer 84, and the purpose of condenser 88 and resistance 86 will be explained later.

Since the load circuit associated with cathode 68 is connected between the cathode and ground, the potential of the cathode 68 will increase in a positive direction for increases in the intermediate frequency carrier intensity. In the present system, the synchronizing signals are transmitted at substantially full carrier intensity, and the intensity of the transmitted carrier is decreased or reduced for image signals representing increases in light intensity. This is conventional modulation in television transmitting systems. Accordingly, the potential of the cathode 68 will be most positive during synchronizing signal intervals, and the positive potential of this element will decrease when signals are transmitted representing white in the picture.

A conductor 90 is connected between the junction of the inductance 82 and the potentiometer resistance 84, and is for the purpose of supplying the demodulated video signal to the control electrode of synchronizing signal amplifier tube 92 which includes a cathode, a control electrode and an anode. The cathode of the tube 92 is

connected to ground by way of resistance 94, and the value of this resistance is so chosen that the amplifier is most effective for signal intensities such as those developed during synchronizing intervals. The anode of tube 92 is connected to positive terminal 96 by way of load resistance 98. The amplified synchronizing signals that are present at the anode of tube 92 extend in a negative direction and are applied to a synchronizing signal separating device 100.

Any suitable synchronizing signal separating device may be used, such that separate horizontal and vertical synchronizing signals may be applied, respectively, to the horizontal deflection generator 102 and the vertical deflection generator 104. These elements operate to produce voltage variations of proper intensity and wave form, such that when the developed potential variations (or current variations) are applied to deflecting coils 106 and 108, the cathode ray beam developed in the "Kinescope" or image producing device 110 will be caused to be deflected in a desired manner and at a desired rate in synchronism with the deflection of the scanning cathode ray beam in the television transmitter.

Demodulated video signals are also obtainable from the movble contact associated with the potentiometer 84, and these video signals are applied to the control electrode of video amplifier tube 112 by way of conductor 114. The potentiometer 84 operates as a contrast control to vary the intensity of the video signals applied to the video amplifier tube. The video amplifier tube 112 includes at least a cathode, a control electrode and an anode, and the cathode is connected to ground by way of resistance 115 while the anode is connected to positive terminal 116 by way of load resistance 118, peaking inductance 120 and decoupling resistance 122. A relatively large filter condenser 124 is connected between ground and the junction of the decoupling resistance 122 and the inductance 120.

Amplified video signals will then be present at the anode of tube 112, and the polarity of these signals will be such that the synchronizing signals extend in a negative direction. These amplified video signals are then applied to the control electrode of the electron gun structure 126 contained within the picture reproducing tube 110 by way of coupling condenser 128.

The image producing tube may be a conventional "Kinescope" with the second anode thereof having applied to it an appropriate high voltage for imparting the desired velocity to the developed cathode ray beam. The electron gun structure 126 of the image producing tube includes, in addition to the control electrode, a cathode and a first accelerating anode 130. The first accelerating anode 130 is connected to positive terminal 132, and a pair of resistances 134 and 136 are connected in series between positive terminal 132 and ground. The resistance 136 is preferably the resistance element of a potentiometer and the movable contact of the potentiometer is connected to the control electrode of the electron gun structure by resistance 138.

The cathode of the electron gun structure is connected to the junction of resistances 134 and 136. By this arrangement the control electrode of the electron gun structure is maintained at an average negative potential with respect to the cathode, the degree of potential difference depending upon the adjustment of the movable contact along the potentiometer resistance 136.

This element provides a background control for the image producing tube.

The amplified video signals as applied to the control electrode of the electron gun structure therefore modulate the current intensity of the developed cathode ray beam to produce an image on the viewing screen or target of the image producing tube 110 in a manner well known to those skilled in the art.

In order that the receiver will be most effective to produce television images of substantially constant apparent light intensity with a minimum of flicker, and in order to overcome any undesired or spurious modulations of the radio frequency carrier by reason of the action of airplane propellers or similar moving apparatus located adjacent the transmitter, an appropriate automatic volume control circuit must be provided to alter the gain of the television receiver. The gain control is preferably exercised on at least some of the intermediate frequency amplifying tubes, and in the particular circuit shown in Figure 1 of the drawing, tubes 16 and 38 of the intermediate frequency channel are subjected to automatic volume control potentials.

For developing the desired automatic volume control potentials, the video signals developed at the anode 74 (across load resistance 80) are utilized. At this diode the video signals have a polarity such that the synchronizing signals extend in a negative direction.

In order that desirable automatic volume control potentials may be developed, an automatic volume control rectifier tube 140 is provided which includes a cathode 142 and an anode 144. The cathode 142 is connected directly to the anode 74 of one of the demodulator diodes, while the anode 144 is connected to ground by way of load resistance 146. The cathode 142 is normally maintained at a positive potential relative to the anode, and for maintaining such a potential difference, the cathode 142 is connected to a source of low voltage positive potential (such as, for example, 12 volts) by way of resistance 148. With the cathode 142 normally maintained at a positive potential with respect to the anode 144, the automatic volume control rectifier tube 140 is rendered non-conductive.

As stated above, however, the potential of the video signals developed at the anode 74 of one of the demodulator diodes is such that the synchronizing signals extend in a negative direction, and when the intensity of the synchronizing signals or of the image signals is in excess of the bias voltage applied to the cathode of the automatic volume control rectifier tube 140, the cathode will be driven negative with respect to the anode 144. The rectifier 140 is then rendered conductive and current is permitted to pass through the resistance 146 with the result that a negative potential is developed at the anode 144 of the rectifier tube. The intensity of this negative potential depends upon the intensity of the video signals applied to the cathode 142 in a negative direction in excess of the normal bias potential applied to terminal 149.

If the received signals are of relatively low intensity, it is possible that the intensity of the video signals as applied to the automatic volume control rectifier may not at any time exceed the positive bias applied to the cathode 142, and under such circumstances no automatic volume control potential will be developed across resistance 146. By reason of the application of the positive potential to the cathode 142, a delayed automatic

volume control action will result, and accordingly the television receiver will operate at full gain.

If, however, the received signals increase in intensity, then the bias potential applied to the automatic volume control tube 140 may be exceeded at various intervals, and particularly during the intervals of synchronization, since the carrier is transmitted at full intensity during these intervals. Should an exceedingly strong radio frequency signal be received, it is possible that the bias potential applied to the automatic volume control rectifier tube may be exceeded for an appreciable portion of each line deflection cycle.

It has been found that for best operation of the receiver, the automatic volume control action should be relatively rapid and should be responsive to relatively sudden increase in receiver carrier intensity. Filter condenser 150 is connected in parallel with the load resistance 146 to provide a slight filtering action, but the size of this condenser is relatively small in order to afford the desired rapid automatic volume control action. A resistance 152 is connected between the anode 144 and the automatic volume control conductor 22 for isolation purposes, and in order to filter out any undesired fluctuations that may be induced into conductor 22, a relatively small condenser 154 may be provided.

With the arrangement as above described, and when the time constant of the automatic volume control circuit (resistance 146 and condenser 150) is made relatively short, acceptable television images may be produced at the image producing tube which are substantially free from any objectionable flicker or pulsation due to the low deflection rate or due to any disturbing influence intermediate the transmitter and the receiver.

The fast acting automatic volume control action, however, results in a degeneration of the lower video frequencies as well as the vertical blanking and synchronizing signals. It has been found, however, that the low frequencies could be effectively and satisfactorily restored and synchronization improved by means of a "low boost" circuit associated with the demodulator diode used for supplying video and synchronizing signals to tubes 92 and 112. Resistance 86 and condenser 88 are therefore included in the circuit, and if the condenser 88 is made relatively large, a potential variation may be produced across the resistance 86 which will assist in increasing the voltage variations in the low frequency end of the image signal frequency spectrum. If further accentuation of the low frequencies is desired, this could undoubtedly be accomplished by providing a fast direct current component inserter or "clamp circuit" in the receiver, or by the inclusion of an arrangement for accentuating the low frequencies in the transmitter before modulation and transmission.

When the "low boost" circuit is provided, as described above, the undesired effects on the low frequencies produced by the fast automatic volume control are overcome, and as a result a satisfactory and desirable television image is produced on the viewing screen of the image reproducing tube 110.

From the description of the circuit arrangement shown in the figure, three intermediate frequency amplifying tubes are specifically referred to, although it is to be understood that a greater or lesser number of tubes may be used. Furthermore, as shown in the figure, the automatic volume control potentials are applied to two of

the three intermediate frequency amplifying tubes, but if desirable or necessary, this action may also be applied to all of the intermediate frequency amplifying tubes, and to the radio frequency input amplifier.

It is preferable that the tubes used in the intermediate frequency amplifier be of the screen grid variable mu remote cut-off type in order that the automatic gain control may be applied as desired. When such tubes are used, the suppressor electrode is normally connected to ground while the screen electrode has applied thereto a potential somewhat less than the potential applied to the anode, and, as indicated in the figure, this reduced potential is obtained by a voltage drop across a screen grid resistor and the potential of the screen grid is held substantially constant by use of a filtering condenser.

In most applications it will not be necessary to have the receiver tunable over a predetermined range for the reason that the transmitter may be operated on a single predetermined frequency. If, however, it is desirable to tune the receiver to one or another of the plurality of transmitters, a tuning arrangement in the radio frequency amplifier and in the oscillator could conveniently be applied.

It is immaterial what type image producing tube is used, and although electromagnetic deflection is shown in the drawing, it is to be understood that either electromagnetic or electrostatic deflection may be used, or a combination of such deflections.

The particular type coupling used between intermediate frequency amplifying tubes is more or less immaterial insofar as the present invention is concerned, and the choice of the coupling circuit and transformers used will depend upon the band of frequencies to be amplified and the particular frequency of the intermediate frequency carrier. Those shown and described herein have been found satisfactory, however, for the particular frequencies employed.

Various alterations and modifications may be made in the present invention without departing from the spirit and scope thereof, and it is desired that any and all such alterations and modifications be considered within the purview of the present invention, except as limited by the hereinafter appended claims.

Having now described my invention, what I claim as new and desire to have protected by Letters Patent is:

1. A television receiver for receiving a video signal modulated radio frequency carrier including a carrier amplifier channel for increasing the amplitude of the received signals, means to demodulate the amplified signals to produce a video signal, a diode rectifier including a cathode and an anode, means for normally maintaining the cathode positive with respect to its associated anode, means for applying the produced video signal to the cathode of said diode whereby signals in excess of the bias potential will cause conduction of the diode to produce a variable negative control potential at the anode thereof, a short time constant filter associated with the anode of said diode, means for applying the produced negative control potential to the carrier amplifying channel to control the gain thereof, means to apply the produced video signal to a television image producing device, and means associated with said last named means for accentuating the low frequency component of the video signal to compensate for the attenuation of

such component by reason of the controlled variation in the gain of the amplifier channel and the short time constant filter associated with the diode.

2. A television receiver for receiving a video signal modulated radio frequency carrier including a carrier amplifier channel for increasing the amplitude of the received signals, means to demodulate the amplified signals to produce a video signal, a rectifier, means for normally biasing the rectifier against conduction, means for applying the produced video signal to said rectifier whereby signals in excess of the bias potential will cause conduction of the rectifier to produce a varying negative control potential, a short time constant filter associated with said rectifier, means for applying the varying negative control potential to the carrier amplifying channel to alter the gain thereof, means to apply the produced video signal to a television image producing device, and means associated with said last named means for accentuating the low frequency component of the video signal to compensate for the attenuation of such component by reason of the short time constant filter and the controlled alteration in the gain of the amplifier channel.

3. A television receiver wherein relatively low frequency horizontal and vertical deflection frequencies are employed comprising an intermediate frequency carrier amplifying channel for increasing the intensity of the received signals, means to demodulate the intermediate frequency carrier to produce a video signal series, means to rectify the video signal series to generate a direct current potential having a value determined by the intensity of the video signal in excess of a predetermined value, means to apply the generated direct current potential to the intermediate frequency amplifier to control the gain thereof, a short time constant filter associated with the rectifying means, a second demodulator having a load circuit for producing a second video signal series, and means for applying said second video signal series to an image producing device, said load circuit and said last named means including circuit elements for accentuating the low frequency component of the second video signal series to compensate for the attenuation of such components due to the fast acting automatic gain control action produced by the generated direct current potential.

4. A television receiver comprising an intermediate frequency carrier amplifying channel for increasing the intensity of the received signals, means to demodulate the intermediate frequency carrier to produce a video signal series, means to rectify the video signal series to generate a varying direct current potential having a value determined by the intensity of the video signal, means to apply the varying direct current potential to the intermediate frequency amplifier to control the gain thereof, a short time constant filter associated with the rectifying means, a second demodulator responsive to said intermediate frequency carrier for producing a second video signal series, and means for applying the second video signal series to an image producing device, said last named means including circuit elements for accentuating the low frequency component of the second video signal series to compensate for the attenuation of such components due to the fast acting automatic gain control action.

5. A television receiver comprising a signal carrier amplifying channel for increasing the intensity of the received signals, means to demodulate the signal carrier to produce a video signal series, means to rectify the produced video signal series to generate a variable direct current potential having a value determined by the intensity of the video signal, means to apply the variable direct current potential to the amplifier to vary the gain thereof, a low capacity electron storage element associated with the rectifying means, a second demodulator responsive to the signal carrier to produce a second video signal series, and means for applying the second video signal series to an image producing device, said last named means including circuit elements for accentuating the low frequency component of the second video signal series to compensate for the attenuation of such components due to the relatively rapid variations in gain control action produced by the variable direct current potential.

6. A television receiver including a video signal carrier amplifier having a plurality of discharge tubes, means to apply the amplified video signal carrier to a pair of demodulating elements to produce two separate series of video signals, means to rectify one of the produced series of video signals to generate an automatic volume control potential having a value determined by the intensity of the video signals in excess of a predetermined value, a short time constant filter associated with the automatic volume control circuit, means to apply the automatic volume control potential to the video signal carrier amplifier to control the gain thereof, and means to apply the other video signal series to an image producing tube, said last named means including elements to accentuate the low frequency compcnents of the said other video signal series thereby to compensate for the attenuation of such components due to the fast acting automatic volume control action whereby a visual image of substantially constant average light intensity may be produced on the image producing tube.

7. A television receiver including a video signal carrier amplifier having a plurality of discharge tubes, means to apply a video signal carrier amplified thereby to a pair of demodulating elements to produce two separate series of video signals, means to rectify one of the produced series of video signals to generate an automatic volume control potential having a value determined by the intensity of the video signals, a short time constant filter associated with the automatic volume control circuit for decreasing the rate of change of the generated control potential, means to apply the automatic volume control potential to the video signal carrier amplifier to control the gain thereof, and means to apply the other video signal series to an image producing tube, said last named means including elements to accentuate the low frequency components of the said other video signal series thereby to compensate for the attenuation of such components due to the automatic volume control action whereby a visual image of substantially constant light intensity may be produced on the image producing tube.

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