

Dec. 3, 1940.

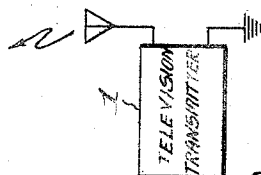
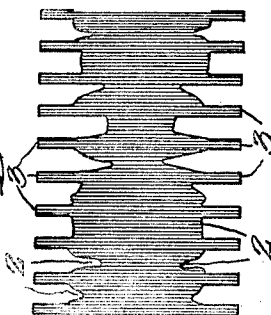
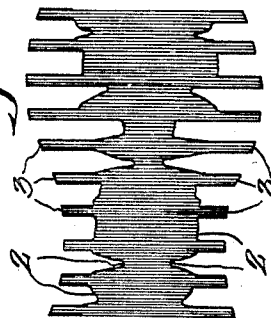
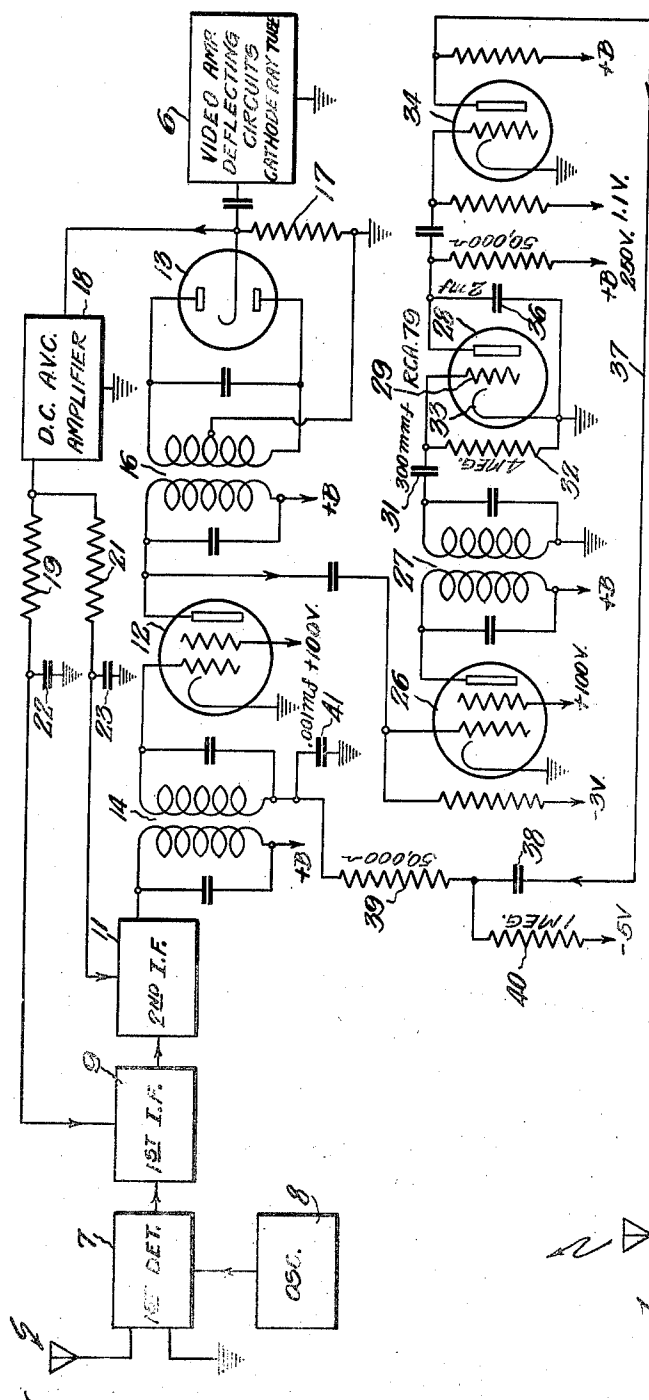
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2,223,982

RADIO SYSTEM

Filed Jan. 29, 1937

2 Sheets-Sheet 1



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RADIO SYSTEM

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2 Sheets-Sheet 2

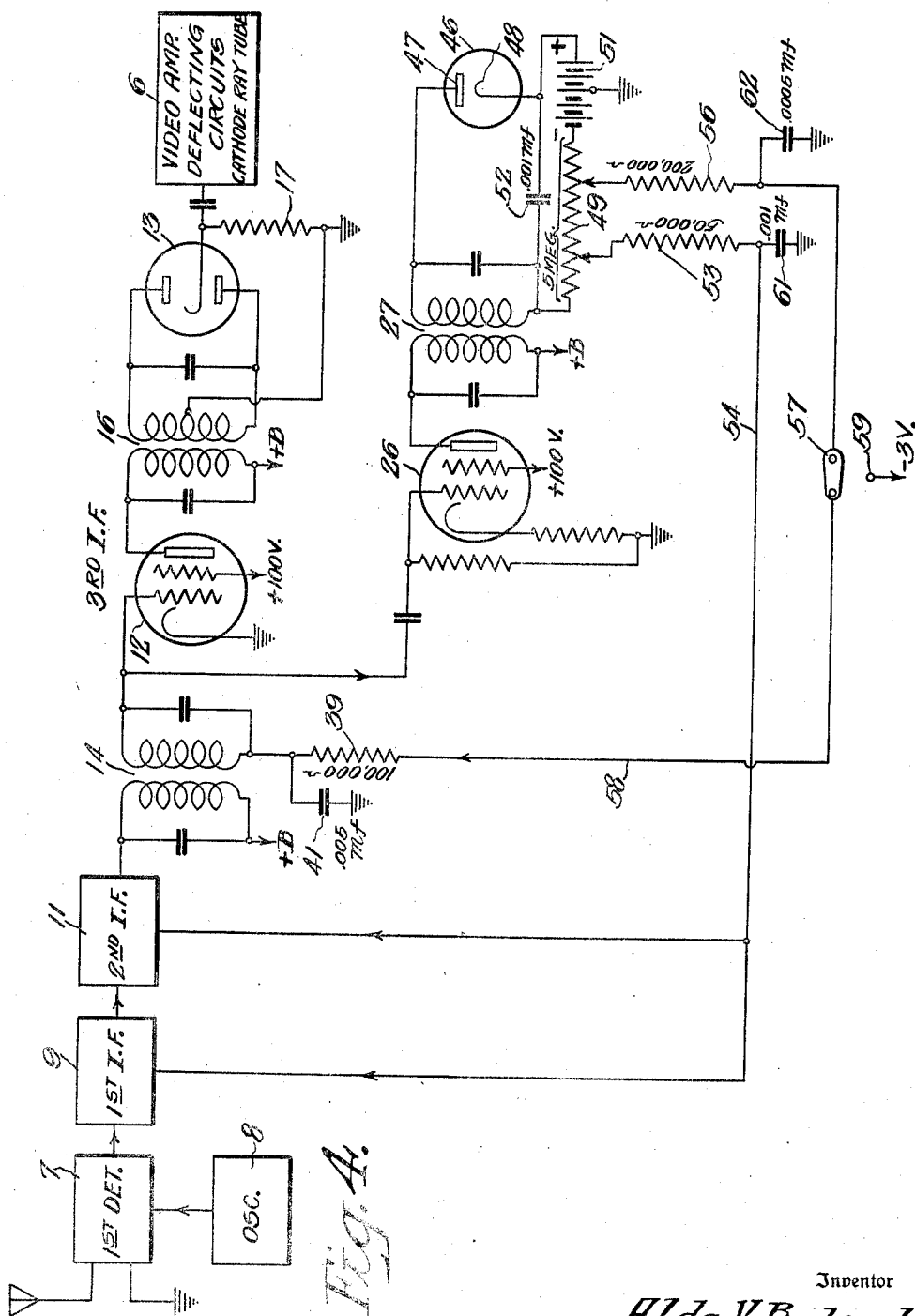


Fig. 4.

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UNITED STATES PATENT OFFICE

2,223,982

RADIO SYSTEM

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7 Claims. (Cl. 178—7.5)

My invention relates to short wave radio systems and particularly to radio systems for the transmission and reception of pictures.

5 An object of my invention is to provide an improved method of and means for reducing or substantially eliminating at a radio receiver the effects of an undesired modulation, such as cross-modulation, of the transmitted carrier wave.

10 Such an undesired modulation may be produced by the metal propeller of an airplane where a television signal is being transmitted from the airplane.

15 A further object of my invention is to provide an improved television receiver.

My invention will be described specifically in connection with a television system in which the transmitter is located on an airplane. In such a television system, it has been found that when 20 the metal propellers on the airplane are about one-quarter wave length long from the hub to the tip of the blade for a certain wave length used in transmission (50 megacycles, for example) the received field strength on the ground is 25 greatly altered by the change in the angular position of the propellers. In the particular installation being described, the propellers were of the two-blade type and, during flight, rotated about 1500 R. P. M. thereby modulating the television carrier and its television modulation component at about 50 cycles per second. The magnitude of such propeller modulation is a variable amount up to about 50 percent modulation, depending upon the position of the antenna and 30 the direction of the receiving point from the airplane.

It has been found that when the transmitted signal includes a pilot signal, or, in the specific system to be described, control or synchronizing impulses, which normally are of constant amplitude, it is possible to reduce or eliminate the effect of such cross-modulation by introducing at the receiver a modulation derived from said pilot signal which is equal in amplitude, but opposite in polarity, to the undesired modulation. 45

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

50 Figure 1 is a view showing a television system embodying my invention,

Figures 2 and 3 are diagrams which are referred to in explaining the invention, and

55 Figure 4 is a circuit diagram of a television receiver constructed in accordance with another embodiment of my invention.

Referring to Fig. 1, my invention is shown applied to a television system in which the transmitter, indicated at 1, is of the type described in British Patent No. 407,409. In such a transmitter a horizontal synchronizing impulse is 5 transmitted at the end of each scanning line and a vertical synchronizing impulse is transmitted at the end of each picture frame. All of these synchronizing impulses are of the same amplitude, the vertical synchronizing impulses 10 being of greater duration than the horizontal synchronizing impulses, in order to facilitate frequency separation of the two groups of synchronizing impulses at the receiver. In this transmitter the synchronizing signals are of the same 15 polarity as picture signals in the "black" direction and have a greater amplitude than the maximum amplitude of pictures in the "black" direction. The composite signal comprising picture signal and synchronizing impulses is caused to 20 modulate the carrier wave in such direction that the synchronizing impulses cause the carrier wave to have maximum amplitude.

The signal which is radiated from the transmitter before the undesired propeller modulation 25 or the like has occurred is shown in Fig. 2. The picture signal is indicated at 2 and the horizontal synchronizing impulses are indicated at 3, the vertical synchronizing impulses not being shown. The horizontal synchronizing impulses occur at 30 the rate of 10,200 per second and the vertical synchronizing impulses occur at the rate of 30 per second in the specific system being described, all of the synchronizing impulses being of constant fixed amplitude in the absence of undesired modulation. 35

In Fig. 3 there is shown the transmitted signal after it has been modulated by the airplane propellers and as it appears at the receiver antenna. It will be noted that such modulation causes the 40 synchronizing impulses to be of different heights, as well as causing the envelope of the wave to have a sine wave contour. That is, the propeller modulation modulates the synchronizing modulation to produce what is known as "cross-modulation." It will be apparent that the drawings 45 have been simplified by showing only a few of the synchronizing impulses that occur during one cycle of propeller modulation.

The receiver shown in Fig. 1 is of the same 50 general type described in the above-mentioned British patent. The cathode ray tube, the deflecting circuits, and the video frequency amplifier are indicated generally at 6. The receiver 55 portion which amplifies and demodulates the

received carrier wave for supplying the video signal to the unit 6 preferably is of the super-heterodyne type comprising a first detector 7, a tunable oscillator 8, a plurality of intermediate frequency amplifiers 9, 11 and 12, tuned to about 11 megacycles, and a second detector 13. The I. F. stages 11 and 12 and the I. F. stage 12 and detector 13 are shown coupled by the usual tuned I. F. transformers 14 and 16, respectively. The detector 13 may be of the double-wave rectifier type illustrated, the video signal appearing across an output resistor 17.

The particular receiver shown in Fig. 1 is provided with the usual automatic volume control circuit, as well as with a special control circuit for introducing the reverse polarity modulation which cancels out the propeller modulation. The A. V. C. circuit, which is conventional in design, includes a direct current amplifier 18 having its input circuit connected across the output resistor 17. The output of the amplifier 18 is supplied to the I. F. amplifiers 9 and 11 through resistors 19 and 21 to control the amplification of said amplifiers, condensers 22 and 23 being provided to give the desired time constant for proper A. V. C. action. This time constant is such that the A. V. C. circuit will not respond to quick changes in signal amplitude, such as those occurring in $\frac{1}{10}$ second or less.

Referring now to the above-mentioned special control circuit, in accordance with one embodiment of my invention, I supply either a radio frequency or an I. F. signal from the output of amplifier such as amplifier 12 to an amplifier 26, and through an I. F. transformer 27 to a vacuum tube 28. The connection between the transformer 27 and the control grid 29 of tube 28 includes a grid condenser 31. A grid resistor 32 which has a high resistance, 4 megohms, for example, is connected between the grid 29 and the cathode 33 of tube 28. As will be explained later, the time constant of the circuit including condenser 31 and resistor 32 is such as to put a bias on grid 29 which varies with the envelope of the received synchronizing impulses. The voltage supplied to the plate of tube 28 is such that the change in plate current is linear with respect to this varying grid bias.

The amplifier 28 is coupled to an amplifier 34 through which the comparatively low frequency signal corresponding to the undesired modulation is supplied to an I. F. amplifier tube for varying its grid bias. In the output circuit of tube 28 a by-pass condenser 36 is provided for filtering out the I. F. carrier.

The propeller modulation signal is supplied, in the specific circuit illustrated, from amplifier 34 through a conductor 37, a coupling condenser 38 and a filter resistor 39 to the control grid of amplifier tube 12. A suitable biasing voltage is supplied to the control grid of tube 12 through a suitable grid leak resistor 40 and through the resistor 39. A filter condenser 41 is provided which, together with resistor 39, functions to filter out any I. F. carrier which may not be removed by the by-pass condenser 36. Condenser 41 also keeps the low end of the secondary of I. F. transformer 14 to ground so far as I. F. in the transformer 14 is concerned.

Since the amplifier tube 12 is of the usual exponential or variable-mu type employed where the gain is to be controlled, and since the tube is operated on the non-linear part of its grid voltage-plate current characteristic, the propeller modulation signal supplied over conductor 37

modulates the I. F. signal being supplied to amplifier 12. The number of amplifier stages in the special control circuit 23-34 is so chosen that this modulation is of opposite polarity to the propeller modulation already on the I. F. carrier. When grid 29 of tube 28 goes more negative, due to drawing more grid current, the bias on tube 12 goes more negative, thus reducing the gain of tube 12. By making the amplitude of the bucking modulation the same as that of the modulation to be removed, the television signals will be substantially free of propeller modulation at the unit 6.

As previously stated, the time constant of the circuit comprising grid condenser 31 and grid 15 resistor 32 is such as to cause the undesired modulation signal to appear in the plate circuit of tube 28. The action of this portion of the circuit is as follows:

The I. F. signal supplied to the grid 29 has such polarity that the synchronizing impulses, that is, the I. F. carrier representing these impulses, drive the grid 29 positive whereby condenser 31 is charged due to electrons from the cathode of tube 28 reaching grid 29. This charge leaks off condenser 31 through resistor 32, but the time constant is such that the charge does not leak off much between successive horizontal synchronizing impulses. On the other hand, the adjustment is such that the charge leaks off condenser 31 rapidly enough to permit the voltage on grid 29 to follow the envelope of the synchronizing impulses. It should be noted that the tube 28 does not demodulate the I. F. carrier to produce video signals. This is because the time constant of the circuit 31-32 and the other circuit constants for tube 28 are such that the picture modulation 2 (Fig. 3) varies the grid 29 over a linear portion of the tube characteristic since the amplitude of the I. F. carrier is held within the operating limits of the circuit.

In the system just described the time constant of the circuit including condenser 31 and resistor 32 is about .0012 second. Since this time is about eight times the interval between adjacent synchronizing impulses, there will be no appreciable change in bias between synchronizing impulses. However, it should be noted that this time constant permits the bias to change in accordance with the low frequency propeller modulation.

In this system the grid-cathode conductivity of tube 28 is such when the grid 29 is positive that even a small fraction (for example, $\frac{1}{100}$) of this conductivity is high compared with the conductivity of the grid leak 32. This is desirable because grid 29 is not positive for the entire duration of a synchronizing impulse but, instead, is positive only for the short duration of the peaks of the I. F. sine wave carrier. The horizontal impulses themselves have a duration of about $\frac{1}{40}$ of the interval between them.

In Fig. 4 there is shown an embodiment of my invention in which the bucking modulation signal is derived by means of a diode rectifier and in which this signal serves both for bucking out undesired modulation and for supplying the desired automatic volume control. In Figs. 1 and 4, like parts are indicated by the same reference numerals.

Referring to Fig. 4 it will be seen that the I. F. signal is supplied through the amplifier 26 and transformer 27 to a diode rectifier 46 having an anode 47 and a cathode 48. The lower end of the secondary of transformer 27 is connected

to the cathode 48 through a resistor 49 and voltage supply such as battery 51, the battery being provided to prevent signals below a given amplitude from causing a flow of current through the diode.

A by-pass condenser 52 is provided, the circuit including this condenser and the resistor 49 having substantially the same time constant as the grid condenser-grid resistor circuit 31-32 in Fig. 1. Also, the diode 46 is a low resistance device, its resistance being about 400 ohms when the electrode 47 is positive. The resistor 49, on the other hand, has a resistance of about 4 megohms. It follows that even though the diode 46 is conducting only a small percentage of the time, it will supply the necessary charging current to condenser 52. Therefore, there is a current flow through resistor 49 which follows the envelope of the synchronizing impulses. There are no picture signals in the output of diode 46 since the negative voltage applied to anode 47 by the charge on condenser 52 prevents the picture modulation from causing a flow of diode current.

The voltage drop across resistor 49, or across a portion thereof, is supplied through a filter resistor 53 and a conductor 54 to the control grids of the amplifier tubes in one or more I. F. amplifier stages such as amplifiers 9 and 11. This voltage is of the proper amplitude and polarity to substantially buck out the propeller modulation as described in connection with Fig. 1.

Preferably an additional control voltage of less amplitude is supplied to the control grid of I. F. amplifier 12 to buck out the propeller modulation more exactly. This voltage is taken from a point on resistor 49 and supplied through a resistor 56, switch 57 and conductor 58 to the said control grid. By moving switch 57 to the contact point 59, the amplifier tube 12 has normal bias applied thereto and a bucking voltage is supplied to amplifiers 9 and 11 only. The condensers 61 and 62 cooperate with resistors 53 and 56, respectively to function as filters for removing I. F. signal.

Attention is called to the fact that in Fig. 4 the I. F. signal for amplifier 26 is supplied from the output circuit of amplifier 11 rather than from the output circuit of amplifier 12. Therefore, the signal supplied through conductor 58 controls the gain of an amplifier following the point from which the control signal is derived. This makes it possible to buck out the propeller modulation completely by a proper adjustment of the circuit.

The values of various circuit elements have been indicated on the drawings in ohms, megohms, microfarads, and micro-microfarads. It is to be understood that these values are merely given by way of example and that they may be varied within wide limits.

While I have shown the control voltage or voltages applied to I. F. amplifiers, it should be understood that they may be applied to radio frequency amplifiers or to a balanced amplifier or video signals, such an amplifier comprising two exponential tubes connected in push-pull.

I claim as my invention:

1. A television system comprising means for transmitting a carrier wave modulated by picture signals by synchronizing impulses occurring at a comparatively high frequency and by framing impulses occurring at a comparatively low frequency, said impulses having a greater amplitude than said picture signals and said modulation being in such direction that said impulses in-

crease the amplitude of said carrier wave, a television receiver having means for intercepting said modulated carrier wave after an undesired low frequency modulation has been superimposed thereon, the frequency of said undesired modulation being of the order of the frequency at which said framing impulses occur, means for demodulating said carrier wave to produce picture signals, an amplifier preceding said demodulating means and comprising an amplifier tube having a plurality of electrodes including a control grid and having a non-linear grid-voltage plate-current characteristic, means for deriving from said intercepted signal at a point preceding said demodulating means a low frequency signal corresponding to said undesired modulation, and means for supplying said low frequency signal to said control grid with such polarity and amplitude as to substantially reduce said undesired modulation.

2. A television system comprising means for transmitting a carrier wave modulated by video signals including picture signals and periodically recurring high frequency synchronizing impulses and low frequency framing impulses, said impulses having a greater amplitude than said picture signals and said modulation being in such direction that said impulses increase the amplitude of said carrier wave, a television receiver having means for intercepting said modulated carrier wave after an undesired low frequency modulation has been superimposed thereon, said low frequency being of the same order as that of said framing impulses, means for demodulating said carrier wave to produce picture signals, an amplifier preceding said demodulating means and comprising an amplifier tube having a plurality of electrodes including a control grid and being of the variable-mu type, means for deriving from said intercepted signal at a point preceding said demodulating means a low frequency signal corresponding to said undesired modulation, and means for supplying said low frequency signal to said control grid with such polarity and amplitude as to substantially reduce said undesired modulation.

3. A television receiver for the reception of a carrier wave modulated by picture signals, by high frequency synchronizing impulses and by low frequency framing impulses, and cross-modulated by an undesired signal of low frequency as compared with the frequency of occurrence of said synchronizing signals but having a frequency which is of the same order as that of said framing impulses, said receiver being of the superheterodyne type including means for converting an incoming signal to an I. F. signal, means for detecting said I. F. signal and reproducing the picture represented by said picture signals, a control circuit connected to be supplied with said I. F. signal, rectifier means in said control circuit for deriving from said I. F. signal a control signal corresponding to said undesired modulation, the time constant of said rectifier means being such that it does not derive picture signals from said I. F. signal, and means for supplying said control signal to at least one of said I. F. stages with such polarity and amplitude as to tend to cancel out said undesired modulation, said one I. F. stage comprising an amplifier tube having a non-linear grid voltage-plate current characteristic.

4. A television receiver for the reception of a carrier wave modulated by picture signals, synchronizing impulses occurring at a comparatively high frequency, and cross-modulated by an un-

desired signal having a comparatively low frequency, said impulses being of greater amplitude than said picture signals and modulating said carrier wave in such direction as to increase its amplitude, said receiver comprising means for intercepting said modulated carrier wave and for converting it to an I. F. signal, an I. F. amplifier for amplifying said I. F. signal, said I. F. amplifier comprising an amplifier tube having a plurality of electrodes including a grid electrode and having a non-linear grid-voltage plate-current characteristic, an amplifier tube having at least three electrodes including a control grid and a cathode, a condenser, a resistor connected in shunt to said condenser, means for impressing said I. F. signal across said control grid and said cathode through said condenser, the time constant of the circuit including said condenser and said resistor being such that said undesired signal only appears in the output of said last amplifier, and means for supplying said undesired signal to the grid electrode of said I. F. amplifier tube with such polarity as to buck out said undesired signal modulation.

5. A television receiver for the reception of a carrier wave modulated by picture signals, synchronizing impulses occurring at a comparatively high frequency, and finally by an undesired signal having a comparatively low frequency, said impulses being of greater amplitude than said picture signals and modulating said carrier wave in such direction as to increase its amplitude, said receiver comprising means for intercepting said modulated carrier wave and for converting it to an I. F. signal, an I. F. amplifier for amplifying said I. F. signal, said I. F. amplifier comprising an amplifier tube having a plurality of electrodes including a grid electrode and having a non-linear grid-voltage plate-current characteristic, an amplifier tube having at least three electrodes including a control grid and a cathode, a grid resistor connected between said control grid and said cathode, a grid condenser, means for impressing said I. F. signal across said grid resistor through said grid condenser, the time constant of the circuit including said grid condenser and said grid resistor being such that said undesired signal only appears in the output of said last amplifier, and means for supplying said undesired signal to the grid electrode of said I. F. amplifier tube with such polarity as to buck out said undesired signal modulation.

6. A television system for transmitting pictures from an aircraft driven by propellers of electrically conducting material, said system comprising a television transmitter on said aircraft which includes means for radiating a carrier wave which is modulated by video signals which signals include picture signals and periodically recurring synchronizing impulses of greater amplitude than picture signals of like polarity, said radiated wave having the undesired characteristic that it is modulated by said propellers when they drive said aircraft, said undesired modulation occurring at a frequency within the frequency range of said video signals, a television receiver for receiving said radiated carrier wave having said undesired modulation, means for demodulating said received wave to produce a video signal, an amplifier preceding said demodulating means, said receiver further comprising means for deriving from said synchronizing impulses a control voltage which varies in accordance with said undesired propeller modulation, and means for varying the gain of said amplifier in accordance with said control voltage in such sense and amount as to substantially buck out said propeller modulation.

7. A television receiver for the reception of a carrier wave modulated by picture signals and by periodically recurring synchronizing impulses which impulses are of greater amplitude than picture signals of like polarity, means for intercepting said modulated carrier wave after an undesired low frequency modulation has been superimposed thereon, means for demodulating said carrier wave to produce picture signals, an amplifier preceding said demodulating means, means for deriving from said intercepted signal at a point preceding said demodulating means a low frequency control voltage corresponding to said undesired modulation, means for varying the gain of said amplifier in accordance with said control voltage in such sense and amount as to substantially buck out said undesired modulation, and additional means for controlling the amplification of said intercepted signal before it is impressed upon said demodulating means, said additional means comprising an automatic volume control circuit which decreases said amplification in response to an increase in the amplitude of the intercepted carrier wave.

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