Sept. 29, 1942. H. E. GOLDSTINE 2,296,919

DIRECT CURRENT INSERTION

Filed July 17, 1940 2 Sheets-Sheet 1

Fig. 1

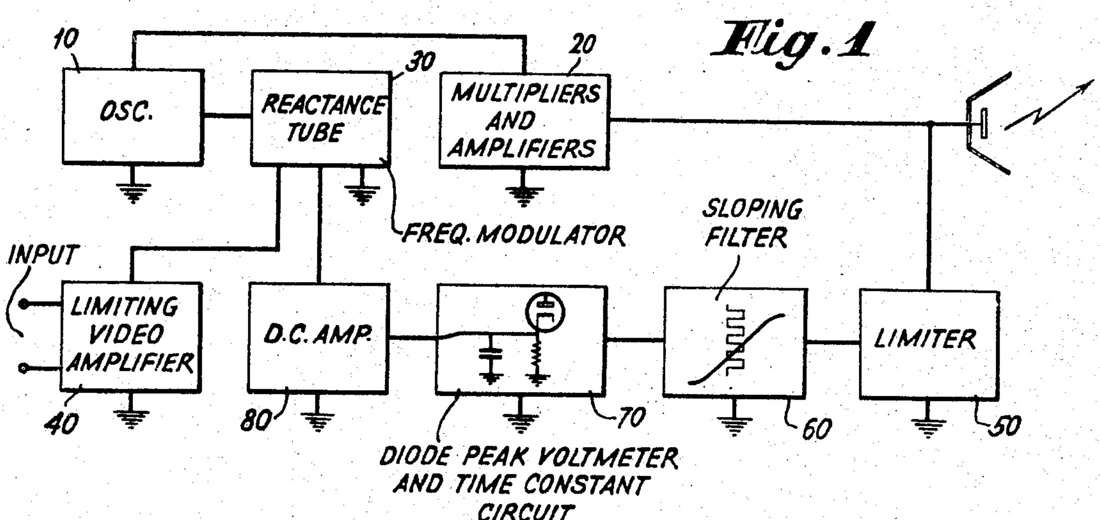



Fig. 2

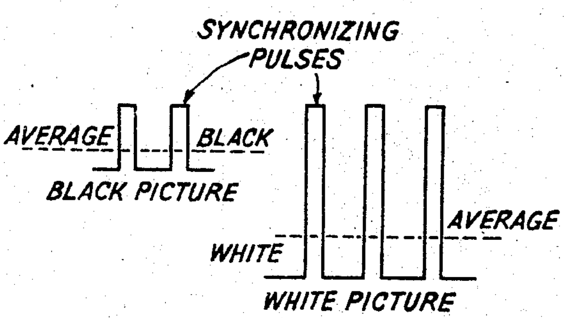



Fig. 2a

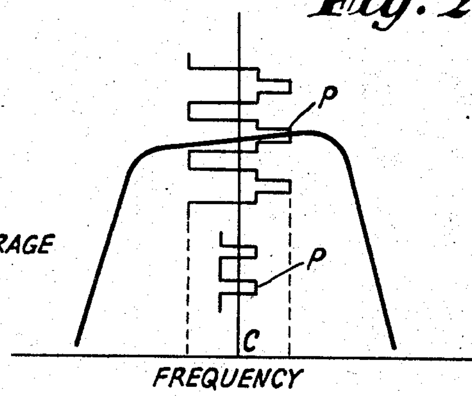



Fig. 2b

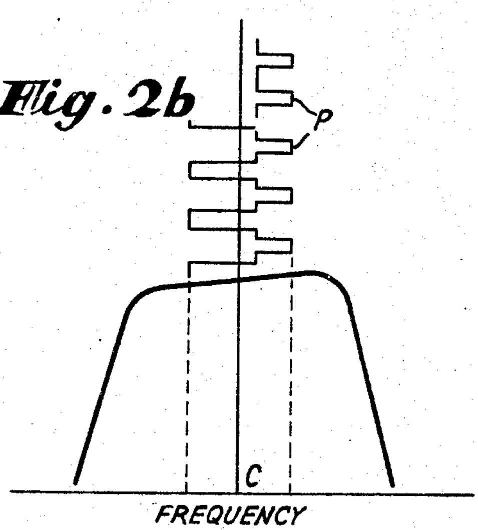
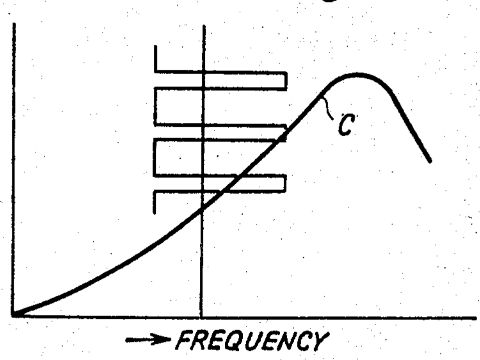



Fig. 2c




NOTE: USING D.C. INSERTION TO SHIFT CARRIER AND KEEP PEAK OF SYNCHRONIZING PULSES AT SAME FREQUENCY

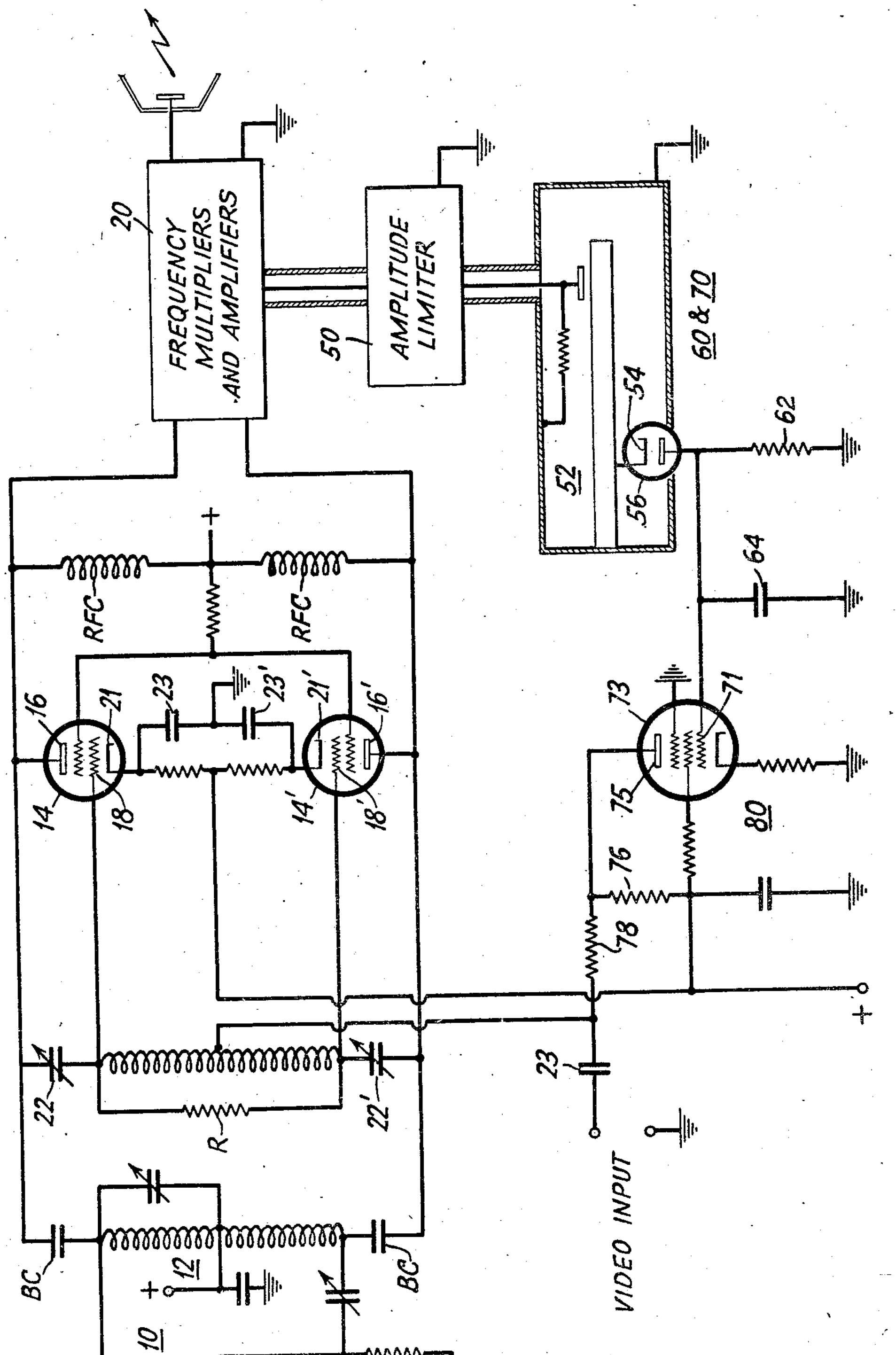
INVENTOR
HALLAN E. GOLDSTINE
BY H.S. Grover
ATTORNEY

DIRECT CURRENT INSERTION

Filed July 17, 1940

2 Sheets-Sheet 2

Fig. 3




INVENTOR
HALLAN E. GOLDSTINE
BY H. S. Grover
ATTORNEY

Patented Sept. 29, 1942

2,296,919

# UNITED STATES PATENT OFFICE

2,296,919

## DIRECT-CURRENT INSERTION

Hallan E. Goldstine, Rocky Point, N. Y., assignor to Radio Corporation of America, a corporation of Delaware

Application July 17, 1940, Serial No. 345,895

16 Claims. (Cl. 178—7.1)

This application concerns frequency modulation of carrier waves in accordance with controlling potentials such as, for example, video signals, and includes a new and improved method of and means for providing a direct-current or slowly varying bias on the modulator such that peak frequency deviations will be stabilized in the frequency spectrum regardless of the make-up or weight or contrast of the subject or picture being sent.

Many advantages are to be gained by the use of frequency modulation television picture transmission. In television pictures the average weight of the picture varies from time to time and this results in shifting of the mean carrier frequency. When this happens the peaks of deviations due to synchronizing impulses will not fall in the proper position in the frequency spectrum. By using my direct-current insertion method and means peak frequency deviations due to the synchronizing impulses will be positioned in the same place in the bandpass characteristic regardless of the nature of the picture. If my method of direct-current insertion is not used, the frequency group of the synchronizing impulses will change their position in the frequency spectrum depending upon the nature of the picture due to the fact that, in this case, the average energy determines the effective center or carrier position. By using my direct-current insertion method and keeping the peak deviations caused by synchronizing pulses at the same position with respect to frequency, the synchronizing impulses will then always be located in the same place in the bandpass frequency characteristics and will not suffer distortion when the nature of the picture changes.

In describing my invention reference will be made to the attached drawings wherein:

Fig. 1 illustrates schematically the principal units or elements of an oscillation generator modulated as to frequency by signals such as, for example, television signals, in combination with means arranged in accordance with my invention for direct-current insertion in the system to hold the peak deviations due to synchronizing impulses at the proper point in the transmitted band;

Figs. 2, 2*a*, 2*b* and 2*c* are graphs or curves illustrating the functioning of my improved method and means; while

Fig. 3 illustrates a circuit arrangement of an oscillator the frequency of which is modulated by video signals in combination with means for inserting a direct-current component into the modulator circuits to hold the peak deviations due to synchronizing impulses in the assigned position in the frequency channel.

In Fig. 2, I have illustrated graphically a television signal with synchronizing pulses. In Fig. 2*a*, is illustrated graphically the position of a wave, modulated in frequency by the television signal and synchronizing signal, in the bandpass characteristic of the system. It is noted that as the picture weight or ratio of black to white thereof changes, the mean or carrier frequency C changes its position. This results in that the peaks P of the deviation caused by the synchronizing impulse move to an improper position in the bandpass resulting in distortion. An object of this invention is to hold the synchronizing peak deviations in their assigned position in the bandpass of the system as illustrated in Fig. 2*b*.

My method and means involves shifting the carrier or mean frequency as a function of the peaks of the deviations caused by the synchronizing impulses so that the said peak frequency deviations are held constant. This method and means is not to be confused with automatic frequency control methods and means used in frequency modulation systems. In the latter systems, the mean or carrier frequency is controlled as a function of deviations of the mean or carrier frequency.

There are several ways this direct-current insertion can be applied to a frequency modulated transmitter, and I have, in this application, disclosed in Fig. 1 a frequency modulated transmitter including the elements by means of which is supplied the necessary direct-current or low frequency component to change the mean or carrier frequency as a function of peak synchronizing currents used for modulating the transmitter frequency so as to maintain the peaks of deviations caused by the synchronizing impulses essentially at the same frequency. In the system disclosed, modulation of the carrier frequency, in accordance with picture signals, is described but other signals wherein the same or similar problems arise may be used.

**10** represents an oscillation source the output of which is supplied to a unit **20** comprising amplifiers and frequency multipliers and limiters or one or more of the same as desired. **30** is a means for modulating the frequency of the generated oscillations. This means may, as indicated, comprise a reactance tube modulator. **40** is a source of modulating potentials indicated here as video signals in an amplifying and limiting stage. The oscillations at 10 are modulated in frequency by the means 30 under control of the signals from 40 and the modulated oscillations are amplified in 20 and radiated or used otherwise.

The video signals impressed on 40 are therein passed by an amplifier and, if desired, a limiting amplifier, so that the synchronizing impulses will not change their relative height or amplitude during the program transmission. Frequency modulated carrier wave energy at the oscillator output or from a multiplier or from the radiating means is picked up and supplied to a sloping filter 60 and peak detector 70. The sloping filter may be of the concentric line type, as described in my United States application Serial No. 341,111 filed June 18, 1940. If necessary, a limiter 50 may be included between the pick-up means and the filter 60.

The output from the sloping filter may be used to control a peak voltmeter of the diode or other type so that the synchronizing pulses will operate a voltmeter on their peak amplitude. The rectified voltage from the peak detector 70 is passed through a time constant circuit and thence to a direct-current amplifier 80 wherein it is amplified and applied to the modulating means 30 which changes the frequency of the transmitter. The necessary time constant circuits are included in the amplifier so that the change in frequency will be slow and will not present any appreciable flicker in the picture background.

In Fig. 3, I have illustrated essential details of the frequency modulation system of my invention. Here, 2 is an oscillator tube having its anode 4 and grid 6 and cathode 8 connected in regenerative circuits 12 coupled by condensers BC to the anodes 14 and 14' respectively of the reactance tube modulators 16 and 16'. The grids 18 and 18' of tubes 14 and 14' are coupled by phase shifting condensers 22 and 22' to the anodes 16 and 16' respectively. The cathodes 21 and 21' are connected by condensers 23 and 23' to ground as is a point on the inductance 13 of circuit 12. Voltages of the generated frequency are set up in phase quadrature relation on the grids and anodes of each tube 14 and 14' so that these tubes form a variable reactance in shunt to the circuits 12. The tubes 14 and 14' are shown in separate envelopes but may be in a single envelope as for example, a type 832 tube may be used. A voltage of the oscillator frequency is developed between the anodes 16 and 16' due to the radio-frequency in circuit 12. The voltage on the control grids 18 and 18' is advanced something like 90 degrees by the condensers 22 and 22' and resistance R. As a consequence, the pulses of current which reach each anode leads the voltage on the said anode by about 90 degrees. Since the reactance tubes here have a plate current which leads the plate voltage they act like condensers. When the negative bias on the grids 18 and 18' of the tubes 14 and 14' is decreased, i. e., when the grids become more positive due to modulation voltages, the current pulses increase in amplitude, the capacity reactance of the reactance tubes due to electron current decreases, and the capacitive effect reflected in the generator circuits 12 increases thereby lowering the frequency of operation of the generator. Conversely, if the grids 18 and 18' go more negative the reactance is increased, the capacitive effect reflected in the generator circuits 12 decreases and the frequency of operation is raised. Frequency modulation of the generated oscillations in accordance with video signals is accomplished by impressing the video signals through a condenser 23 on the grids 18 and 18' in phase.

The modulated output is supplied to the grids of multiplier and/or amplifier and/or limiter stages in 20 and, thence, to a utilization means. Some of the modulated wave is fed to a limiter 50 and thence to a resonant circuit 52 in the form of a line and from the line 52 to the cathode 54 of a diode peak detector 56 the anode of which is connected to ground by a resistance 62. The resonant circuit has a sloping characteristic as illustrated at C in Fig. 2c and converts the frequency deviations to amplitude changes. The resistance 62 and condenser 64 forms a time constant device which passes only the very low alternating current or the direct current.

The peak diode detector may operate at any particular frequency along the line of multipliers. In this particular case, I have shown the diode peak detector coupled to the 500 Mc. output stage. The diode detector 56 is so biased by resistance 62 and condenser 64 that peak swings only of the wave due to the synchronizing impulses which exceed a preselected value in the frequency range are operative to produce direct-current output which flows in the resistance 62 to produce on the grid 71 a potential which becomes more negative as the current in the rectifier output increases. The diode peak detector feeds the grid 71 of a direct-current amplifier tube 73 which reverses the phase of the direct current. The anode 75 of the direct-current amplifier 73 is connected to its cathode by a resistance 76 and to the grids 18 and 18' of the reactance tubes 14 and 14' by the resistance 78. As stated, tube 73 reverses the direct current so that when the peaks of the synchronizing pulses increase current through resistance 62 increases and the potential supplied to grid 71 becomes more negative. This decreases the current output of tube 73 to raise the voltage at the plate end of resistance 76 thus making the grids 18 and 18' of the reactance modulator tubes more positive with respect to the cathodes and thus causing the mean frequency of operation to decrease. As the peaks of frequency swings decrease, the operation is reversed and this tends to maintain the peaks of the wave swings due to the synchronizing voltage at about the same frequency.

The diode peak detector in the circuits shown is associated with a section of concentric transmission line approximately ¼ wave length long having a characteristic as shown at C in Fig. 2c. However, a parallel tuned circuit may be substituted or the sloping side of a high pass filter may be used.

What is claimed is:

1. In a system for controlling the peak frequency swings of oscillations, modulated in frequency by video signals including synchronizing impulses, irrespective of changes in the average weight of said video signals, means comprising a circuit converting frequency changes to amplitude changes and a biased rectifier producing rectified current only in response to converted waves having excessive peak amplitudes, responsive to peak frequency swings which go beyond a selected frequency and means controlled by said last named means for changing the mean frequency of said oscillations as a function of the extent to which said peak swings go beyond said selected frequency to thereby maintain the peaks of the swings at about said selected frequency.

2. In a system for maintaining the maximum frequency of oscillations supplied by a generator and modulated in frequency by video signals including synchronizing signals, at a selected substantially fixed frequency irrespective of changes in average weight of said video signals, means excited by said modulated oscillations and responsive to peak frequency swings which exceed said selected frequency for producing a direct-current component the intensity of which is a function of the extent of the peak swings beyond said selected frequency said means comprising a biased diode rectifier, and means excited by said direct current component for changing the mean frequency of operation of said generator as a function of the intensity of said direct-current component.

3. In a system for maintaining peak deviations of oscillations produced in a generator and modulated in frequency by video signals including synchronizing signals, at a selected substantially fixed point in the frequency spectrum irrespective of changes in average weight of said video signals, means comprising a biased rectifier having a low time constant output circuit responsive to peak deviations which exceed said selected frequency for producing a direct-current component characteristic of said peak deviations, and means for decreasing the mean frequency of operation of said generator as a function of the intensity of said direct-current component.

4. Apparatus for limiting the peak frequency deviations of oscillations modulated in frequency by voltages characteristic of television signals without disturbing the effect of a change in contrast in said picture on the modulation of said oscillations which includes a direct current biased detector for producing direct current voltage the value of which is proportional to the extent of peak frequency deviation of said oscillations beyond a selected frequency, a circuit having a relatively low time constant, means for passing said produced direct current voltage through said circuit having a relatively low time constant, and means for changing the mean frequency of said oscillations an amount proportional to the value of said direct current voltage as modified by said time constant circuit.

5. Signalling apparatus including a modulator for modulating the frequency of oscillations in accordance with signalling voltages characteristic of a subject and synchronizing voltages, a limiter for limiting the frequency modulated oscillations, a circuit for converting frequency swings of the limited oscillations which go beyond a selected maximum frequency swing, into corresponding amplitude variations, a biased direct current rectifier for rectifying peaks of amplitude variations to derive a direct current component, and means for controlling the mean frequency of said oscillations in accordance with the amplitude of said direct current component.

6. In a frequency modulator including an oscillation generator, a reactance tube modulator coupled thereto and means for controlling the impedance of said reactance tube by signals, means for limiting the modulated waves, means for deriving from said limited modulated oscillations a potential proportional to peak swings thereof which go beyond a selected frequency said last-mentioned means for deriving said potential comprising a diode detector, a resistor connected in series with the cathode of said detector so as to cause self-biasing thereof, and a condenser in shunt to said resistor, and means for additionally controlling the impedance of said reactance tube in accordance with said derived potential.

7. In a frequency modulator including an oscillation generator, a reactance tube modulator coupled thereto and means for controlling the impedance of said reactance tube by video signals, means for deriving from said modulated oscillations a direct-current potential proportional to peak swings thereof which exceed a selected frequency, means for reversing the polarity of said direct-current potential, and means for additionally controlling the impedance of said reactance tube in accordance with said potential of reversed polarity.

8. In means to be used with an oscillation generator modulated by video signals for maintaining the peak deviations of said oscillation generator at a predetermined point in the frequency spectrum irrespective of changes in contrast of the subject represented by said video signals, a reactance tube modulator coupled with said oscillation generator to control in part the frequency of operation thereof, a circuit having a sloping characteristic coupled to said oscillation generator, a wave peak rectifier subjected to an initial bias coupled to said last named circuit to rectify the peak currents supplied thereby and to derive from said rectified currents a direct-current potential, and a coupling between said wave peak rectifier and an electrode in said reactance tube to control the impedance thereof, said coupling including an electron discharge device.

9. In means to be used with an oscillation generator modulated by video signals for maintaining the peak deviations of said oscillation generator at a predetermined point in the frequency spectrum irrespective of changes in average intensity of the said video signals, a reactance tube modulator coupled with said oscillation generator to control in part the frequency of operation thereof, a circuit having a sloping characteristic coupled to said oscillation generator, a wave peak rectifier coupled to said last named circuit to rectify the peak currents supplied thereby and to derive from said rectified currents a direct-current potential, a direct-current potential amplifying and reversing tube having input electrodes coupled to said rectifier and a coupling between the output electrodes of said amplifier tube and an electrode in said reactance tube to control the impedance thereof.

10. In a system for maintaining the peak frequency swings of oscillations modulated in frequency by signals, at a selected substantially fixed frequency irrespective of changes in the average intensity of said signals, a circuit including a peak rectifier responsive to frequency swings which go beyond said selected frequency for producing current when said selected frequency is exceeded, said rectifier comprising a biased diode, and a control circuit coupled to said diode rectifier and controlled by said currents for changing the mean frequency of said oscillator as a function of the extent to which sad peak swings go beyond said selected frequency to thereby maintain the peaks of the swings at about said selected frequency.

11. In a system for maintaining peak deviations of oscillations produced in a generator and modulated in frequency by videe signals

including synchronizing signals at a selected substantially fixed point in the frequency spectrum irrespective of changes in the average weight of said video signals, a limiter for limiting the modulated oscillations, a circuit comprising a direct current biased detector for producing from the limited oscillations, a direct current component characteristic of peak deviations of said oscillations which exceed said selected frequency, and a control circuit coupled to said last named circuit and responsive to said direct current component for controlling the means frequency of operation of said generator.

12. In a frequency modulator including an oscillation generator, a reactance tube modulator coupled thereto and means for controlling the impedance of said reactance tube by video signals, a frequency responsive circuit and a biased rectifier having a low time constant output circuit coupled to said generator for deriving from said modulated oscillations a potential proportional to peak swings thereof which go beyond a selected frequency, and a control circuit coupled to said last named circuit and to said generator for additionally controlling the frequency of the oscillations generated in accordance with said derived potentials.

13. In a frequency modulator including an oscillation generator, a reactance tube modulator coupled thereto and means for controlling the impedance of said reactance tube by video signals, a frequency responsive circuit and a rectifier for deriving from said modulated oscillations a direct current potential proportional to the peak swings thereof which exceed a selected frequency, an electron discharge tube for reversing the polarity of said direct current potential, and a control circuit for additionally controlling the impedance of said reactance tube in accordance with said potential of reversed polarity.

14. In a frequency modulator including an oscillation generator, a reactance tube modulator coupled thereto and means for controlling the impedance of said reactance tube by video signals, a frequency responsive circuit and a rectifier coupled to said generator for deriving from said modulated oscillations a direct current potential proportional to the peak swings thereof which exceed a selected frequency, an electron discharge tube coupled to said rectifier for reversing the polarity of said direct current potential, and a control circuit coupled to said last tube and to said reactance tube for additionally controlling the impedance of said reactance tube in accordance with said poential of reversed polarity.

15. In a wave length modulation system, a circuit wherein wave energy the wave length of which is to be modulated flows, a modulation circuit coupled to said first named circuit and controlled by video signals including synchronizing signals for moduulating the wave length of the oscillations generated in said circuit, a wave length responsive circuit and a biased wave peak rectifier excited by modulated wave energy derived from said responsive circuit for producing currents characteristic of peak deviations in the wave length of said wave energy which exceed a selected deviation, and a control circuit coupling said rectifier to said first named circuit for additionally controlling the wave length of the wave energy flowing therein in accordance with said produced currents.

16. In a system for limiting the peak frequency swings of oscillations modulated in frequency by signals, to a selected substantially fixed frequency, irrespective of changes in the average intensity of said signals, a current amplitude limiter excited by said modulated oscillations, a circuit including a peak rectifier having a relatively low time constant output circuit responsive to frequency swings which go beyond said selected frequency for producing current when said selected frequency is exceeded, connections between said circuit and said current amplitude limiter, and a control circuit coupled to said peak rectifier and controlled by said currents for changing the mean frequency of said oscillator as a function of the extent to which said peak swings go beyond said selected frequency to thereby maintain the peaks of the swings at about said selected frequency.

HALLAN E. GOLDSTINE.