

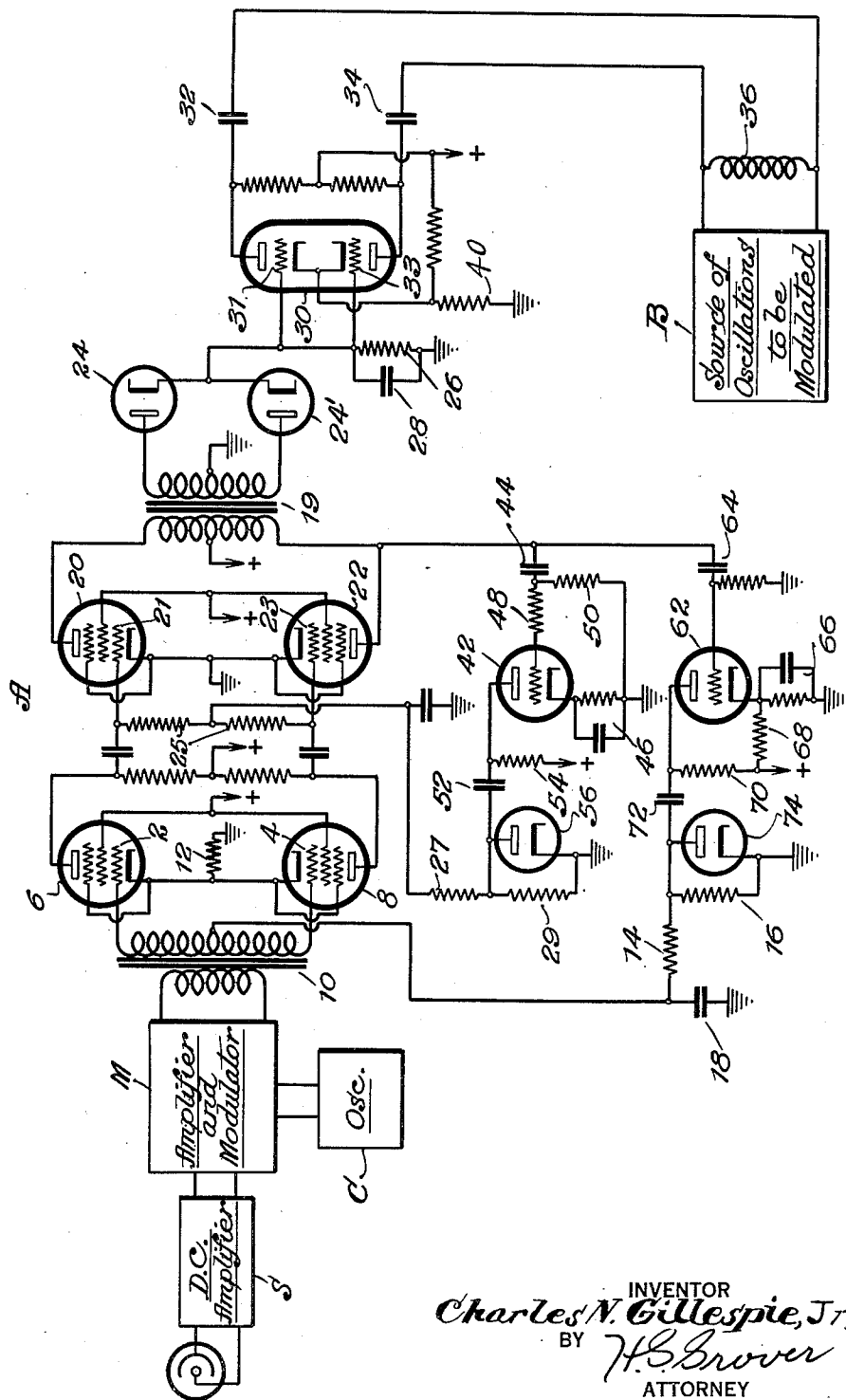
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MODULATION AMPLIFIER AND MODULATOR

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MODULATION AMPLIFIER AND MODULATOR

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This application relates to a new and improved modulated wave amplifier and to the same in a timing modulation circuit. The novel means of this system may be put to wide use in the radio art and is particularly applicable to subcarrier frequency modulation by currents derived from facsimile scanning.

An object of this invention is to provide a method of and means for compensating for variations in gain of the direct current amplifier and for drift in steady state direct current in the output of a facsimile scanner amplifier when this signal is used for amplitude modulating a subcarrier which is then used for frequency modulating another carrier.

In describing my invention, reference will be made to the attached drawing wherein a single figure illustrates the essential features of a controlled amplifier and modulator arranged in accordance with my invention.

Referring to the drawing, S represents the scanner amplifier whose output is used to modulate a subcarrier from C in an amplitude modulator M. In practice it is difficult to provide an output at S which does not vary with a steady, unvarying input to the amplifier. Unless the direct current output can be held steady with an unvarying input the output is not representative of the input. This would result in change in picture weight and is caused by changes in resistance values due to heating, changes in tube electrode voltage, etc.

The output from modulator M, which is an amplitude modulated tone (for example, 16 kc.), is passed through my novel amplifier, designated generally at A and used to modulate the timing of a wave source at B. If the output of modulator M is not a true representation of the scanned subject, the timing modulation likewise would not be a true representation of the subject. My novel amplifier A corrects the modulation currents and feeds them to the timing modulator B.

As stated above, the amplitude modulated wave from M is applied in push-pull to the grids 2 and 4 of the pentode tubes 6 and 8 through the input transformer 10. These push-pull tubes are biased for normal operation by the cathode resistor 12, the biasing circuit being completed through resistances 14 and 16 which for the time being may be considered to provide no biasing potential. The amplitude modulated signal carrying wave is amplified in this stage and supplied by resistive and capacitive couplings 25 to the control grids 21 and 23 of an additional stage comprising tubes 20 and 22. The grids 21 and 23 get their bias

from resistor 29 by way of resistors 25 and 27. The modulated wave after amplification is fed by transformer 19 to the diode rectifiers 24 and 24', which may be two electron discharge systems in a single envelope or may be comprised of two separate systems in different envelopes. The two cathodes of the diodes 24 and 24' are connected together and to ground by diode output resistance 26 and carrier bypass or filter condenser 28. The resistance 26 is coupled to the modulator tube 30. This tube 30 may comprise two tube systems in separate envelopes or may comprise two tube systems in a single envelope as shown. Tube 30 has its grids 31 and 33 tied together and connected to the resistor 26. The cathodes of tube 30 are tied together and connected to ground by a self-biasing resistor 40. The anodes of two tube systems of 30 are connected by way of coupling condensers 32 and 34 to the frequency controlling reactance 36 of a source of oscillations the timing of which is to be modulated. The connections are such that the condensers 32 and 34 are in a circuit in shunt to the inductance 36 and this capacitive circuit is completed through the impedance of the electron systems in tube 30. The capacity shunting 36 as a consequence depends on the conductivity of the tube systems in 30. When the conductivity of the tubes is high the condensers 32 and 34 are practically shunted across 36. When the conductivity of the tube systems in 30 is low, the circuit across 36, including condensers 32 and 34, may be considered substantially an open circuit.

The net voltage applied to the grids 31 and 33 is the difference of the potentials developed in resistances 26 and 40. With the potential drop in 26 and the range through which it varies (as the subject scanned varies from black to white) known, the value of resistance 40 is made such that the grids 31 and 33 are modulated through the desired range. The resistor 26 provides a positive bias for the grids 31 and 33 while resistor 40 provides a negative bias.

As the potential developed through 26 increases, the negative bias on the grids 31 and 33 is reduced so that the capacity in the circuit across 36 is increased and the timing of the oscillations produced in the source is lowered. The maximum potential produced in resistor 26 may represent black and the frequency of the generator is then at its lowest value. When the drop in resistor 26 decreases, the potential on grids 31 and 33 becomes more negative and the capacity in the circuit across inductance 36 decreases and the frequency goes up. White may be represented by

the minimum potential drop in resistance 26, at which time the frequency of the generated wave is maximum.

The amplified modulated tone is also fed through condensers 44 and 64 to the tubes 42 and 62 respectively. Tube 42 is connected as a limiting amplifier so that the output of this tube is constant as long as the trough of modulation does not fall below the value required for complete limiting. The point at which this limiting takes place is determined by the values of resistors 46, 48, 50, and 54, which determine the point at which limiting starts in the tube 42. If the trough falls below a selected value at which limiting takes place, the output of tube 42 decreases. This produces a decrease of potential fed by resistance 54 through condenser 52 to the diode rectifier 56 and causes a drop in the output of this rectifier. This decreases the negative potential at the diode-anode end of resistor 29 and as a consequence lowers the negative potential on the grids 21 and 23 of amplifiers 20 and 22 and increases their gain until the modulated wave trough goes back up to its selected point at which limiting takes place again in tube 42 to restore the negative bias on grids 21 and 23. Thus the lowest instantaneous value of alternating voltage can never fall below a selected value. It is noted here that the output of the scanner in these systems is generally modulated about 50 or 60 percent., and further, that this system might not operate satisfactorily on a full 100 percent. modulated signal.

Thus the trough of modulation which corresponds to white never exceeds a set value and the timing modulator will never swing the carrier farther than the desired frequency corresponding to white. The arrangement will not compensate for decrease of the white depth when the modulated wave trough remains above the threshold of the limiting amplifier 42.

The control means, including the limiting amplifier 42, thus compensates for drifts in the steady state direct current amplifier S output in one direction.

In raising the operating point of the tubes 20 and 22, described above, however, the modulation peaks of the wave being amplified, which corresponds to black, may be raised, and to an undesired extent. These peaks are applied from the anode of tube 22 through coupling condenser 64 to tube 62, normally biased to cutoff by resistors 66 and 68. The cutoff bias here and applied voltage are so related that when these peaks exceed a selected value the tube 62, which is normally cut off, supplies a potential from resistor 70 through coupling condenser 72 to diode 74 to cause the same to produce in resistor 16 a negative potential sufficient to pull the bias on the control grids 2 and 4 of the first stage more negative. This reduces the gain of the tubes 6 and 8 and hence, pulls down the value of the modulation peaks so that frequency modulator tube 30 cannot swing the carrier farther than the desired black frequency.

This control means including the biased amplifier 62 thus compensates for drifts in the steady state current at the output of the direct current amplifier S and the compensation here is in a direction opposite to that provided by the control circuit including amplifier 42.

The output of these two automatic controls is such that the peak frequency swing will not exceed a predetermined amount and the frequency cannot be swung beyond said limits.

Although obviously my system may be operated with various types of tubes in the several stages, in practice I found the following tube arrangement gave satisfactory results:

5 Tubes 6 and 8—type 6SK7
Tubes 20 and 22—type 6SJ7
Tubes 24 and 24'—type 6H6
Tubes 42 and 62—type 6J5
10 Tubes 56 and 74—the halves of a tube type 6H6

The diode rectifiers 56 and 74 are shown as being separate but it will be understood that they may be included in a single envelope.

What is claimed is:

1. In an amplitude modulated wave relaying system, an amplifier of controllable gain having an input and an output, a circuit for impressing said amplitude modulated wave on the input of said amplifier, a utilization circuit coupled to the output of said amplifier, and means actuated by the modulated wave for raising the gain of said amplifier when the trough of the modulation on the amplified wave falls below a first selected minimum value and for lowering the gain of said amplifier when the modulation peaks exceed a selected maximum value separated from said first selected value by a range substantially equal to the modulation range.

2. In an amplitude modulated wave relaying system, an amplifier of controllable gain having an input and an output, a circuit for impressing said amplitude modulated wave on the input of said amplifier, a utilization circuit coupled to the output of said amplifier, a gain control circuit for said amplifier actuated by the modulated wave for raising the gain of said amplifier when the trough of the modulation on the amplified wave falls below a first selected value, and a gain control circuit for said amplifier actuated by said modulated wave for lowering the gain of said amplifier when the modulation peaks exceed a selected value separated from said first value by the modulation range.

3. In a system for amplifying recurring potentials of wave form having peaks and troughs, a tube amplifier system having input electrodes excited by said potentials and having output electrodes from which amplified potentials may be derived, a control circuit excited by the potentials and coupled to the amplifier for raising the gain of the amplifier when the potentials fall below a selected trough value, and a control circuit excited by the potentials and coupled to the amplifier for lowering the gain of the amplifier when the potentials exceed a selected peak value separated from said trough value by a selected range.

4. In a wave relaying system, at least two electron discharge tubes each having input and output electrodes, circuits coupling said tubes in cascade, a source of wave energy to be relayed coupled to the input electrodes of one tube, an output circuit coupled to the output electrodes of the other tube, means for raising the gain of one of said tubes when the trough of the applied wave falls below a selected value, and means for lowering the gain of the other tube when the peaks of said applied wave exceeds a selected value.

5. In a wave amplifier system, an electron discharge device amplifier having input electrode excited by wave energy to be amplified and having output electrodes from which the amplified wave energy may be derived, a tube hav-

ing input electrodes and output electrodes, means for applying said wave energy to the input electrodes of said tube, means for biasing said tube to supply a constant output for wave amplitudes which exceed a selected value, said tube supplying less output when the wave input is less than said selected value, a circuit coupling the output of said tube to said device amplifier to control its gain in accordance with the tube output, a second tube having input electrode excited by said wave energy and having output electrodes, means for biasing said second tube to cut off for wave amplitudes which are less than a selected value, and a circuit coupling the output electrodes of said second tube to said amplifier to control its gain in accordance with the output of said second tube.

6. In apparatus of the class described, a source of current the wave form of which has peaks and troughs, a tube amplifier system having input electrodes on which the current is impressed and having output electrodes from which amplified current is derived, a second tube having input and output electrodes and operating at saturation for impressed voltages above a selected value corresponding to said wave troughs, connections for impressing voltages representative of current from said source on said input electrodes of said second tube, a coupling between said second tube output electrodes and said amplifier for changing the gain of the amplifier when the output of said second named tube changes, an additional tube having input and output electrodes and operating at cutoff for impressed voltages which are less than a selected peak value, connections for impressing voltages representative of current from said source on the input electrodes of said additional tube, and a coupling between the output electrodes of said additional tube and said amplifier for changing the gain of the amplifier when the output of said additional tube changes.

7. Apparatus of the class described in claim 6 including a rectifier in the coupling between said second tube and said amplifier and wherein a second rectifier is included in the coupling between the output electrodes of said additional tube and said amplifier.

8. In apparatus of the class described, a source of current the wave form of which has peaks and troughs, a tube amplifier system having input electrodes on which the current is impressed and having output electrodes from which amplified current is derived, a first control tube having input and output electrodes, connections for impressing potentials representative of current from said source on the input electrodes of said first control tube and biasing the control tube so that said tube acts as an amplitude limiter except in the presence of trough values of said current which fall below a selected value, connections between said first control tube output electrodes and said amplifier for changing the gain of the amplifier when the output of said control tube changes, a second control tube having input and output electrodes, connections for impressing potentials representative of current from said source on the input electrodes of said second control tube and biasing the same so that said second control tube operates at cutoff in the presence of potentials below a selected peak value, said cutoff bias being overcome by potentials which exceed said selected peak value, and connections between the output electrodes of said second control tube

and said amplifier for changing the gain of the amplifier when the output of said second control tube changes.

9. The method of amplifying amplitude modulated wave energy the modulation envelope of which varies between a maximum or peak modulation value and a minimum or trough modulation value which includes these steps, amplifying said wave energy, decreasing the amplification of said wave energy on peaks thereof which exceed a selected value, and increasing the amplification thereof on troughs thereof which fall below a selected value.

10. The method of amplifying amplitude modulated wave energy the modulation envelope of which varies between a maximum or peak modulation value and a minimum or trough modulation value which includes these steps, amplifying said wave energy, producing a control potential when said peaks exceed a selected value, decreasing the amplification of said wave energy in accordance with said control potential, producing a control potential when said troughs fall below a selected value and increasing the amplification of said wave energy in accordance with said last mentioned control potential.

11. In apparatus of the class described, a source of current the wave form of which has peaks and troughs, a tube amplifier system having input electrodes on which the current is impressed and having output electrodes from which amplified current is derived, a first control tube having input and output electrodes, a connection between the output of said tube amplifier and the input of said first control tube for impressing the output of said amplifier system on the input electrodes of said first control tube, a direct current biasing circuit for said control tube to bias said tube so that it operates as an amplitude limiter except in the presence of trough values of said amplifier output which fall below a selected value, connections between said first control tube output electrodes and said amplifier for changing the gain of the amplifier system when the output of said control tube changes, a second control tube having input and output electrodes, a connection between the output electrodes of said amplifier system and the input electrodes of said second control tube for impressing the output of said amplifier system on the input electrodes of said second control tube, a direct current biasing circuit for said second control tube to operate the same at cutoff in the presence of potentials below a selected peak value, said cutoff bias being overcome by potentials which exceed said selected peak value, and connections between the output electrodes of said second control tube and said amplifier system for changing the gain of the amplifier when the output of said second control tube changes.

12. In apparatus of the class described, a source of current the wave form of which has peaks and troughs, a tube amplifier system having input electrodes on which the current is impressed and having output electrodes from which amplified current is derived, a first control tube having input and output electrodes, a coupling between the output electrodes of said tube amplifier and the input electrodes of said first control tube for impressing the output of said amplifier system on the input electrodes of said first control tube, a direct current biasing circuit for said first control tube to bias said tube so that it operates as an amplitude limiter except in the presence of trough

values of said amplifier output which fall below a selected value, a rectifier tube coupling said first control tube output electrodes to said amplifier for controlling the gain of the amplifier system when the output of said first control tube changes, a second control tube having input and output electrodes, a coupling between the output electrodes of said amplifier system and the input electrodes of said second control tube for impressing the output of said amplifier system on the input electrodes of said second control tube, a direct current biasing circuit for said second control tube to operate the same at cutoff in the presence of potentials below a selected peak value, said cutoff bias being overcome by potentials which exceed said selected peak value, and a rectifier tube coupling the output electrodes of said second control tube to said amplifier system for controlling the gain of the amplifier when the output of said second control tube changes.

13. In apparatus of the class described, a source of current the wave form of which has peaks and troughs, a tube amplifier system including two tubes each having input and output electrodes with the input electrodes of one tube coupled to the output electrodes of the other tube, an input circuit for impressing said current from said source on the input electrodes of said other tube, an output circuit coupled to the output electrodes of said one tube, a first control tube having input

and output electrodes, a coupling between the output electrodes of said one amplifier tube and the input electrodes of said first control tube for impressing the output of said amplifier system on the input electrodes of said first control tube, a direct current biasing circuit for said first control tube to bias said tube so that it operates as an amplitude limiter except in the presence of trough values of said amplifier output which fall below a selected value, a rectifier coupling said first control tube output electrodes to said one amplifier tube for changing the gain of the amplifier system when the output of said first control tube changes, a second control tube having input and output electrodes, a circuit coupling the output electrodes of said one amplifier tube to the input electrodes of said second control tube for impressing the output of said amplifier system on the input electrodes of said second control tube, a direct current biasing circuit for said second control tube to operate the same at cutoff in the presence of potentials below a selected peak value, said cutoff bias being overcome by potentials which exceed said selected peak value, and a rectifier coupling the output electrodes of said second control tube to said other amplifier tube for changing the gain of the amplifier system when the output of said second control tube changes.

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