

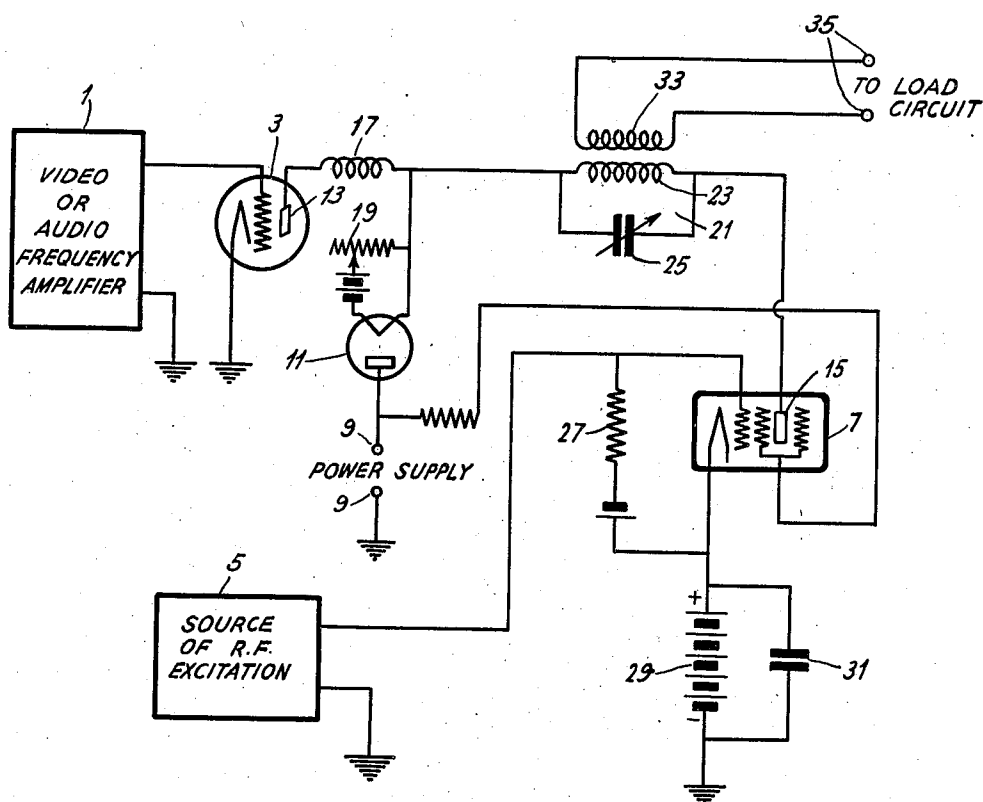
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MODULATION SYSTEM

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MODULATION SYSTEM

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The present invention relates to a modulation system, and particularly to a system applicable for use both for the direct and alternating current modulation of a transmitter, and is particularly suited for modulation where the control signals vary between zero frequency and any selected maximum frequency.

One of the principal objects of the invention is to provide ways and means for producing variations in amplitude of carrier frequency energy, which carrier may be a radio, superaudible or tone frequency which is produced in the transmitter, in accordance with some control signal. The invention particularly finds application to the television transmission systems where the control signals are developed by some desired form of scanning. Therefore, while reference will be made in this description to the modulation of a transmitter particularly by video signals which result from the scanning of some subject of which it is desired to produce an electro-optical representation at desired receiving points, it is, of course, to be understood that the system also finds application for the modulation of a transmitter by direct current, audio, super-sonic or low intermediate frequency control signals.

In the past, it has been customary to provide arrangements of the so-called "plate modulation" types of transmitters wherein there was included in the output of the modulator tube a resistor for the purpose of reducing the voltage applied to the oscillator or the radio frequency amplifier tube in order to permit high degrees of modulation. However, with such systems it has been substantially impossible to obtain 100% modulation of the carrier where a constant or zero frequency control signal persists longer than momentarily, since the modulator tube, even in the event that the signals serving to modulate the transmitter carry the modulated tube to a point on its characteristic where the tube is very highly conducting, cannot serve as a direct short circuiting device. The present invention aims to provide ways and means for obtaining 100% modulation of the carrier. The invention also seeks to provide a signal modulation system which is of an extremely simple nature and set up, and which is highly efficient in operation.

A further object of the invention is to provide a modulation system in which the transmitter may be controlled over long periods of time even though the frequency of the control signal remains fixed (i. e. zero frequency) as is often the case in television systems where an area of constant light brilliance is scanned, such as when-

ever a title area is scanned. To provide for this feature the system employs either an emission limited or a multi-grid thermionic tube so arranged as to pass a constant current over a wide range of plate voltage and this tube is then utilized in preference to any inductive impedance element in the energy supply or output circuit of the modulator.

Other objects and advantages of the invention will, of course, become apparent and immediately suggest themselves to those skilled in the art to which this invention is directed from a reading of the following specification and claims in connection with the accompanying drawing wherein the single figure thereof illustrates conventionally one circuit arrangement for carrying out the aims and objects of this invention.

If reference is now made to the drawing, the signals serving to modulate the transmitter are developed in a video or audio frequency amplifier 1 which may be of any conventional or known type. For example, one type of transmitter for developing the video signals may be of the general form disclosed by the application of R. H. George and H. J. Heim, Serial 560,758. Other forms of transmitter for developing the video frequency signals may be of the general type disclosed by V. K. Zworykin and described for example in the journal of the Franklin Institute for January 1934, volume 217, No. 1, pages 1 through 38; or, for example, may be of the general type disclosed in the various articles appearing in the "Proceedings of the Radio Engineers" for December, 1933, volume 21, No. 12, or for that matter any other suitable form of video or audio frequency energy source may be utilized. However, for simplicity, transmission of video signals only will be described herein.

In connection with such a system, the video frequency signals representing a sequence of elemental areas of a subject scanned are supplied to the input circuit of a modulator tube 3 by way of a direct connection or through any suitable coupling. Also within the system, carrier frequency oscillations of desired frequency, such as a radio or tone frequency, are developed by means of a suitable oscillation generator source 5. The source 5 is preferably controlled to produce constant frequency. The general form of oscillator arrangement (shown herein only conventionally) may be any of the types well known in the art, for example, any of those types known as the Hartley (shunt or series feed), the Colpitts, the tuned-plate tuned-grid, the dynatron, the T. N. T., the piezo crystal, the Barkhausen-Kurz, the so-

called "Magnetron", the tuning fork type, or any other known type. The radio frequency oscillations developed in the source 5 of the above described character are then impressed upon the input circuit of a carrier frequency amplifier tube 7 which is a radio frequency amplifier where the source 5 develops radio frequencies. In order to energize both the modulator tube 3 and the carrier frequency amplifier tube 7 plate circuits, a suitable power supply source (not shown) is connected to the terminal points 9. In series with this power supply source any desired type of constant current tube 11 is connected. The tube 11 has been shown as being a saturated diode, but any suitable constant current tube may be substituted for this diode and, for example, it is suggested that a tube of the pentode type may be satisfactorily employed in place of the diode where the screen electrode of the pentode is maintained at a positive voltage relative to the cathode but less positive than the plate electrode, and a fixed bias voltage is supplied to the control grid. A pentode tube and circuit of this character for supplying constant current for any desired purpose has been disclosed in co-pending application of H. J. Heim, Serial No. 42,818. The output from the constant current tube 11 is then supplied to energize the output circuit of both the modulator tube 3 and the carrier frequency amplifier tube 7 by way of the connections made to the plate electrodes 13 and 15 thereof respectively. In the circuit connecting the constant current tube 11 with the plate electrode 13 of the modulator tube 3, there is provided a choke coil 17 to block any carrier frequency oscillations from the modulator tube. The current flowing through the diode 11 is suitably controlled by means of the filament rheostat 19 in known manner. The current supplied to the plate electrode 15 of the carrier frequency amplifier tube 7 passes through the tuned circuit 21 comprising the transformer primary 23 and the tuning condenser 25. The carrier frequency developed in the oscillator 5 is then supplied to the input circuit of the carrier frequency amplifier 7 by way of the coupling resistor 27 although it is, of course, obvious that there may be substituted where desired a tuned circuit to connect the carrier frequency amplifier with the oscillation source.

In order to provide a circuit which is capable of modulating the radio frequency carrier 100%, there is provided for the carrier frequency amplifier tube 7 a suitable source of biasing voltage 29 serially connected with the cathode. The biasing source 29 is shunted by any suitable capacity element 31 which by-passes rapid energy fluctuations. This capacity is particularly desirable where the resistance of the biasing source 29 is extremely high. It is, of course, obvious that there may be substituted for the carrier frequency amplifying screen grid tube 7 herein shown any desired form of amplifier tube such as a triode, for example, where suitable neutralization is provided or there may be substituted, where desired, a tube of the pentode or other multi-electrode type or even a push-pull stage utilizing any of the foregoing types of tubes suggested may be utilized. The output energy from the carrier frequency amplifier tube 7 is then fed by way of the transformer secondary 33 to the load circuit terminals 35. The load circuit may then include an antenna, if radio frequency energy transmission is desired, or a transmission line, if wire line transmission is desired.

The device of the type above described may be

briefly summarized as to its operation by a very brief description wherefrom it will be seen that the modulating signals are supplied to the input circuit modulator tube 3. Both the modulator tube and the carrier frequency amplifier tube 5 draw plate voltage from the power supply 9 through the constant current tube 11 through which current passed is dependent upon the emission from the filament and, therefore, the temperature of the tube. According to known 10 characteristics of a saturated diode of this character it can be appreciated that for a wide range of voltage drop across this tube, the value of the current passed through the tube will remain substantially constant. This current therefore will 15 normally divide between the modulator tube 3 and the radio frequency amplifier tube 7. If, now, for example, it be assumed that the modulator tube is blocked or biased to cut-off by a negative potential applied to its grid so that no 20 current passes therethrough all of the current passed by the saturated diode will pass through the carrier frequency amplifier tube 7. Similarly, if the signal current applied to the modulator tube is of the opposite polarity, then it can be 25 seen that practically all of the current can be made to pass through the modulator tube 3 and very little or none through the carrier frequency amplifier tube 7 because the sum of the currents flowing through the modulator 3 and the amplifier 7 must, for all conditions, be equal to the constant current flowing through the diode. Since the tube 7 controls the amplitude of the carrier frequency wave developed in the oscillator 5 which is to be supplied to the terminal points 35, this amplitude naturally will depend upon the value of the current flowing through the tube 7. Therefore, it can be seen that the tube 3 modulates the carrier frequency output of the tube 7 by varying the current flowing through tube 7. 40

It can readily be seen for any steady condition in the modulator tube 3, the current flowing through the saturated diode 11 will remain constant indefinitely and, therefore, the output of the tube 7 will also remain constant so long as 45 the condition remains the same in the tube 3. Therefore, a circuit arrangement of the type herein-described provides a system for direct current modulation of a transmitter and makes it possible to transmit long duration picture signals of uniform light intensity or darkness, and this feature, particularly in connection with the use of a constant current tube, finds great utility and possesses great advantages over the high inductance choke in the output of the modulator 55 tube frequency used in connection with sound broadcasting because of the fact that the inductive choke is not able to hold the current constant excepting for very short periods of time.

It is also known that whenever the output of 60 the carrier frequency amplifier tube 7 can be varied from zero to a value equal to twice its average value, the resulting output carrier current is said to be 100% modulated. This effect is obtained with the arrangement herein described by virtue of the fact that biasing voltage source 29 is utilized for the purpose of raising 65 the potential of the cathode of the carrier frequency amplifier tube 7 considerably above that potential which is applied to the cathode of the modulator tube, and this biasing voltage permits operating of tube 3 at its full rating and the tube 7 at a value less than its full rating.

In the accompanying drawing, the various cathodes are shown incomplete but, of course, 75

the manner of completing the circuits is obvious and with the ground connection shown for completing each circuit, it is believed that the understanding of the invention will be full and complete in all respects.

Many and various modifications of the scheme hereinabove suggested may be made and utilized without departing from the spirit and scope of the invention hereinabove set forth and, therefore, it is believed that any and all of these modifications may be utilized and resorted to where they fall within the meaning of the various hereinafter appended claims.

Having now described the invention, what is claimed and desired to secure by Letters Patent is the following:

1. A signalling system comprising a modulator tube and a carrier frequency amplifier each having a cathode and an anode of which the cathode of the modulator is maintained at a predetermined potential relative to ground, means for supplying signal energy upon the input circuit of the modulator tube, a source of direct current potential including a constant current thermionic device for energizing both the modulator and the carrier frequency amplifier, a source of carrier frequency energy connected to the carrier frequency amplifier input circuit, a load circuit coupled with the output from the carrier frequency amplifier, and constant potential biasing means connected with the amplifier cathode to raise the potential thereof above that of the modulator cathode whereby the signal modulated output of the carrier frequency amplifier may be varied from a zero value to a value equal to twice its normal value in accordance with variations in signal energy intensity.

2. In combination, a carrier frequency energy source and a carrier frequency amplifier comprising at least an anode and a cathode, a modulator having an anode and a grounded cathode, said modulator being connected to modulate the carrier frequency output of said carrier frequency amplifier, a common source of energizing voltage for said modulator and said carrier frequency amplifier, said source including a constant current thermionic device included in said energy supply circuit, and means for biasing the cathode of said carrier frequency amplifier high relative to ground whereby 100% modulation of the carrier frequency is obtained.

3. A modulation system comprising a modulator tube and a high frequency amplifier tube each including an anode and a cathode, means for sup-

plying control signal energy to the input circuit of the modulator tube, an energizing source for both the modulator and high frequency amplifier tube, said energizing source including a constant current thermionic device, a source of carrier frequency energy to be modulated, said carrier frequency source being connected to the high frequency amplifier tube input circuit, a load circuit coupled with the output from the high frequency amplifier tube, and constant voltage biasing means connected with the cathode of the high frequency amplifier tube to bias the cathode positive relative to the modulator cathode to permit the signal modulated output thereof to vary from a zero value to a value equal to twice its normal value.

4. A modulation system comprising a modulator tube including an anode and a cathode, said cathode being maintained at a predetermined fixed potential relative to ground, a high frequency amplifier tube, said high frequency amplifier tube comprising an electron emitting electrode and at least two cold electrodes, a constant current source of energy including a power supply source connected with the plate circuit of both said modulator and high frequency amplifier tubes, a source of high frequency energy connected with one of the cold electrodes of said high frequency amplifier tube, a source of signal energy connected with the input circuit of said modulator tube, a load circuit coupled with the output from said high frequency amplifier tube, and a source of positive biasing voltage in series with the electron emitting electrode of said high frequency amplifier tube for biasing the amplifier tube electron emitting electrode positive relative to the modulator tube cathode.

5. In a constant current system for obtaining 100% modulation wherein a modulator tube and a carrier frequency amplifier tube each including anode and cathode elements are provided and wherein the cathode of the modulator tube is maintained at a predetermined potential relative to ground, the method steps comprising supplying control signals to the modulator tube, developing fixed frequency oscillations and supplying said oscillations to the carrier frequency amplifier tube, energizing both the modulator and amplifier tubes from a common constant current supply, biasing the cathode of the amplifier tube positive relative to the modulator tube cathode, and feeding the resultant modulated oscillations to a load circuit.

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