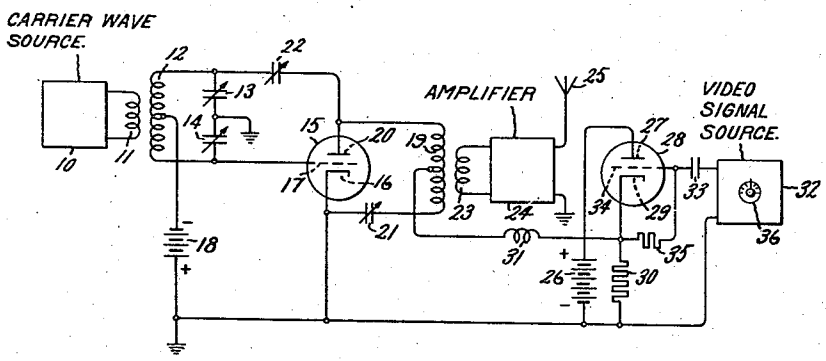
Dec. 1, 1942. R. B. DOME 2,303,830

TELEVISION MODULATOR

Filed Sept. 23, 1941



Inventor:
Robert B. Dome,
by Harry E. Dunham
His Attorney.

Patented Dec. 1, 1942 2,303,830

UNITED STATES PATENT OFFICE

2,303,830

TELEVISION MODULATOR

Robert B. Dome, Bridgeport, Conn., assignor to General Electric Company, a corporation of New York

Application September 23, 1941, Serial No. 411,947

4 Claims. (Cl. 178—7.1)

My invention relates to television apparatus, and more particularly to apparatus for modulating a carrier wave in accordance with video signals.

In present day television systems an image to be transmitted is usually scanned in a series of lines, and electrical signals are developed by such scanning, which signals are representative of the brightness of individual successive picture elements of the scanned image. These signals are known as video signals and must, in general, convey two kinds of information: First, the relative brightness of the picture elements, determined by the details of the image; and, second, the average absolute brightness of the picture elements, determined by the background illumination. Thus, the complete video signals must represent both instantaneous and steady conditions and must contain a wide range of frequency components down to and including continuous current components. All these components should be present in the signal which is finally utilized in the transmitter to modulate the radiated carrier waves.

Many television camera tubes are incapable of producing the second type of signal mentioned above, namely, that representing the average absolute brightness of the picture elements, determined by the background illumination. Moreover, amplifiers capable of amplifying low frequency and continuous potentials, as well as higher frequency potentials extending over the wide range of frequencies present in television video signals, are very costly and difficult to build. Hence, it is common practice to use more economical resistance-capacity coupled amplifiers in television apparatus for amplifiying video signals representative of a scanned image.

If either such a camera tube which does not produce signals representative of the average absolute brightness of the image or such a resistance-capacity coupled amplifier be used, low frequency and direct current components are lost, and must be inserted in the video signal before it is utilized to modulate a carrier wave for radiation. Accordingly, it is an object of my invention to provide improved and simplified apparatus for modulating a carrier wave in accordance with a video signal, and for simultaneously inserting in the video signal a continuous potential component representative of the average absolute brightness of picture elements, determined by the background illumination.

It is a further object of my invention to provide improved and simplified means for modulating a carrier wave in accordance with a video signal, which means is not only arranged to insert a suitable continuous potential component into the video signal, but is also arranged to modulate the operating potential for a carrier wave amplifier in accordance with all frequency components of the composite signal with a high degree of fidelity.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, both as to its organization and manner of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing in which the single figure of the drawing represents a television transmitter embodying my invention.

Referring now to the drawing, a source 10 of carrier waves is coupled through an inductance coil 11 to a tuned circuit including an inductance coil 12 and condensers 13 and 14 connected in series across the coil 12. The circuit including coil 12 and condensers 13 and 14 is adjusted to resonance at the frequency of waves from the source 10.

An electron discharge amplifier 15 includes a cathode 16, a control electrode 17 and an anode 20. The cathode 16 is connected to ground, and the control electrode 17 is connected to a point on the tuned circuit between the inductance coil 12 and the condenser 14. A point on the tuned circuit between condensers 13 and 14 is connected to ground, so that oscillating voltages across the tuned circuit appear between the control electrode 17 and the cathode 16 of the device 15. The positive terminal of a source 18 of bias potential for the control electrode 17 is connected to ground and the negative terminal of the source 18 is connected to an intermediate point of the inductance coil 12, whereby bias potential of the source 18 is impressed between the control electrode 17 and cathode 16.

The output circuit of the device 15 includes an inductance 19 connected in series with an adjustable condenser 21 between the anode 20 and the cathode 16 of the device 15. This output circuit is adjusted to resonance at the frequency of the carrier wave from the source 10, by virtue of the fact that the inductance of coil 19 resonates with the condenser 21 and with the interelectrode capacity of the discharge device 15. Neutralization for the stage of amplification including

the discharge device 15 is provided by connection of a condenser 22 between the anode 20 and a point on the tuned input circuit between inductance 12 and condenser 13. By suitable adjustment of the condenser 22 in well known manner, good neutralization of the amplifier stage including device 15 may be obtained.

Carrier waves amplified through the discharge device 15 are transferred inductively from the inductance 19 into an inductance 23, from which they are transmitted through an amplifier 24 whose output is radiated from an antenna 25. Obviously, the carrier wave amplifier device 15 may be connected, if desired, to operate as an oscillator to generate carrier waves.

Operating current for the discharge device 15 is supplied from a source 26 of such current. The negative terminal of this source 26 is grounded, and the positive terminal is connected to the anode 27 of an electron discharge device 28, whose cathode 29 is connected through a resistance 30 to ground. An inductance 31 is connected from the cathode 29 to an intermediate point of the coil 19, thereby to supply the potential across the resistance 30 between the anode 20 and cathode 16 of the device 15.

Video signals from a source 32 are impressed from one terminal of the source through a coupling condenser 33 upon the control electrode 34 of the device 28, the other terminal of the source 32 being grounded. A grid resistance 35 is connected between the control electrode 34 and the cathode 29. Video signals from the source 32 are translated through the discharge device 28, appearing across the resistance 30, and are thence transmitted through the inductance 31 superimposed on the discharge current for the device 15 flowing to the anode 20 thereof. Variation of the operating potential for the device 15 across the resistance 30 in accordance with video signals from the source 32 is thus effective to modulate the intensity of carrier waves amplified through the discharge device 15. The resistance 30 may, if desired, be placed in any circuit of the carrier wave amplifier to modulate its operation in accordance with changes in voltage across this resistance and correspondingly modulate the carrier wave. This resistance 30 may, for example, be placed in the input circuit of device 15 to modulate the grid bias potential. Since the resistance 30 is a common portion of the input circuit and output circuit of the device 28, carrying video signals in both such circuits, the device 28 operates with a large amount of degeneration, and produces modulation of the carrier waves with high fidelity.

Since the resistance 30 and the capacity effective thereacross in connection with the discharge device 28, as well as the effective resistance and capacity associated with the discharge device 15 between the intermediate point of the coil 19 to which inductance 31 is connected and ground, are in general of substantially different values, the inductance 31 may be utilized to provide efficient transmission of video signals from the resistance 30 to the discharge device 15. The manner in which this inductance 31 is so utilized, and the proper adjustments therefor and for the effective resistance and capacity between each end of the inductance 31 and ground, is clearly described and claimed in my application, S. N. 382,701, filed March 11, 1941, for Electric translating circuits, and assigned to the same assignee as the present application.

To attain the object of the invention disclosed in my prior application, it is necessary to make the effective resistance from each end of the inductance 31 to ground respectively equal to the capacitative reactance effective at each end of inductance 31 at the upper limit frequency of signals to be transmitted from the device 28 to the discharge device 15. It is thereafter also necessary to make the reactance of the inductance 31 at such upper limit frequency equal to the average of the two effective resistances.

Assuming that the present standard television signal is used in this apparatus, in which white is represented by zero voltage and black by maximum voltage, and in which synchronizing pulses extend to a somewhat higher voltage than that which represents black, it is necessary that the source 32 impress such voltages on the grid 34 of the device 28 so that white picture elements tend to drive the control electrode 34 in the negative direction and black picture elements and synchronizing pulses tend to drive the control electrode 34 in the positive direction with respect to the cathode 29. When no video signal from the source 32 is impressed on the control electrode 34, the electrode 34 assumes the same potential as the cathode 29, and maximum current is transmitted through the discharge device 28, to provide maximum voltage across the resistance 30. Under such conditions, maximum operating current is transmitted to the discharge device 15, and a carrier wave of maximum intensity is radiated from the antenna 25.

Now if synchronizing signals with no video components are transmitted from the source 32 to the control electrode 34, grid rectification is produced by the control electrode 34 and cathode 29, so that electrode 34 tends to assume a negative potential with respect to cathode 29, and therefore acts to decrease the discharge current flowing through the device 28. The capacity 33 and grid resistance 35 must be chosen to have suitable values to produce this result.

The resistance 35 must be of the order of 500 times as large as the resistance between the control electrode 34 and the cathode 29 of device 28, when the control electrode 34 is just beginning to conduct. The resistance 35 will, in general, be found to produce optimum operation when it has a value of at least as high as 2 to 5 megohms. Its value must, however, not be too high, because if made too high, emission may occur from the control electrode 34 and a consequent positive potential may result across the resistance 35 with subsequent production of additional emission and the building up of still more positive potential, which action eventually leads to destruction of the control electrode.

Having determined the value of resistance 35 which gives a satisfactory high resistance discharge path for condenser 33 without allowing the control electrode to proceed to self-destruction, the size of condenser 33 may be determined. Usually, the time constant of condenser 33 and resistance 35 should be in the order of 1/5 second. In general, the time constant should be determined by experiment and should be made of such value that low frequency and continuous potential components of the video signals are produced on the control electrode 34 and added to the video signal in such amount as to compensate for the loss of such components in the camera tube, amplifier, or other parts of the source 32. It is desirable that such low frequency and continuous potential components be added in such amounts that the peaks of synchro-

nizing pulses always increase the intensity of the carrier wave to its maximum amplitude, corresponding to the maximum output capability of the device 15. Of course, special conditions may require some modification of this adjustment, as for example, if the video signal contains noise peaks of the order of magnitude of the synchronizing pulses, the condenser 33 may have to be made somewhat smaller than would otherwise be expected, in order to avoid adding low frequency and continuous potential components developed from the noise peaks rather than from the synchronizing pulses.

The video signal output intensity of the source 32 should be adjusted by a suitable control 36, so that when the video signal is representative of a white element of the picture, the current through the device 28, and hence the voltage across the resistance 30, will be near zero to obtain deep modulation of the available carrier wave. It is important that the video signals be not allowed to reduce the current through the discharge device 28 and the voltage across resistance 30 to values very near zero, in order to avoid accompanying distortion with consequent improper reproduction of the picture at the receiver.

It is, of course, within the scope of my invention to use any type of carrier wave amplifier for the amplifier stage including the device 15, such for example, as a stage including such devices connected in push-pull or balanced relation. It is also within the scope of my invention to operate the fixed potential end of the resistance 30, or the cathode 16, at a constant potential other than ground, in order that the device 28 may be operated in a region where its discharge current need not approach zero for the representation of a white picture element. It is preferred, however, for simplicity of construction and ease of adjustment of the apparatus to connect both these points to ground.

While I have shown and described a particular embodiment of my invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention in its broader aspects, and I, therefore, aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, a source of video signals deficient in low frequency and continuous potential components, a source of carrier waves to be modulated in accordance with a complete video signal including such components, a resistance, an electron discharge device having an anode, a cathode, and a control electrode, an input circuit connected between said cathode and control electrode and including said source of video signals and said resistance, an output circuit connected between said anode and cathode and including said resistance, said source of carrier waves including a carrier wave amplifier having an input circuit and an output circuit, one of said circuits including said resistance and being arranged so that the amplification of said amplifier varies in accordance with the voltage across said resistance, and means to produce rectification of said video signals by said control electrode and cathode to add low frequency and continuous potential components thereto, thereby to produce a complete video signal across said resistance and to modulate said carrier wave in accordance therewith.

2. In combination, a source of video signals deficient in low frequency and continuous potential components, a source of carrier waves to be modulated in accordance with a complete video signal including such components, said carrier wave source including a carrier wave amplifier having a circuit portion effective to control the amplification of said amplifier as the voltage across such portion is varied, an electron discharge device having an anode, a cathode, and a control electrode, an input circuit connected between said cathode and control electrode and including said source of video signals and said circuit portion, an output circuit connected between said anode and cathode and including said circuit portion, and means for rectifying said video signals by said control electrode and cathode to add low frequency and continuous potential components thereto to produce a complete video signal, said device being thereby effective to complete said video signal and to modulate said carrier wave in accordance therewith.

3. In combination, a source of video signals deficient in low frequency and continuous potential components, an electron discharge device having a control electrode, an input circuit including said electrode, and an output circuit, a resistance common to said circuits, means for applying video signals from said source to said input circuit to reproduce said signals across said resistance, a carrier wave amplifier, means connecting said resistance in circuit with said amplifier for supplying an operating potential thereto, said potential being modulated in accordance with the video signals reproduced across said resistance, and means for rectifying said video signals by said control electrode to add low frequency and continuous potential components to said video signal to reproduce a complete video signal across said resistance and to modulate a carrier wave in said amplifier in accordance therewith.

4. In combination, an electron discharge device having a cathode, an anode, and a control electrode, an input circuit including said control electrode and cathode, an output circuit including said anode and cathode, said circuits including a common load resistor, a source of video signals including synchronizing pulses in said input circuit so poled as to tend to make said control electrode negative with respect to said cathode in the presence of a signal corresponding to white and to make said control electrode positive in the presence of a signal corresponding to black or to a synchronizing pulse, and means for producing rectification of said video signals by said control electrode and cathode to generate a bias potential on said control electrode with respect to said cathode corresponding at each instant substantially to the average amplitude of video signals from said source at such instant, whereby the potential across said load resistor is modulated both by said video signals and by said bias potential.

ROBERT B. DOME.