

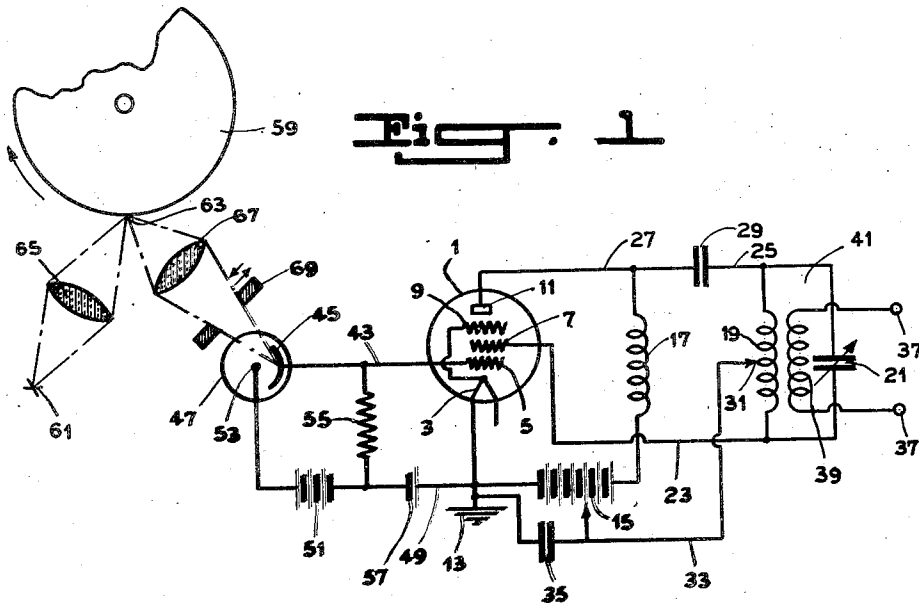
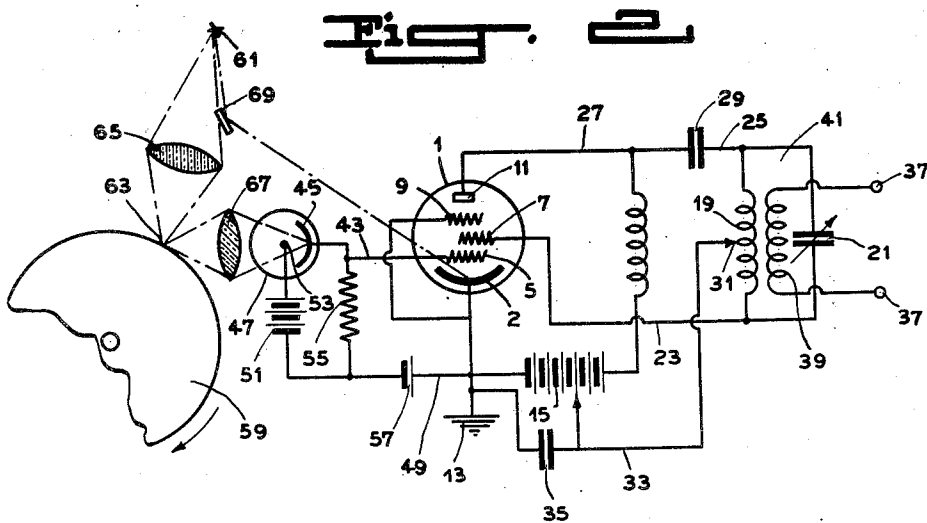
Feb. 19, 1935.

J. N. WHITAKER ET AL

1,991,970

MODULATED OSCILLATOR

Filed Jan. 30, 1932



INVENTORS  
JAMES N. WHITAKER  
& HENRY SHORE

BY *W. B. Moore*  
ATTORNEY

## UNITED STATES PATENT OFFICE

1,991,970

## MODULATED OSCILLATOR

James N. Whitaker, Tuckahoe, N. Y., and Henry Shore, Elizabeth, N. J., assignors to Radio Corporation of America, a corporation of Delaware

Application January 30, 1932, Serial No. 589,859

4 Claims. (Cl. 179-171)

The present invention relates to oscillation generators and is directed primarily to the vacuum tube and its associated oscillation circuit, and provides ways and means by which the generated oscillations may be modulated directly without the need of resorting to separate modulation devices. The invention is particularly useful for facsimile or television transmission purposes in connection with the so-called "scanning heads", although it is apparent that the use may readily be extended to voice telephony and telegraph or printer telegraph circuits.

In the prior art, so far as we are aware, it has heretofore been customary to generate oscillations by means of a vacuum tube oscillator or the equivalent and then to supply the output energy from the oscillator and its associated circuit to a modulator tube upon which is also impressed signal energy corresponding to a message form or the equivalent which is to be transmitted. In this manner the oscillations of any suitable frequency generated by the oscillator are modulated as to amplitude and then transmitted by radio or wire line transmission.

It has also been suggested in the prior art to modulate a tube oscillator through the use of controlling potentials upon one electrode thereof or to use a multi-electrode tube as an element by which a beat frequency resulting from two impressed frequencies will be obtained. However, these arrangements of the prior art are, so far as we are aware, of insufficient stability to be of great usefulness in picture transmission work, and, therefore, recourse has been had to the use of a multi-electrode tube which will function smoothly with high power and still provide extremely stable operation.

An object of the present invention is to simplify the arrangements heretofore known and used in the prior art by providing ways and means whereby the abovementioned features may be carried out through the use of a single vacuum tube only with considerably increased stability of operation.

Another object of the invention is to provide an oscillator circuit, which is generally similar to the type heretofore disclosed by Hartley, except that use is made of a multi-electrode tube, known generally as a pentode, comprising the usual hot or even a cold electrode that emits electrons and four additional electrodes, that is, preferably cold electrodes, which are so connected in the circuit that the hot cathode or the cold electron emitting cathode, the screen electrode and the plate electrode or anode form the electrodes connected

with the usual oscillation circuit and wherein the usual grid electrode of the vacuum tube is used as a means by which the generated oscillations are modulated as to their amplitude, and then so that the suppressor electrode is connected directly to the cathode.

Further objects of the invention are to provide an oscillator which can be modulated directly, which is simple in its construction, an oscillator which is ideally adapted for use with picture transmission systems, and an oscillator which can be constructed with equipment now obtainable in the open market.

Other objects and advantages of the invention will, of course, become apparent by a reading of the following specification and claims in connection with the accompanying drawing; wherein Figure 1 illustrates one form of a multi-electrode tube oscillator using a hot cathode tube wherein the modulation source is connected by way of a direct current coupling, and Figure 2 illustrates a modification of Figure 1 wherein modulating signals are impressed upon a cold cathode type of multi-electrode tube oscillator.

To refer now to the drawing, and first to Figure 1 thereof, the multi-electrode tube 1, having therein the usual electrode elements comprising a hot cathode 3, which may be heated directly or indirectly, and a plurality of cold electrodes commonly known as the grid 5, the screen grid 7, the suppressor grid 9, and the anode or plate 11, is connected so that the filament 3, screen grid 7 and the plate or anode 9 form with external circuit elements an oscillation generator, which may be of the general type disclosed by Hartley. The cathode 3 in the form shown is preferably grounded at 13 and to this ground lead a source of potential 15 is then connected. The source 15 connects, in turn, with the plate electrode 11 through a choke coil 17 to block radio frequencies from the source 15.

To form a feed back circuit to the screen electrode 7 from the plate 11 the usual tank circuit, comprising the inductance 19 and the capacity 21, each of which may be variable where desired, is connected to the screen electrode 7 by a conductor 23 and to the plate electrode 11 by conductors 25 and 27 through a capacity connection 29. In order to provide voltage on the screen electrode 7 the inductance 19 is center tapped at 31 and connected by way of a conductor 33 to a point on the plate supply battery 15 intermediate its ends. The portion of the source 15 supplying the plate voltage which is tapped by the conductor 33 is shunted by a capacity element 35 grounded at 13.

The output energy from the oscillator circuit above described is taken across terminals 37 which connect with the secondary winding 39 forming with the inductance 19 a transformer. Thus, it is seen that if the tube 1 is considered without respect to the usual grid electrode 5 and the suppressor grid 9 the circuit hereinabove described is substantially the well known Hartley oscillation circuit and will, neglecting other circuit constants, generate oscillations of a frequency dependent upon the values of L and C, that is, inductance and capacity in the tank circuit 41.

If reference is now made to the grid electrode 5 contained within the vacuum tube 1, and it is assumed that the grid is connected by way of a conductor 43 with the cathode 45 of a photo tube 47 or the equivalent, and that the tube cathode 3 is connected by way of a conductor 49 through a battery 51 supplying operating voltage for the photo tube 47 with the anode electrode 53 thereof, it can be seen that light of varying intensities supplied to the photo tube 47 will produce varying voltage drops across the resistor 55 connected between the photo tube cathode and anode. These voltage drops in resistor 55 in turn tend to change the normal potential bias of the grid electrode 5 as supplied from the bias battery 57 connected between the grid 5 and the cathode 3 of the oscillator so as to change the amplitude of the current flowing through the tube 1.

As has been shown, the modulated oscillator system is preferably operated as a so-called "scanning head" for use with facsimile apparatus, meaning that a self-contained unit is mounted adjacent the facsimile record carrier to serve as a combined light translating, amplifying, tone generation and modulating element. According to one suitable form which the invention may assume, the record carrying drum 59, upon which any suitable form of record of which an image is to be produced at one or more separated or remote points is mounted, is so arranged that the record subject carried thereon is subjected to light of constant intensity issuing from a source 61.

The light from source 61 is focussed at a point 63 on the record surface by means of an optical system, conventionally represented by a lens 65. For an indirect transmission such as is suitable for most types of picture transmission or television work, light is reflected from the record subject in varying intensities depending, of course, upon the intensity of light and shadow of successive elemental areas of the record carried upon the record carrier 59 and this light may then be focussed upon the light sensitive photo tube 47 by means of an optical system conventionally shown as a lens 67.

In order to regulate the amount of light which reaches the photo tube 47 a suitable diaphragm 69 is preferably provided. This diaphragm may be adjustable in two directions, that is, both vertically and horizontally, although only the horizontal adjustment has been illustrated herein, or, where desired, the usual form of iris, such as is used on most photographic apparatus for adjusting the aperture, may be provided. In the former case, with the arrangement herein shown, the light as reflected from the record surface may pass through a square or rectangular opening of predetermined size to the photoelectric tube, or in the second case, the opening through which the light is passed to the photo tube may be substantially circular, but by adjustments of varying diameter. Thus, in accordance with the varying tonal densities of successive elemental areas of the

record carried upon the record carrier 59 the current flow through the photo tube 47 is varied continuously so as to produce varying voltage drops across the resistor 55 so as to produce varying potentials upon the grid or control electrode 5 of the tube 1. This, it can be seen, will change the amount of current flowing through the tube, as above stated, and the amount of variation with the system herein shown is, of course, directly proportional to the tonal densities of the successive elemental areas of the record subjected to illumination from the source 61.

Since the values of inductance and capacity in the oscillation tank circuit 41 are not changing during operation, being preferably adjustable only by the actual operation to determine the frequency desired, the frequency of the oscillations generated by the oscillation generator and its associated circuit remains constant, but due to the changes in potential on the grid electrode 5 of the tube 1 the amplitude of the generated oscillations fluctuates in accordance with the variations in light and shadow reaching the photo tube 47 and consequently the generated oscillations may be modulated as to their amplitude by illuminating the photo tube 47 with varying amounts of light.

According to the method shown there may be increased amplitude of the generated oscillations for high intensity illumination upon the photo tube but by reversing the photo tube connections the reverse may take place and the amplitude of the generated oscillations may be decreased for high light values, it, of course, being immaterial which form is used and thus merely a matter of choice of connections.

If, now, it is desired to increase the stability of operation of the system hereinabove disclosed, the suppressor grid 9 contained within the tube 1 may be connected to a point on the cathode 3. This connection with ordinary tubes is usually made internally of the tube, although, of course, it is obvious that an external connection may be made where desired. The function of the suppressor grid 9 of the tube herein disclosed is to suppress secondary electron emission from the plate or anode electrode 11 so as to give greater stability of operation than would be obtained with the ordinary four electrode tube since when the oscillating potentials are such that the instantaneous anode voltage falls below that of the screen grid 7 secondary electron emission would normally take place. This secondary emission would normally tend to reverse the direction of plate current. Such reversals of current cause distortion in the pure sign wave characteristic of the generated oscillations appearing in the tank circuit 41 and give rise to a considerable number of harmonics. If, however, the suppressor grid 9 is connected with the cathode element 3 the pure sign wave characteristic of the oscillator is maintained and, concurrently therewith, the output current is correspondingly increased. This increase of output current, while maintaining the pure sign wave characteristic of the generated oscillations, increases fidelity of operation which naturally adapts itself ideally to facsimile transmission, where distortion would tend to detract from the quality of transmission, as well as the clearness and sharpness of the reproduced image.

If reference is now made to Figure 2 it will be seen that the circuit arrangement is substantially identical to that shown by Figure 1, except that the oscillator tube 1 is not of the hot cathode type but is a cold cathode tube wherein the electron stream flowing toward the positive electrodes is

emitted from a cathode element 2 which may, for example, be a photoelectric cathode illuminated continuously with light of constant intensity.

In the modification suggested by this figure the record carried upon the record carrier 59 is illuminated in the same manner as was shown by Figure 1 and, in addition, a part of the light issuing from the source 61 of constant intensity is directed by means of a reflecting body 69, or the equivalent, so as to follow a path 71 directly to the light sensitive cathode 2 of the tube 1. Due to the constant illumination of the light sensitive cold electrode 2 contained within the tube 1 of Figure 2 an electron stream of predetermined density, dependent upon the intensity of the light beam 71, is continuously emitted. This stream of electrons flows toward the tube anode and with this modification over the heated cathode the system operates substantially identically to that shown by Figure 1.

The invention has been shown as applying to only two forms of vacuum tubes and associated circuits and, also, as applying only to a type of oscillator circuit of the general form disclosed by Hartley, but it, of course, is apparent that many modifications and changes may be made so that the invention may be applicable to the general characteristics of other circuits and to other general types of oscillators such as have been shown by Colpitts and others.

While the invention has also been illustrated as applying principally to systems wherein light is used as the means by which the generated oscillations are modulated as to amplitude, it is, of course, apparent that the system would also function for voice transmission or for telegraphic operation and in such systems any well known type of microphone or keying instrumentality might be substituted for the photo tube 47.

It is therefore believed that the invention should be construed in a broad sense and not limited to the specific form in which it has been shown, and we believe, therefore, that we are entitled to make and use all modifications of the invention which fall fairly within the spirit and scope of the invention as defined by the herein-after appended claims.

Having now described our invention, what we claim and desire to secure by Letters Patent is the following:

1. In a signalling system a vacuum tube containing a plurality of cold electrodes and one hot electrode, a series oscillating circuit connected across two of said cold electrodes, a connection between said hot electrode and a point on said oscillating circuit intermediate the points of connection to said cold electrodes so that upon application of suitable voltages electrical oscillations of predetermined frequency are generated, a source of signalling energy, means for impressing potentials representative of said signalling energy upon a cold electrode of said tube other than the electrodes above-named so that said generated oscillations are amplitude modulated by said signals, a cold electrode in addition to the cold electrodes above-named connected to the hot electrodes above-named connected to the hot elec-

trode to prevent secondary electron emission from the anode electrode, and a load circuit for utilizing said amplitude modulated generated frequencies.

2. A signalling system comprising a multi-electrode vacuum tube, an oscillation circuit operatively associated with the anode, cathode and one grid electrode of said tube so that oscillations are generated in said oscillation circuit, a connection between the cathode and a point on the oscillatory circuit intermediate the point of connection of the grid and anode electrodes, a source of signalling impulses connected with a second grid electrode of said tube for changing the amplitude of the oscillations in said oscillatory circuit by amounts proportionate to the intensity of said signals without altering the frequency of the generated oscillations, and a suppressor grid means contained within the said tube for suppressing secondary electronic emission originating at the anode so as to increase the stability of operation.

3. A modulated oscillator comprising an oscillation circuit, a signal energy source, a load circuit, and a multi-electrode vacuum tube, means for maintaining the cold electrodes of the tube at predetermined voltages relative to the cathode circuit connections between said oscillation circuit and two cold electrodes and one hot electrode of said tube whereby oscillations of predetermined frequency are generated and appear in said oscillation circuit, and circuit connections between said signal energy source, a controlled cold electrode contained within said tube for varying the amplitude of the said generated oscillations without changing the frequency of oscillation by amounts proportionate to the intensity of the signal supplied, and a suppressor grid means contained within said tube for increasing the stability of operation by the suppression of secondary electron emission within the said tube from the high voltage cold electrode.

4. In a signalling system, a vacuum tube containing a cold cathode and a plurality of additional cold electrodes, a series oscillating circuit connected across two of said cold electrodes, a connection between the said cold cathode and a point on said oscillatory circuit intermediate the points of connection to said first-named cold electrodes so that upon application of suitable voltages electrical oscillations of predetermined frequency are generated, a source of signalling energy, means for impressing potentials representative of said signalling energy upon a cold electrode of said tube other than the electrodes above-named so that said generated oscillations are amplitude modulated by said signals, a cold electrode in addition to the cold electrodes above-named, said last named cold electrode being connected to the cold cathode to suppress secondary electron emission from the anode electrode, and a load circuit for utilizing said amplitude modulated generated frequencies.

JAMES N. WHITAKER.  
HENRY SHORE.