Feb. 7, 1933. R. S. OHL 1,896,785

MODULATING DEVICE

Filed July 1, 1931

FIG. 1

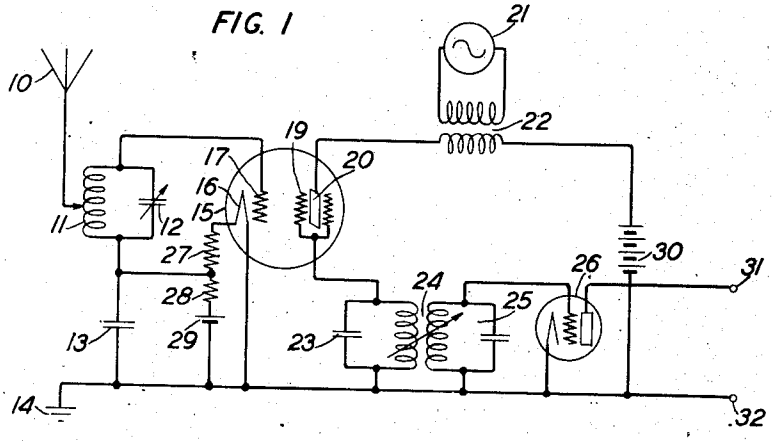
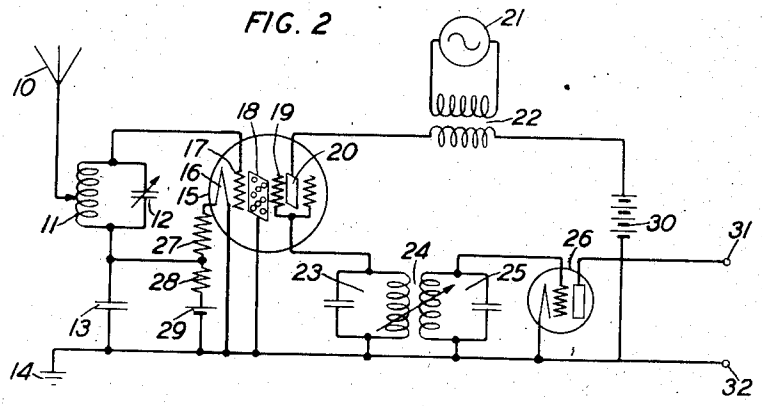


FIG. 2



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UNITED STATES PATENT OFFICE

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MODULATING DEVICE

Application filed July 1, 1931. Serial No. 548,079.

This invention relates to heterodyne detectors and modulators of the space discharge type and more particularly to detector arrangements for use in systems where strong heterodyne currents are combined with weak incoming signal currents, or where the heterodyne frequency is relatively close to the frequency of the incoming signals.

In heterodyne detectors currents of three different frequencies are usually involved. These currents represent respectively the incoming signal, the heterodyne oscillation and the detected output or beat frequency current. It is important to be able to adjust the circuits of the detector to control the amplitude of each current without disturbing or changing the amplitude of either of the other currents in so doing. This necessitates separate circuits for each frequency which are substantially independent of each other, that is, circuits which have no mutual reactions.

In accordance with the invention a space discharge device is provided having a cathode and anode, a control electrode, a screen grid, and in some cases an additional shielding electrode. When the space discharge device is used as a heterodyne detector, the incoming signals are impressed upon the control electrode. The local oscillator is connected to the anode and the beat frequency or detector current output is taken from the screen grid. The screen grid performs its usual function as a shield or screen between the anode and the control electrode as in the various forms of radio frequency amplifiers employing the so called screen grid tubes, and in addition, the screen grid serves as an auxilary anode to which is connected a load circuit for the output current. Where additional shielding is required between the anode and the control grid, a perforated screen or shield may be inserted between the control grid and the screen grid and this screen or shield is connected directly to the cathode.

The invention will be fully understood from the following specification and the accompanying drawing in which:

Fig. 1 shows a portion of a radio receiving system employing the invention; and

Fig. 2 shows a similar system in which an auxiliary shielding electrode has been inserted.

Referring to Fig. 1, 15 is a space discharge detector having a cathode 16, a control electrode 17, a screen grid 19, and an anode 20. A local source 21 of continuous oscillations is coupled through a transformer 22 to the anode 20. The screen grid 19 is grounded through a circuit 23 which is resonant to the frequency of the detected output currents originating in the space discharge device 15. The tuned circuit 23 is coupled by means of an adjustable coupling transformer 24 with a similar tuned circuit 25 which latter circuit is connected with a space discharge device 26 which may be an amplifier. The control grid 17 is connected with an antenna 10 through a tuned circuit comprising an inductance 11 and a variable condenser 12. The tuned circuit 11, 12 is connected through a fixed condenser 13 to ground 14. The cathode 16 is directly grounded at one end and is connected to ground at the other end through resistances 27 and 28 and a filament heating battery 29. A suitable grid biasing potential is supplied by the fall of potential in resistance 27 due to the filament heating current passing therethrough. The anode 20 is connected to ground through the primary winding of the transformer 22 and a space current supply battery 30. The output circuit of space discharge device 26 is connected to any suitable load circuit through a pair of terminals 31 and 32.

In the operation of the system of Fig 1, incoming signals are received upon the antenna 10 and are impressed by means of the tuned circuit 11, 12 upon the control grid 17. Heterodyning oscillations are impressed upon the anode by the local source or generator 21 acting through the transformer 22. By the well known modulating or detecting action of the space discharge device 15, combination currents are produced, the most commonly used of which have a frequency determined by the difference between the frequencies of the incoming signals and of the local oscillations. Output currents of the difference frequency are selectively received

in the tuned circuits 23 and 25 and impressed upon the space discharge device 26. The tuned circuit 23 offers a large impedance for the difference frequency, causing currents of that frequency to be efficiently transmitted through the coupling device 24 to the tuned circuit 25 and the space discharge device 26. The impedance of the circuit 23 for the heterodyne frequency of the generator 21 is relatively very small. Because of this small impedance the screen grid 19 is effectively grounded at the heterodyne frequency through the circuit 23 with the result that the screen grid 19 serves to screen the anode 20 from the control grid 17 in the same manner as the screen grid in a radio frequency amplifier employing a screen grid tube. Due to the screening which is provided, the local oscillations, which may be very strong, are effectively prevented from being impressed upon the control grid circuit together with the relatively weak incoming signal. The screening arrangement takes the place of elaborate neutralizing and balancing arrangements heretofore employed for separating the circuits of the incoming signal and heterodyne oscillators.

When the incoming signal and the local oscillators have frequencies which are relatively high and close together any coupling of the several tuned circuits with one another such as that due to electrostatic capacity between the detector electrodes tends to make the adjustment of one circuit affect the adjustment of the others. Such interaction of the circuits is diminished by the isolation afforded by the use of separate electrodes and by the screening effect of screen grid 19 and may be practically completely eliminated. Due to the absence of reaction, the local source 21 may be adjusted in frequency and amplitude without disturbing the tuning of circuit 11, 12 and the circuit 11, 12 may be tuned without affecting either the frequency or amplitude of the oscillations generated by local source 21.

The system of Fig. 2 differs from that of Fig. 1 in the addition of an auxiliary shielding element. This shielding element comprises a perforated or woven shield 18 inserted between the control grid 17 and the screen grid 19. The shield 18 is directly connected to ground 14.

The operation of the system of Fig. 2 is similar to that of Fig. 1 The presence of the additional screen or shield 18 increases the shielding effect between the control grid 17 and the anode 20. The shield 18 also serves to screen the control grid 17 from the screen grid 19, preventing reaction between the respective tuned circuits 11, 12 and 23, 24, 25.

While in a detecting system the frequency of the output current is considerably below the frequency of the input current in the usual case, the invention may equally well be applied to a modulating device in which the output frequency is higher than the input frequency. The advantages of the arrangement disclosed are not solely dependent upon the particular selection of input and output frequencies employed.

What is claimed is:

1. A modulating system comprising a space discharge device having a cathode, an anode, a control grid, and a screen grid positioned between said anode and said control grid, two sources of currents to be combined, means for connecting one of said sources to said control grid and to said cathode, means for connecting the other of said sources to said anode and to said cathode, and means connected to said screen grid and to said cathode for utilizing combination currents generated in said space discharge device.

2. A modulating system comprising a space discharge device having a cathode, an anode, a control electrode, and a shield electrode positioned between said anode and said control electrode, two sources of currents to be combined, means for connecting one of said sources to said control electrode and to said cathode, means for connecting the other of said sources to said anode and to said cathode, and means connected to said shield electrode and to said cathode for utilizing combination currents generated in said space discharge device.

3. A modulating system comprising a space discharge device having a cathode, an anode, a control grid, and a screen grid positioned between said anode and said control grid, three branch circuits connected to said cathode, each of said circuits being connected to a different one of the remaining electrodes, a source of incoming signal current connected in the branch circuit leading to said control grid, a second source of alternating current in the branch circuit leading to the anode, and means associated with the branch circuit leading to the screen grid for utilizing combination currents.

4. A modulating system comprising a space discharge device having a cathode, an anode, a control grid, and a screen grid positioned between said anode and said control grid, a separate circuit from said cathode to each of said other electrodes, sources of impressed waves in two of said circuits, one of said sources being connected to said control grid and the other source being connected to the anode, and means associated with the screen grid circuit for utilizing output current.

5. A heterodyne detector comprising a space discharge device having a cathode an anode, a control grid and a screen grid for shielding said control grid from said anode, a source of waves to be detected, means for impressing waves from said source upon said

space discharge device through said control grid, a source of oscillations to be combined with said waves, said source of oscillations being connected to said discharge device through the anode, and a load circuit for utilizing combination currents connected to said space discharge device through said screen grid, said load circuit being tuned to discriminate between said oscillation and said combination currents.

6. A heterodyne detector comprising a space discharge device having a cathode, an anode, a control grid and screen grid for shielding said control grid from said anode, a source of waves to be detected, means for impressing waves from said source on said space discharge device through control grid, a source of oscillations of slightly different frequency from said waves to be detected, said source being connected to said space discharge device through the anode, a load circuit connected between said screen grid and the cathode for utilizing combination currents of relatively low frequency, said load circuit being antiresonant at the frequency of said combination currents, whereby the impedance of said load circuit is made negligible at the frequency of said oscillations and said screen grid effectively prevents interaction between said source of waves and said source of oscillations.

In witness whereof, I hereunto subscribe my name this 30th day of June, 1931.

RUSSELL S. OHL.