July 11, 1933. B. F. MIESSNER 1,917,728

DISCHARGE TUBE CATHODE ENERGIZING

Filed March 30, 1928

Fig. 1.

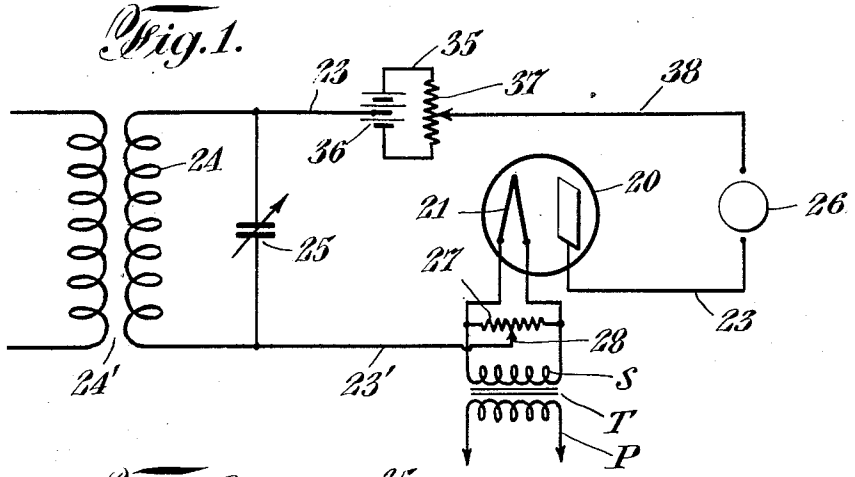
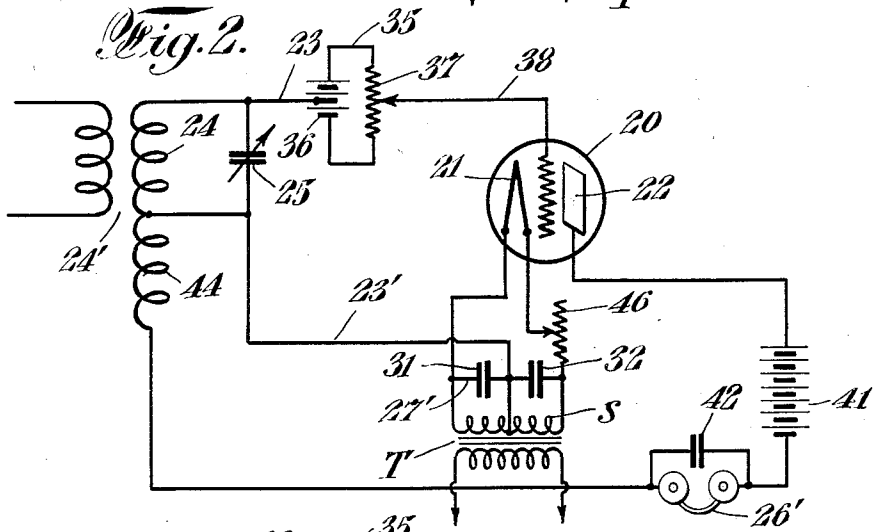



Fig. 2.



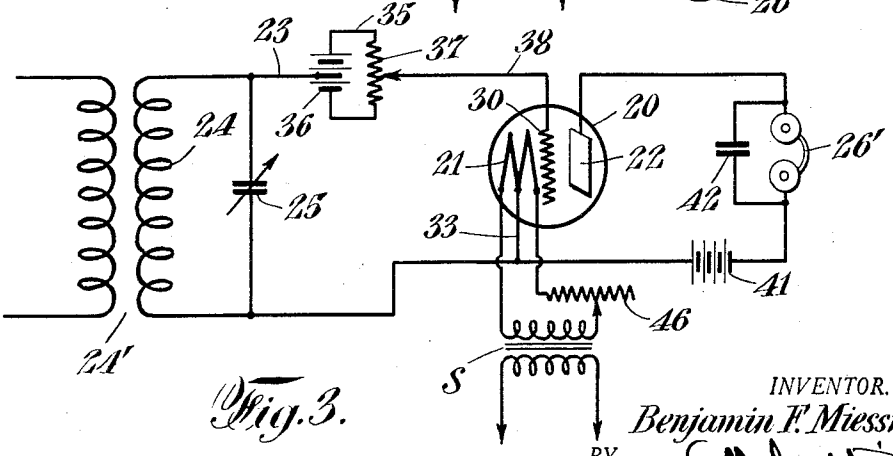




Fig. 3.

INVENTOR.
Benjamin F. Miessner
BY
ATTORNEY.

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# UNITED STATES PATENT OFFICE

BENJAMIN F. MIESSNER, OF SHORT HILLS, NEW JERSEY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO RADIO CORPORATION OF AMERICA, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

## DISCHARGE TUBE CATHODE ENERGIZING

Application filed March 30, 1928. Serial No. 265,922.

The present application is a substitute for a portion of my copending application Serial No. 30,163, filed May 14, 1925, which in turn is a substitute for a portion of my original application Serial No. 578,079, filed July 28, 1922.

The present invention, disclosed in both of the above referred to applications, relates generally to energizing the cathode or filament of vacuum and like discharge tubes with alternating current when such tubes are used in amplifying and detecting systems, and includes in particular so arranging and connecting the tubes in circuits as to permit them to act effectively as amplifiers or detectors while avoiding in large measure hum effects of the alternating current.

Another particular object is to energize the cathode of a tube with alternating current, and to so connect and further energize the tube that it can be used in connection with an element responsive to audible frequency currents to effectively detect high frequency currents modulated at audible frequency while avoiding in large measure audible hum effects from the alternating current.

Other objects of my invention will appear as this description progresses, reference being had to the accompanying drawing, in which

Figure 1 is a more or less diagrammatic illustration of a circuit and apparatus embodying my invention; and

Figures 2 and 3 are similar figures showing different forms of my invention.

Prior to my invention as disclosed in the above figures it was the general practice in the use of electron discharge apparatus comprising a heated cathode and an anode, and, in some instances, an auxiliary electrode usually designated a grid, to heat the cathode by direct current of substantially constant potential, as from a battery or direct current generator. In general the connections of the circuits to the cathode have been made at one side or the other of the cathode heating circuit with the result that all parts of the cathode or filament have not had the same potential with respect to the anode or grid, the difference being as much as the total heating current potential impressed upon the cathode or filament. Where steady direct current is employed for heating this difference of potential is constant and does not produce any periodic current variations in the circuits connected to the cathode.

It is convenient in many cases to employ alternating current for cathode energizing, but when so energized connections of the anode or grid to one side of the heating current circuit produce periodic current and potential variations in the anode or grid circuits which variations can be intercepted in translating devices as troublesome hum.

For example, if a vacuum tube system is used for amplifying or rectifying weak high frequency signaling currents, as in radio, the effect of employing an alternating current for heating the cathode will be to set up periodic current and potential variations in the circuits of the system when the usual circuit connections to the filament heating system are used, the frequency of which variations is equal to the frequency of the heating current in cycles per second. If the tube is an amplifier these variations may be amplified. The responsive devices usually employed in radio signaling, such as telephones, are highly responsive in the frequency range usual to commercial alternating current supply systems, with the result that hum effects will be produced which may be undesirable, or seriously interfere with signaling.

In the embodiment of my invention illustrated in Figures 1, 2 and 3, I provide a source of alternating current for heating the filamentary cathodes of the tubes shown, but I so connect the plate and grid circuits of the electron discharge apparatus with the filament system as to prevent the production of pulsations in the circuits of these electrodes which would otherwise result from the use of alternating current for heating the cathode, and use potentials independent of the heating circuit potentials for energizing the plate and grid electrode for desired operation as detector or amplifier or both.

In Figure 1, I disclose an electron dis-

charge device comprising an evacuated receptacle 20 in which are mounted the filamentary cathode 21 and a plate anode 22, this apparatus being of well-known construction and designed to rectify the alternating currents flowing in the circuit 23 which is illustrated as comprising the winding 24 and the variable capacity 25. The device 26 in the anode circuit indicates any responsive device requiring direct current for its operation, as a telepone. When the circuit is utilized for radio reception the winding 24 may constitute the secondary winding of a transformer or coupling element 24′ for coupling the circuit to an antenna circuit, or for interstage coupling for coupling the circuit to a preceding stage. Included in the circuit 23 may be a source of current 35 for placing a bias on the plate or grid as the case may be. This comprises a battery 36 bridged by a potentiometer 37. The circuit wire 23 connects to the center of the battery 36 and the wire 38 leading to the device 26 may be connected through a shiftable contact to any desired point along the potentiometer 37 for obtaining either a positive or negative bias, thus determining the mode of operation of the tube.

For heating the cathode 21 I provide a source of alternating current comprising a transformer T having the primary winding P and the secondary winding S. This transformer will usually be of the step-down variety to enable the filament 21 to be heated from the usual house circuits. Shunting the terminals of both the secondary winding and the cathode is a resistance 27 which should be of such value as to assure substantially all of the secondary output of the transformer being delivered to the cathode. The resistance 27 is preferably provided with a sliding contact 28 which is connected with one terminal 23′ of the alternating current circuit 23, the other terminal 23″ of this circuit being connected with the terminal of the plate or anode 22.

In describing the mode of operation of my improved apparatus it is assumed that the cathode 21 requires a potential of six volts for properly heating it. This explanation may be more readily understood if it is assumed that at any one instant one terminal of the transformer and the corresponding terminal of the filament has a potential of plus three volts and at the same instant the opposite terminal has a potential of minus three volts. This means that the center point of the secondary winding,—that is, its electrical center—and the electrical center of the filament will be at zero potential. Necessarily, the electrical center of the shunt resistance 27 will also be at zero potential while the potential of its ends will be equal to the potentials of the corresponding terminals of the secondary winding and the filament (disregarding drops in potential due to the resistance of the connecting leads).

By taking the connection for the circuit 23 from the electrical center of the balancing resistance 27, where the potential variations are substantially nil, the periodic variations of the alternating current is eliminated from the circuit 23, leaving only the steady potential of battery 36 for energizing the anode in the right way to produce the best rectifying effect for detection. By virtue of the adjustability of the slidable contact 28 along this resistance 27, the adjustment for best results can be easily and quickly obtained. Attention is also directed to the fact that the resistance 27 has substantially no reactance to high frequencies traversing the circuit 23. It thus offers no disturbing impedance or reactance to radio frequencies, which are generally very high, and enable my invention to be utilized for radio frequency amplification.

In Figure 2 I have illustrated a different embodiment of my invention in connection with a simple circuit which may be used for producing high frequency electrical oscillation, as in heterodyne reception, in which use is made of the grid 30 interposed between the cathode and the plate or anode, in the usual manner. In this form of my invention the same arrangement of balancing resistance 27 and central tap 28 may be employed, but for the purpose of illustrating an alternative arrangement I have shown the secondary S as being shorted by a shunt 27′, which comprises two condensers 31 and 32 which are connected in series, one terminal 23′ of the high frequency circuit being connected with the shunt 27′ at a point intermediate the condensers 31 and 32, which point will have the same potential as the electrical centers of the secondary winding and the filament, respectively. Conduction between the filament circuit and the outer circuit 23 occurs substantially the same as that shown in Figure 1, except the high frequency currents flowing in the circuit 23 pass to the filament by electro-static action rather than by direct conduction, as in Figure 1. As described of the resistance 27, the condenser shunt 27′ will interpose substantially no reactance to high frequencies.

In the plate circuit of this embodiment is included a battery 41 and reproducing means 26′, such as a loud speaker or usual telephone head set. A condenser 42 may be shunted across this reproducing means. In producing the electrical oscillations in this circuit, as for heterodyne reception, I make use of a tickler coil 44 inductively related to the winding 24, and operating in conjunction with the tube to perform a regenerating function. This tickler coil also serves to amplify the currents passed through the tube. The coil

24 may be inductively coupled to an antenna circuit or through interstage coupling to a preceding stage, as I have before described. A rheostat 46 may be interposed in the filament circuit. As described in connection with Fig. 1, the battery 36 and potentiometer 37 permit of energizing the electrode to which connected, in this case the grid, independently of the filament heating circuit for desired operation of the tube, as for amplification, detection, or both.

In the construction shown in Figure 3, which illustrates a simple radio receiving circuit, current is supplied to the cathode 21 by the secondary winding S of the transformer, just as in the preceding arrangement, but in this construction the cathode is provided with a third external terminal 33 which connects with the center of the filamentary cathode and the alternating current or high frequency current circuit 23. The theory of operation of this circuit is analogous to that of the preceding circuits and further explanation thereof appears to be unnecessary.

I do not intend to be limited to the particular details and circuit connections herein described, as it will be evident that the broad features of my invention can be practiced by other apparatus and other circuit connections than those specifically shown.

I claim:

1. In a system for receiving high frequency electrical signals modulated at audible frequency including means for amplifying said signals, means for detecting said signals including a three electrode vacuum tube and a device responsive to audible frequency current components associated with the output circuit of said tube, means for energizing the filament of said tube with alternating current energy, means for connecting a high frequency input circuit to the grid electrode and filament system of said tube so as to be substantially independent of the alternating current potentials employed for energizing said filament, and independent means for energizing the grid electrode of said tube for operation as a rectifier, whereby disturbing hum production in said audible frequency responsive device is materially avoided.

2. In a system for receiving high frequency electrical signals modulated at audible frequency including a three electrode vacuum tube having a heated cathode, means responsive to audible frequency current components associated with the output circuit of said tube, means for heating the cathode of said tube with alternating current energy, a high frequency signal receiving circuit connected between said heated cathode and the grid electrode of said tube so as to be substantially independent of the alternating current potentials employed in the heating of said cathode, and independent means for energizing said grid electrode with respect to said cathode to produce desired operation of said tube, whereby disturbing hum production in said means responsive to audible frequency currents is materially avoided.

3. In a system for receiving high frequency electrical signals modulated at audible frequency including a three electrode vacuum tube having a heated cathode, means responsive to audible frequency current components associated with the output circuit of said tube, means for heating the cathode of said tube with alternating current energy, a high frequency signal receiving circuit connected between the cathode heating system and the grid electrode of said tube so as to be substantially independent of the alternating current potentials employed in the heating of said cathode, and independent means for energizing said grid electrode with respect to said cathode for causing said tube to make the received modulated high frequency signal energy effective on said responsive means.

4. In a system for receiving high frequency electrical signals modulated at audible frequency, the combination of a three electrode vacuum tube having a hot cathode, a system for heating said cathode with alternating current energy, a high frequency signal receiving circuit connected between the cathode heating system and grid electrode of said tube so as to be substantially independent of the alternating current potentials employed in the heating of said cathode, an output circuit connected between the plate electrode of said tube and said cathode heating system so as to be substantially independent of the alternating current potentials employed in the heating of said cathode, means responsive to audible frequency current components associated with said output circuit, and independent means in both of said circuits for energizing the grid and plate electrodes of said tube to cause it to function as an efficient rectifier of the high frequency signal energy for action on said responsive means.

In witness whereof, I hereunto subscribe my name this 28th day of March 1928.

BENJAMIN F. MIESSNER.