March 9, 1937. G. J. KELLEY 2,072,953

CASCADED ELECTRON TUBE SYSTEM

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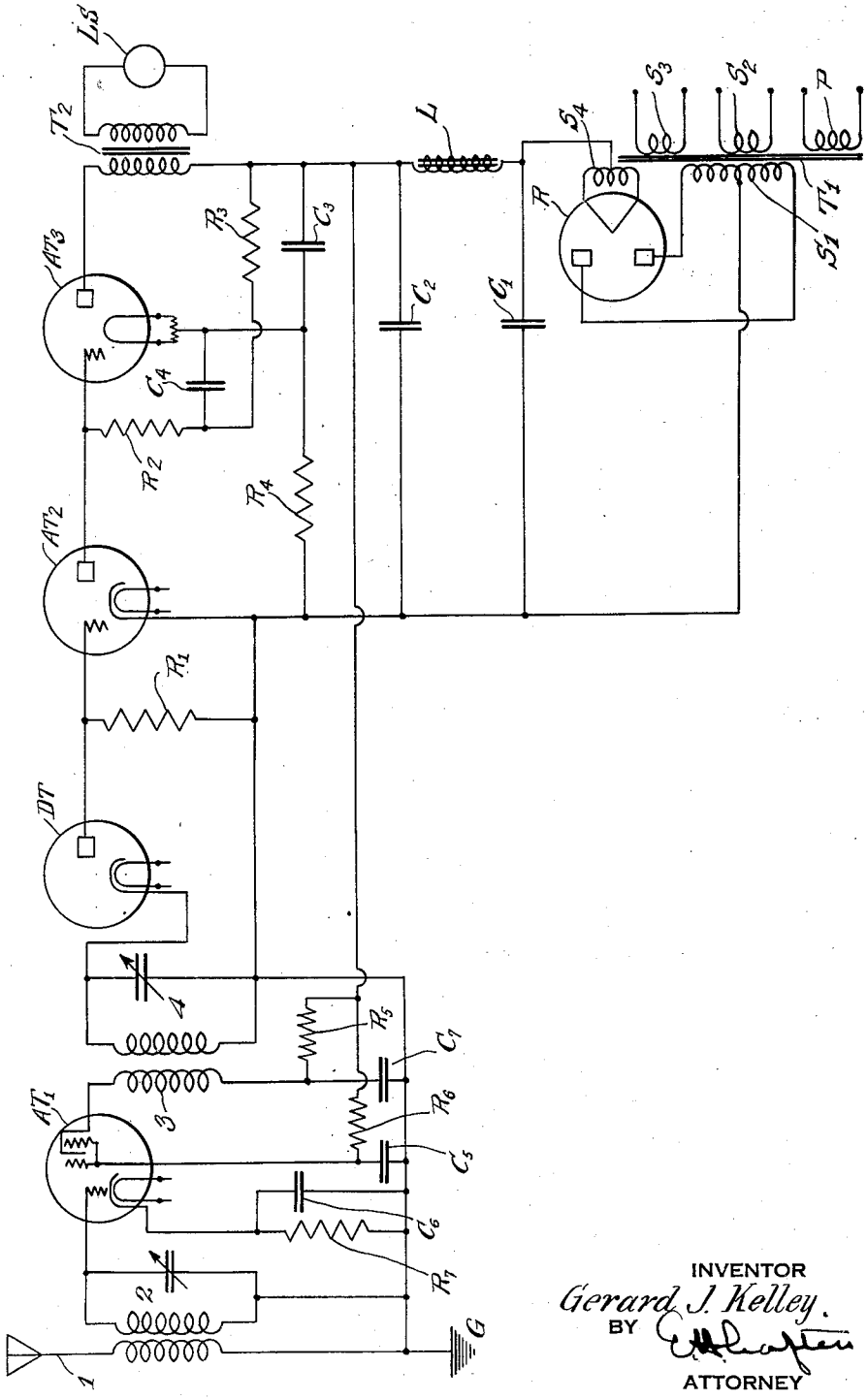


Fig. 1.

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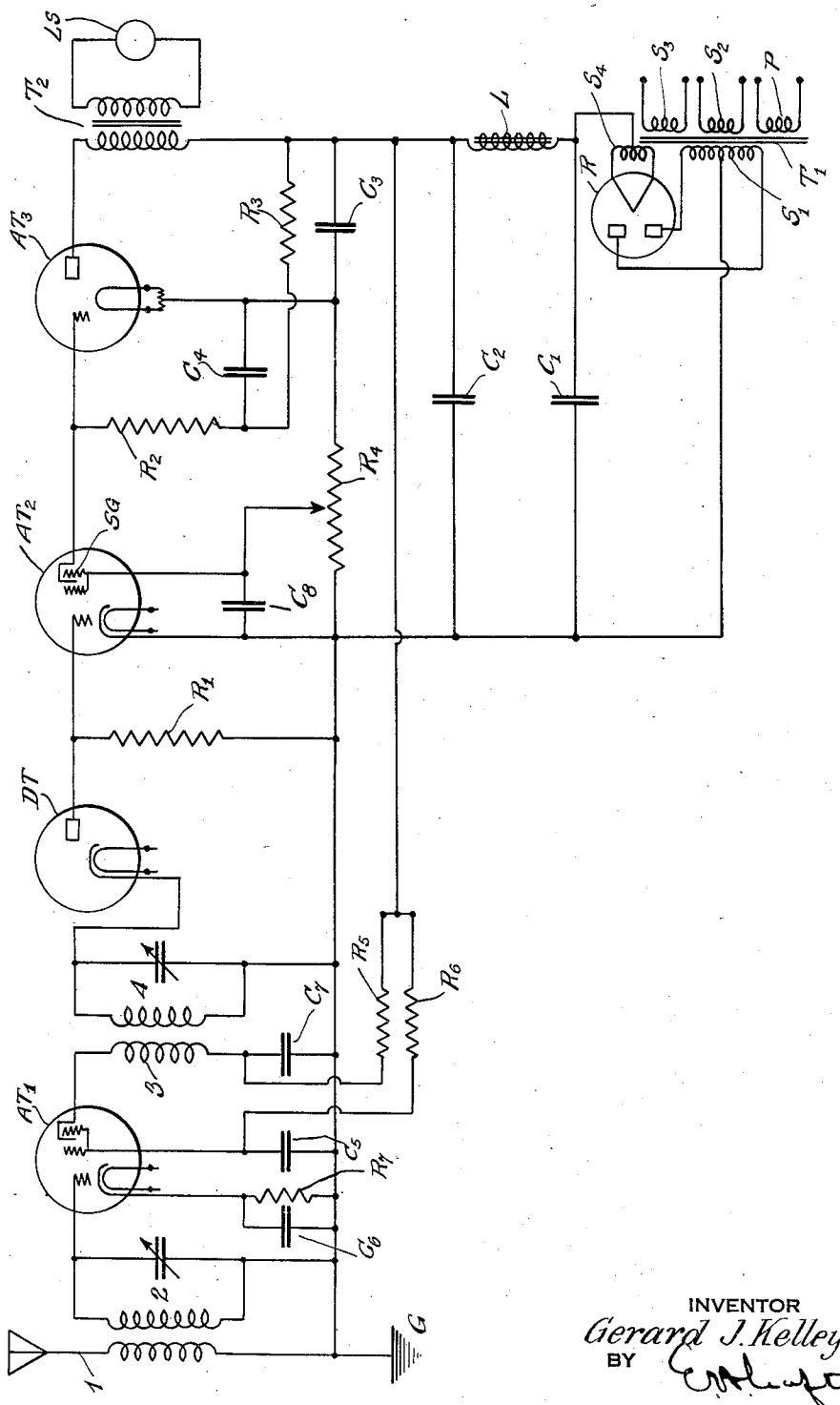


Fig. 2.

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CASCADED ELECTRON TUBE SYSTEM

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Application March 15, 1932, Serial No. 598,984

4 Claims. (Cl. 250—20)

My present invention relates broadly to cascaded electron tube systems, and more particularly to such systems adapted to repeat, amplify, detect and translate alternating electrical currents.

An object of my said invention is efficient and faithful functioning of the elements of the systems utilized by me towards accomplishing novel results. A particular object is to utilize effects produced from the signal alternating electrical currents after introduction of them into the system to contribute beneficially to the desired functioning of the system. Another object is to rectify modulated high frequency carrier currents for usual detection purposes, and to additionally utilize the direct current component of the rectified currents for developing a useable biasing potential for effecting in a helpful way the operation of succeeding elements in the system.

Further objects and the features of my said invention will be appreciated from the following description based upon the two figures of the accompanying drawings in which like reference characters represent like parts so far as practicable.

Fig. 1 diagrammatically illustrates the features of my invention usefully embodied in a radio receiver.

Fig. 2 is the system of Fig. 1 modified to include a special control feature.

Referring to Fig. 1, the element 1 is an antenna coupled to a screen-grid type of electron tube AT_1 through a tunable circuit 2, the output of which tube includes a primary coil 3 coupled to a second tunable circuit 4, thus constituting a tunable radio frequency amplifier of form usual in the radio receiving art.

I show connected across tunable circuit 4 an alternating current rectifying device DT of any suitable form, a two-electrode tube having heated cathode and associated anode being illustrated. In series with the rectifier I insert a resistance R_1, and across this resistance I connect the input electrodes of a multiple electrode tube AT_2, shown for example as a usual three electrode tube, preferably connected and energized to amplify.

It is thus seen that alternating current impressed on series connected rectifier DT and resistance R_1 will develop across resistance R_1 a rectified or unidirectional potential which is impressed as a biasing potential on the grid of tube AT_2, the proportions of which potential depend upon the intensity of the impressed alternating current. This biasing results in direct current component of the output current of tube AT_2 varying responsively with the bias potential established on the grid of tube AT_2, and therefore with the intensity of the bias establishing incoming alternating current.

It is possible to amplifiedly extend this effect to make practical use of it. In my co-pending application Serial Number 451,562, filed May 12, 1930, Patent No. 1,954,779, April 10, 1934, I show various examples of so-called "direct-coupled" cascaded electron tube systems capable of relaying and amplifying direct current effects. I employ a like arrangement in Fig. 1 in connecting the grid of the output tube AT_3 directly to the plate of tube AT_2, and coupling the tubes for energy transfer therebetween by a high resistance R_2 as explained in my said co-pending application. This arrangement provides for the responsively variable direct current component of the output current of tube AT_2 developing in coupling resistance R_2 a responsively varying grid biasing potential for output tube AT_3 having its input electrodes connected thereacross, which effect thereby reaches the output circuit of this last tube in considerably amplified form, but in response accord with the intensity characteristics of the incoming signal currents. In other words, when the system is operating to receive incoming signals the average plate current of the output tube does not remain at the mid-point of the plate current characteristic curve, a condition striven for in prior electron tube amplifier systems, but drifts away from this point in proportion to the strength of the incoming signals.

In prior consideration of so-called "direct-coupled" electron tube systems, such as disclosed in copending application of S. Y. White, Serial Number 381,754, filed July 29, 1929, Patent No. 2,032,193, February 25, 1936, and my aforesaid co-pending application, it was considered undesirable to permit the rectification of the incoming signal current to sustainedly displace the direct current component of the plate current of the output circuit from the mid-point of the characteristic curve for fear of introducing early distortion in the power output ability of the output tube, so that it has been the practice to use so-called "stabilizers" to correctively overcome the effect.

I have now found that permitting the in-accord responsive displacement of the average of the space current of the output tube is not undesirable, but to the contrary is helpful and ben-

eficial to a system such as disclosed in Fig. 1. Instead of the undistorted power output ability of the output tube being decreased, as was previously contemplated, I find that permitting the displacement to take place increases the undistorted power output ability, I having accomplished as much as a 100 percent increase over normal in usual commercial types of amplifier output tubes, and with decidedly pleasing tonal effects. Since I have been unable to arrive at any satisfactory explanation of the physics involved in bringing about the results I have produced, I attempt no explanation in connection with this description.

When I use a high frequency tunable circuit for the input circuit 4 in advance of an electron emitting diode for the rectifier DT as shown, I prefer to connect the diode anode to the grid of the succeeding tube AT_2, as in this way I lessen the damping effect on the tunable circuit of grid current flow from tube AT_2.

The system of Fig. 1 is shown energized in conventional manner from a source of alternating current connected across primary P of transformer T_1. A rectifier R is supplied with alternating current by secondary winding S_1, the rectified current being filtered by the system comprising inductance L and condensers C_1 and C_2. Condenser C_3 is a signal current by-pass across the output circuit of output tube AT_3. T_3 is a transformer for transferring signal current to a translating device LS. R_3 is a potential reducing resistance in series with coupling resistance R_2 and the space current path of tube AT_2. Condenser C_4 is a signal current by-pass. R_4 is a potential developing resistance for the output circuit of tube AT_2. R_5 and R_6 are potential reducing resistances for the plate and screen-grid electrodes of tube AT_1, and condensers C_5 and C_7 are the usual filter and signal current by-pass condensers. Resistance R_7 shunted by condenser C_6 is the usual arrangement for developing a biasing potential for tube AT_1. The cathodes of tubes AT_1, DT, and AT_2 are shown as of the indirectly heated type, and the heaters of these tubes may be heated by current from any suitable source, such as secondary winding S_3 on transformer T_1. The cathode of tube AT_3 is shown to be of the filament type, and may be heated by current from any suitable source, such as secondary winding S_2. The filament of rectifier tube R is shown supplied with heating current from secondary S_4.

In Fig. 2 I use a tube at AT_2 of the screen-grid type having an electrode SG electrostatically shielding the anode from the control grid. I positively energize the screen-grid by a chosen connection to a potential point in resistance R_4, the connection being by-passed as is usual by a condenser C_8. Since resistance R_4 is in series with the discharge path of output tube AT_3, its degree of developed unidirectional potential therein depends upon the degree of direct current component of the current in the discharge path, as does the potential established on screen-grid electrode SG. The resulting variation of potential on screen-grid SG produces an effect opposing variation in the output current of tube AT_3, or tending to limitedly stabilize the effect. The arrangement of Fig. 2 provides for limiting the effect in the output circuit in a desired degree, thus facilitating designing a system properly coordinated throughout.

While I have described my invention around radio receiving systems, no limitations are intended thereby, the invention being of broad scope as set forth in the appended claims.

Having fully described my invention, I claim:

1. In an electrical signal current transmitting system, a screen-grid tube, means including a signal current rectifier determining the control grid biasing potential of said tube as a function of the intensity of said signal current, and means for impressing on the screen-grid of said tube amplified reflections of variations of said control grid biasing potentials.

2. In an electrical signal current transmitting system, a tunable input circuit for the signal currents, a current rectifier and resistance series related connected across said tunable circuit, a screen-grid tube having its control electrode and cathode conductively connected across difference of potential points in said resistance, a second resistance in the anode-cathode circuit of said tube, a multiple electrode tube having its control electrode and cathode connected across difference of potential points in said second resistance, a third resistance through which the anode-cathode current of said second tube flows, and a connection between the screen-grid of said first tube and a selected potential point in said third resistance.

3. In an electrical system for transmitting alternating signal currents, means for rectifying said currents, means in series with said rectifying means for effectively developing unidirectional potential from the rectified component of said currents, a multiple electrode tube having its input electrodes so connected to said unidirectional potential developing means that the resulting unidirectional potential impressed on the control electrode of said tube constitutes an effective operating biasing potential on said control electrode whose value is a function of the intensity of said signal currents, and means, including a second tube utilizing the resulting output currents of said tube, for determining the potential of a second electrode of said first tube.

4. In an electrical signal current transmitting system, the combination of a tunable signal circuit, a two-electrode tube having cathode and anode elements and an effective resistance in series therewith connected across said tunable circuit, whereby unidirectional potentials are effectively developed in said resistance by the currents from said circuit rectified by said tube, a multiple electrode tube having its input electrodes so connected to said resistance that the resulting unidirectional potential impressed on the control electrode of said second tube constitutes an effective operating biasing potential on said control electrode whose value is a function of said signal currents, a third tube for utilizing the resulting output currents of said second tube, and a direct current path between the third tube space current path and a cold electrode of the second-tube other than the control electrode and plate thereof.

GERARD J. KELLEY.