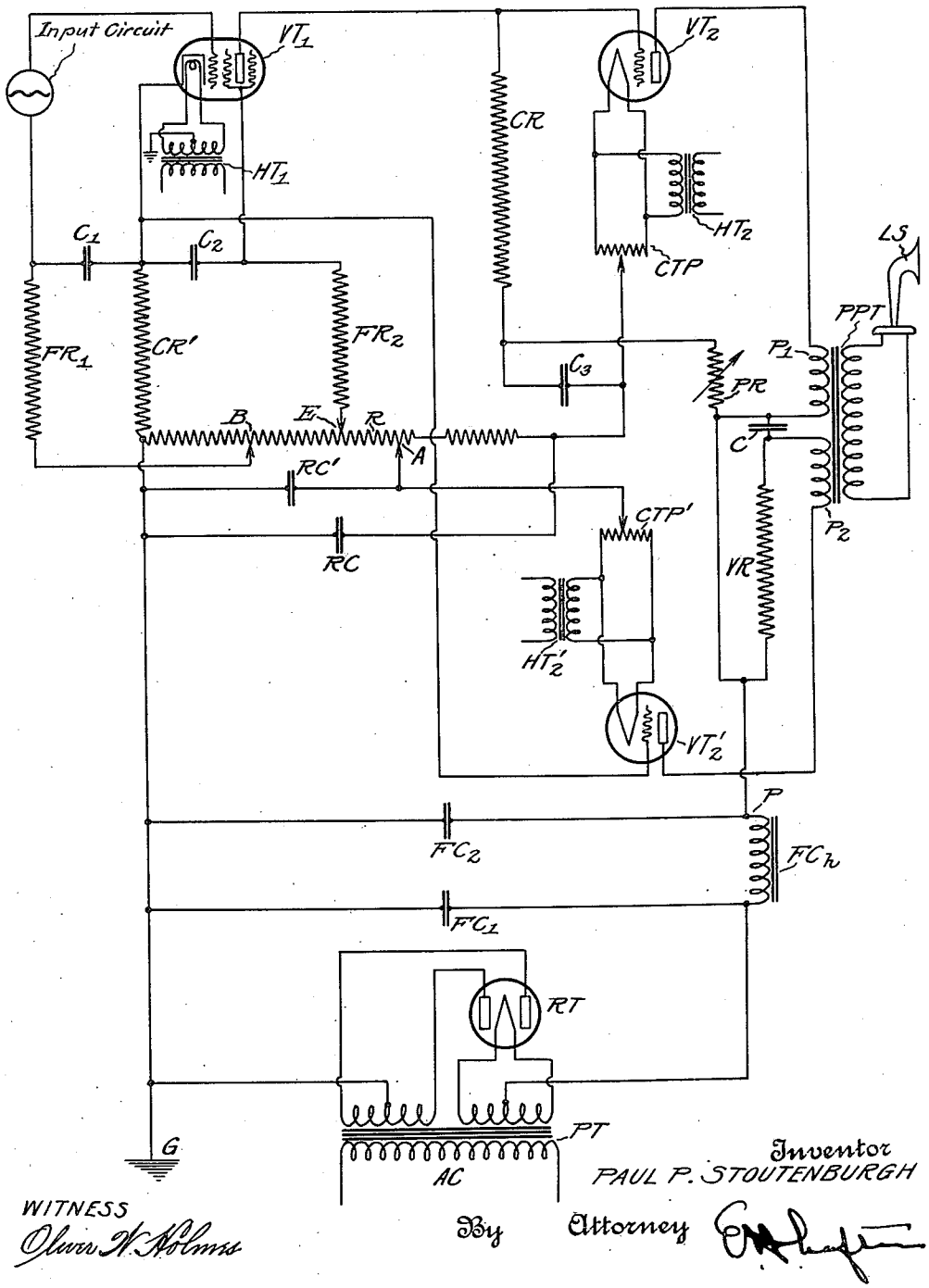
Sept. 1, 1936. P. P. STOUTENBURGH 2,052,730

DIRECT COUPLED TUBE SYSTEM

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Fig. 1.



WITNESS

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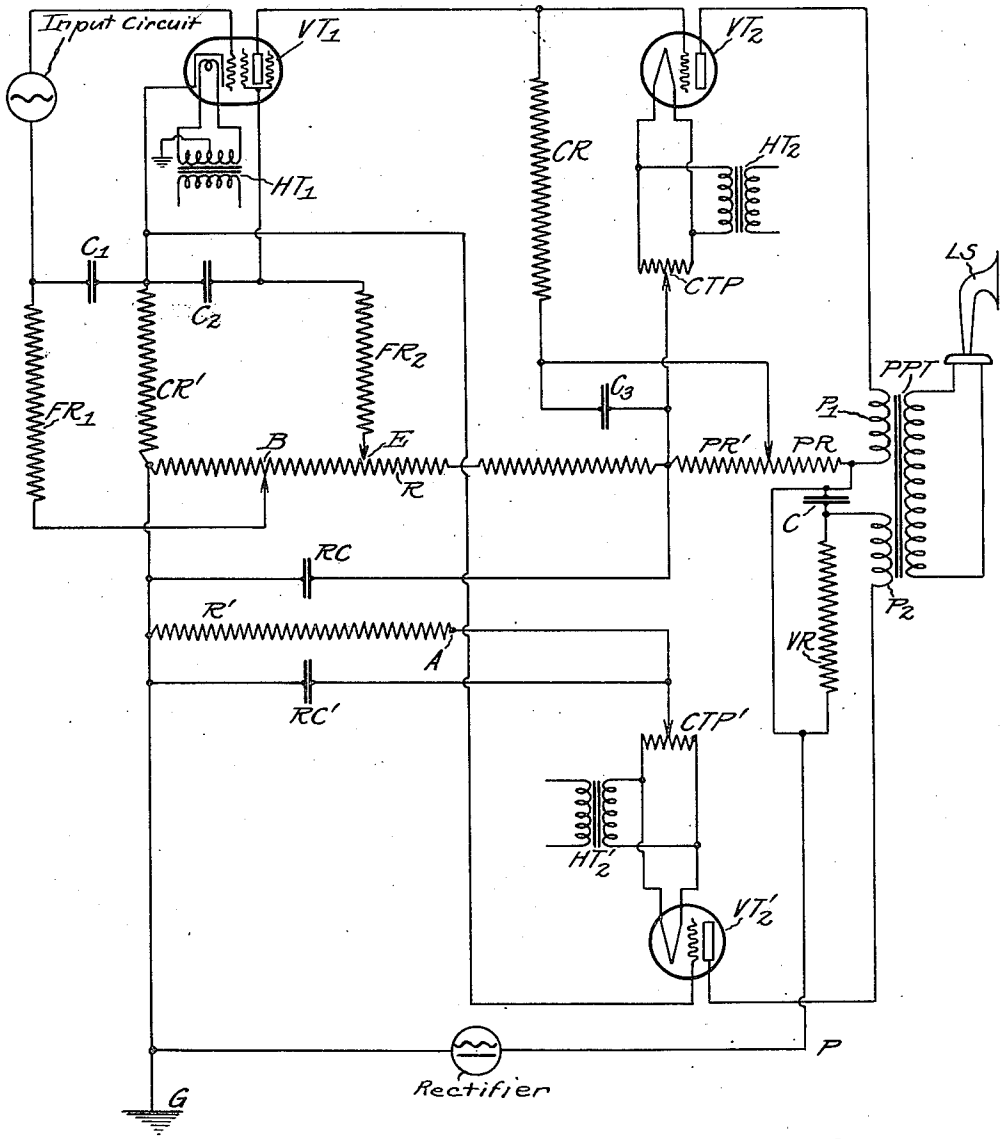
By Attorney

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Fig. 2.



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DIRECT COUPLED TUBE SYSTEM

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Application April 11, 1930, Serial No. 443,294

5 Claims. (Cl. 179—171)

My invention relates generally to direct coupled tube systems and more particularly to a push pull direct coupled tube system.

In previous attempts to employ the principles of direct coupling of tubes in cascade it has been deemed necessary to employ two completely stabilized direct coupled tube systems, each containing two or more tubes of like number, the two systems being coupled together in push-pull arrangement with push-pull input as well as push-pull output circuits.

It is the object of this invention to adapt the principles of direct coupling of tubes to two tubes connected in push-pull arrangement with respect to their output circuits and having their input circuit direct-coupled to the plate-to-cathode circuit of a single tube.

Another object of my invention is the stabilization of each of the push-pull tubes from potentials developed by the space current flow through the tube to which they are direct coupled.

Other objects of my invention will become apparent as the description thereof is developed with reference to the accompanying drawings in which Fig. 1 diagrammatically illustrates the circuit arrangement of my invention, and Fig. 2 diagrammatically illustrates a modification thereof.

Referring to Fig. 1 RT designates a full wave rectifier energized through a power transformer PT the primary of which is energized from a source of alternating current AC. The output terminals of the rectifier system are shunted by a filter system comprising filter condensers FC_1 and FC_2 and a filter choke coil FC_h, the terminals G and P of the filter system comprising the grounded, or negative terminal and the positive terminal respectively of the source of supply, hereinafter designated as a source of unidirectional pulsating current which term is to be construed as including a generator or like source of voltage as well as the rectifier and filter system shown.

The terminal P of the source of unidirectional current is connected to the plate of tube VT_2 through primary P_1 of a push-pull output transformer PPT, the secondary of which is connected to a loud speaker LS, preferably of the electrodynamic type. The terminal P is connected to the plate of tube VT'_2 through a voltage regulating resistance VR and the primary P_2 of the transformer PPT, the two primaries P_1 and P_2 being connected together by a condenser C of low impedance to signal currents. The filaments of tubes VT_2 and VT'_2 are energized through heating current transformers HT_2 and HT'_2 respectively, provided with center-tap potentiometers CTP and CTP' respectively.

The center-tap potentiometer CTP of tube VT_2 is connected through a resistance R, which may include as a portion thereof the field winding of the electrodynamic speaker LS, to the negative terminal G of the source of unidirectional current, and the center-tap potentiometer CTP' of the tube VT'_2 is connected to the point A on the resistance R.

The cathode of the tube VT_1 is energized by means of a heating current transformer HT_1 and is connected to the terminal G through a coupling resistance CR'. The grid of the tube VT_1 is connected through an input system, which may be a circuit resonant at audio or radio frequencies or which may include a phonograph pick-up device or like device developing alternating current or fluctuating unidirectional current potentials, to a point, B, on the resistance, R, through a filter resistance FR_1, the filter resistance FR_1 being shunted to the cathode of tube VT_1, by a condenser C_1. The screen-grid of tube VT_1 is connected to a point E, on the resistance R through a filter resistance FR_2, which likewise is shunted to the cathode of the tube VT_1. It is to be understood however that, although I prefer to include the grid and screen-grid filters FR_1—C_1, and FR_2—C_2 the omission of either or both of these filters will not depart from the spirit of my invention as defined by the claims appended hereto.

The plate of tube VT_1 is directly connected to the grid of tube VT_2 and these in turn are connected to the terminal P, through a coupling resistance CR and a plate current regulating resistance PR. The signal current path of the grid to cathode circuit of tube VT_2 is completed through a condenser C_3. It is to be understood that the resistance PR may be replaced by a potentiometer connected between the terminal P and the center-tap potentiometer, CTP, the variable tap of the substituted potentiometer being connected directly to the coupling resistance CR, without departing from the spirit of my invention.

The grid of the tube VT'_2 is directly connected to the cathode of tube VT_1.

The resistance R and the point A are by-passed to ground by condensers RC and RC' so that substantially no signal current potentials are developed between points therein.

The operation of the system is as follows: Assuming no signal input the direct current potentials are as follows: The space current flowing

through the tubes VT_2 and VT'_2 develops in the resistance R potentials which are progressively more positive at points removed from the grounded terminal G thereof. Space current flow through the tube VT_1 and through the resistance CR', CR and PR develops potentials which are progressively more positive at points removed from the grounded terminal G of the resistance CR'. The point B, the grid return for the tube VT_1, is therefore chosen at such a point along the resistance R that the proper bias is maintained upon the grid of tube VT_1. By choosing the correct relative values of the resistance R and the resistances CR and PR the grid of tube VT_2 may be maintained at the correct bias with respect to the filament thereof. The adjustment of the point A along the resistance R and of the value of the resistance PR permits maintaining the same voltage across the plate to cathode paths of tubes VT'_2 and VT_2 and, at the same time, determining the proper grid bias for the tube VT'_2.

With respect to stabilization, if the plate current of tube VT_2 tends to rise, the current flowing through the resistance R changes the grid bias of tube VT_1 thereby causing more plate current to flow through the resistance CR rebiasing the tube VT_2. If plate current of tube VT'_2 tends to rise the potential between the points A and G of the resistance R increases thereby automatically producing a greater difference of potential between the cathode of tube VT_1 and the point A which difference of potential rebiases the grid of tube VT'_2.

Now with respect to the signal current. Assume a signal arrives at the input circuit. There then develop signal current potentials across the resistances CR and CR' which potentials when applied to the grids of tubes VT_2 and VT'_2 are exactly out of phase, due to the resistance network. The amount of signal current potential developed across the resistance CR may be made equal to that across the resistance CR' by apportioning the values of the resistances CR and PR with respect to the condenser C_3.

Referring now to Fig. 2, I have herein shown the modification of Fig. 1 hereinbefore referred to, namely the connection of the coupling resistance CR to a point between two potentiometer resistances PR and PR' which carry current of the order of the space current of tube VT_1. I have further provided a resistance R' for the tube VT'_2, the potential between the points G and A of the resistance R' being the same as that developed between the points G and A of the resistance R of Fig. 1. Otherwise the circuit arrangements are identical and the operation of the two systems are alike with the feature that the circuit arrangement of Fig. 2 is not so critical in operative adjustment as that of Fig. 1, since the stabilization circuits are substantially independent due to the use of the separate resistances R and R'.

While I have illustrated and described my invention as embodied in a specific apparatus it is to be understood that detail changes may be made therein without departing from the spirit of my invention as defined in the claims appended hereto.

Having thus described my invention, what I claim is:

1. In a direct coupled tube system, the combination of an electron tube, impedances in the output circuit thereof, a pair of electron tubes having push-pull output circuits, direct connections between the grid of each of said pair of tubes and said impedances, whereby biasing potentials developed by the space current flow in the output circuit of said first tube are impressed upon each of said grids, said connections being selected to equalize said biasing potentials.

2. In an amplifier system, the combination of a source of unidirectional fluctuating current, a pair of push-pull output tubes, resistances in series with the space-discharge paths of said tubes across said source, an electron tube, impedances in the anode to cathode circuit thereof, a direct connection from the cathode of said electron tube to the grid of one of said push-pull tubes, a direct connection between the anode of said electron tube and the grid of the other of said push-pull tubes, and connections between said impedances and said source whereby equal direct current potentials are impressed upon the grids of said push-pull tubes.

3. In a direct coupled tube system, the combination of a source of unidirectional current, a pair of output tubes having push-pull output circuits, an electron tube, a direct connection between the cathode of said electron tube and the grid of one of said output tubes, a direct connection between the anode of said electron tube and the grid of the other of said output tubes, an impedance of adjustable magnitude connected between one side of said source and the plate of said electron tube, a second impedance connected between the other side of said source and the cathode of said electron tube, and means for determining the voltage developed between the anode and cathode of each of said push-pull tubes whereby the grid of each of said push-pull tubes has a predetermined bias with respect to the filament of its respective tube.

4. In a direct coupled tube system, the combination of a source of unidirectional current, a pair of output tubes having push-pull output circuits, an electron tube, a direct connection between the cathode of said electron tube and the grid of one of said output tubes, a direct connection between the anode of said electron tube and the grid of the other of said output tubes, an impedance of adjustable magnitude connected between one side of said source and the plate of said electron tube, a second impedance connected between the other side of said source and the cathode of said electron tube, means for determining the voltage developed between the anode and cathode of each of said push-pull tubes whereby the grid of each of said push-pull tubes has a predetermined bias with respect to the filament of its respective tube, and means for maintaining the space current flow through each of said tubes substantially constant but for the signal current variations therein.

5. In a push-pull system, the combination of a pair of output tubes, push-pull output circuits therefor, a source of unidirectional current of greater voltage than the normal energization voltage for the space discharge paths of said tubes, means interposed between the cathodes of said tubes for establishing a potential difference therebetween, means for maintaining equal voltages between the respective anodes and cathodes thereof, and means for maintaining the grids of said tubes at substantially like bias with respect to the cathodes of the respective tubes.

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