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2,398,050

VACUUM TUBE SYSTEM

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FIG. 1.

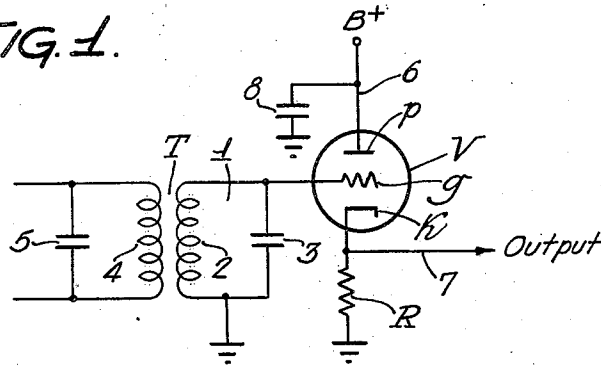


FIG. 2.

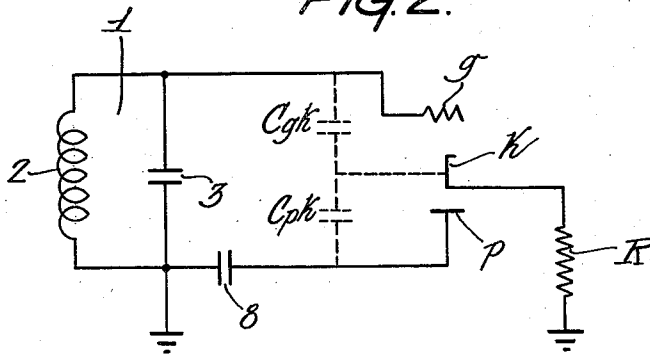
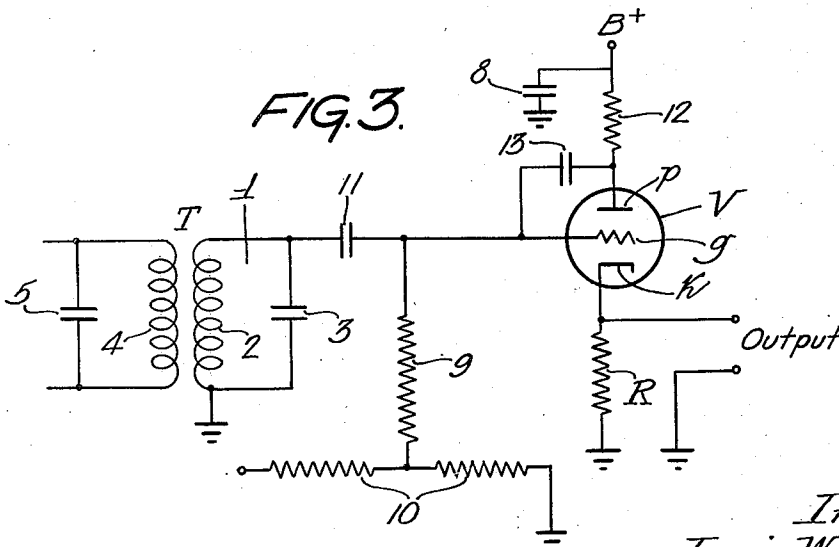


FIG. 3.



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VACUUM TUBE SYSTEM

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9 Claims. (Cl. 179—171)

This invention relates to vacuum tube systems, and more particularly to improvements in cathode follower vacuum tube stages.

Under certain conditions of use, as stated more fully hereinafter, a cathode follower stage is subject to undesired oscillation due to feedback through the interelectrode capacities of the tube. The effect of such capacities is to produce, in combination with the physical circuit elements, an oscillator arrangement of easily recognizable form. This inherent characteristic of the conventional cathode follower stage renders it highly unstable in certain instances, thereby interfering with its normal operation. While the undesired oscillation of such a stage may be inhibited to some degree by critical tuning, this method is not entirely satisfactory.

The principal object of the present invention is to provide a satisfactory method and means for preventing undesired oscillation in a cathode follower stage.

Another object of the invention is to provide a novel method and means for preventing undesired oscillation in a cathode follower stage by neutralization of the feedback voltage appearing on the grid of the cathode follower tube due to the interelectrode capacities thereof.

A further object of the invention is to provide a novel arrangement, in a cathode follower stage, for developing a neutralizing voltage in the anode circuit and for applying such voltage to the grid of the tube, so as to prevent undesired oscillation from taking place.

Other objects and features of the invention will be apparent from the following detailed description with reference to the accompanying drawing, in which

Fig. 1 is a diagrammatic illustration of a conventional cathode follower stage, the purpose of which is to facilitate a clear understanding of the present invention;

Fig. 2 illustrates the oscillator arrangement which is formed under certain conditions of operation of a conventional cathode follower stage such as shown in Fig. 1; and

Fig. 3 is a diagrammatic illustration of a cathode follower stage embodying the present invention.

Referring first to Fig. 1, the cathode follower stage illustrated includes a tuned input circuit 1 comprising the inductance coil 2 and the capacitor 3. As illustrated, the coil 2 may be the secondary winding of a transformer T whose primary winding 4 may also be tuned by the associated capacitor 5. The input circuit 1 is con-

nected between the grid g and the cathode k of the vacuum tube V. The anode or plate p of the tube is supplied with the necessary operating potential by the usual plate circuit 6 including a D. C. voltage source, as indicated by the symbol B+. A cathode load resistor R is connected between the cathode k and ground, and the output is derived from across this resistor by means of the connection 7. A by-pass condenser 8 is connected between the plate p and ground, so that no A. C. voltage appears on the plate.

In order to more nearly approach the theoretical gain of unity, the cathode resistor must be of substantial value, e. g. of the order of 2200 ohms or greater. When such a value is assigned to the cathode resistor in a cathode follower having a tuned input circuit, the cathode is sufficiently above ground to allow the formation of an oscillator circuit, as shown in Fig. 2, which includes the interelectrode capacities of the tube. Referring to Fig. 2, it will be apparent that the interelectrode capacities of the tube form, in conjunction with the physical circuit elements, an oscillator of the well-known Colpitts type, in which the grid g and the plate p are connected to opposite sides of the tuned input circuit, and the capacitances between the grid and the cathode, and between the plate and the cathode, appear as represented in dotted form at C_{gk} and C_{pk} . These interelectrode capacities cause a signal to be fed back to the grid in such phase and magnitude as to cause the grid to have a negative input resistance. Consequently the cathode follower stage oscillates, which of course is undesirable.

In accordance with the present invention, the undesired oscillation of such a cathode follower stage is effectively prevented or controlled by means of the arrangement illustrated in Fig. 3. In this figure, there is illustrated a cathode follower stage which is adapted to supply an output having both D. C. and A. C. components. A D. C. voltage is supplied to the grid g through resistor 9 from a voltage divider 10 connected to a D. C. source (not shown). A condenser 11 is connected between the input circuit 1 and the point of connection of resistor 9 to the grid conductor.

According to the present invention, a small value resistor 12 is connected to the plate p and is included in the plate circuit. The purpose of this resistor is to develop a voltage which can be used to neutralize the voltage appearing on the grid g due to the interelectrode capacities of the tube V. The voltage thus developed is applied to the grid through a condenser 13, the capacitance

of which is determined by the magnitude of the voltage to be neutralized. Since the voltage developed by means of the resistor 12 in the plate circuit is opposite in phase to the voltage appearing on the grid, it tends to neutralize the latter voltage; and if the neutralizing voltage is equal in magnitude to the feedback voltage, complete neutralization is obtained and the undesired oscillation is prevented. The capacity represented by the condenser 13 may consist in part of the normal plate-to-grid interelectrode capacitance of the tube, and in some instances it may consist entirely of such capacitance if resistor 12 is large enough in value.

By way of example, in a physical embodiment of the cathode follower stage illustrated in Fig. 3 employing a 7A4 tube, the condenser 11 had a value of 100 micro-microfarads; resistor 9 had a value of 200,000 ohms; resistor R had a value of 2200 ohms; and resistor 12 had a value of 100 ohms. In such embodiment, it was found that a value of 1.5 micro-microfarads for the condenser 13 was sufficient to stop the oscillation completely, and a stage gain of 8 was obtained. At this point, it should be noted that the gain of the stage may be varied by varying the degree of neutralization, i. e. by assigning different capacitance values to the condenser 13. In the embodiment mentioned, a capacitance value of about 6 micro-microfarads reduced the gain of the stage to approximately 1, which is the gain ordinarily expected from a cathode follower stage.

Considerably higher gains (with the accompanying instability and selectivity of the regenerative circuit) may be obtained from the cathode follower stage, by reducing the value of condenser 13. For example, gains as high as 30 were obtained by using a 5600 ohm cathode resistor and adjusting condenser 13 to the point where the circuit was just below oscillation.

As indicated above, the capacitive connection between the plate and grid, i. e. the condenser 13, may be omitted in some instances, if the value of resistor 12 is increased sufficiently. For example, neutralization may be obtained by increasing the value of resistor 12 to about 4000 ohms and omitting the condenser 13. In such case, the increased neutralizing voltage, due to the increased value of resistor 12, causes the plate-to-grid capacity to become sufficiently large to serve as the neutralizing capacitor.

By means of the invention, as exemplified in Fig. 3, it is possible to effect any desired degree of neutralization of the feedback voltage and, at the same time, control the gain of the stage as above described. Moreover the neutralizing arrangement provided by the present invention is not critical, as the value of condenser 13 may vary considerably while still maintaining freedom from oscillation. It will be apparent also that the method of effecting neutralization according to the invention is extremely simple and inexpensive.

While the invention has been described with reference to the specific illustration, and certain values of the elements have been given by way of example, it will be understood that the invention is not thus limited, but is capable of various modifications within the scope of the appended claims.

I claim:

1. In a vacuum tube system, a vacuum tube having an anode, a cathode and a control grid, an input circuit connected between said grid and said cathode, an anode-cathode circuit including means for supplying an operating potential to said anode, a cathode load resistor included in said

last-named circuit, means for deriving an output from said resistor, and means for developing a voltage in said last-named circuit and for applying said voltage to said grid, whereby to reduce the effect of interelectrode feedback within said tube.

2. In a vacuum tube system, a vacuum tube having an anode, a cathode and a control grid, an input circuit connected between said grid and said cathode, an anode-cathode circuit including means for supplying an operating potential to said anode, a cathode load resistor included in said last-named circuit, means for deriving an output from said resistor, a relatively small anode load resistor included in said last-named circuit, and a capacitive connection between said last-mentioned resistor and said grid, whereby to reduce the effect of interelectrode feedback within said tube.

3. In a vacuum tube system, a vacuum tube having an anode, a cathode and a control grid, a resistor connected between said cathode and ground, an input circuit connected between said grid and ground, means for supplying an operating potential to said anode, means for deriving an output from said resistor, a relatively small resistor connected to said anode, and a capacitive connection between said last-mentioned resistor and said grid, whereby to reduce the effect of interelectrode feedback within said tube.

4. In a cathode follower vacuum tube stage, a method of preventing undesired oscillation due to feedback through the interelectrode tube capacities, which comprises developing in the plate circuit a voltage capable of neutralizing the feedback voltage, and applying the neutralizing voltage to the grid of the tube.

5. In a cathode follower vacuum tube stage, a vacuum tube including an anode, a cathode and a control grid, a tuned input circuit connected to said grid and said cathode, an anode supply circuit connected to said anode and said cathode, a load resistor of substantial value connected to said cathode, there being a tendency of such stage to oscillate due to feedback through the interelectrode capacities of the tube, and means for neutralizing the undesired feedback so as to counteract or reduce said tendency, said means including an impedance in the anode circuit for developing a neutralizing voltage.

6. In a cathode follower vacuum tube stage, a vacuum tube including an anode, a cathode and a control grid, a tuned input circuit connected to said grid and said cathode, an anode supply circuit connected to said anode and said cathode, a load resistor of substantial value connected to said cathode, there being a tendency of such stage to oscillate due to feedback through the interelectrode capacities of the tube, an impedance in said anode circuit for developing a neutralizing voltage, and a capacitive path between said impedance and said grid, whereby said voltage serves to counteract or reduce said oscillatory tendency.

7. A cathode follower vacuum tube stage as defined in claim 6, wherein said capacitive path comprises a capacitor connected between said impedance and said grid.

8. A cathode follower vacuum tube stage as defined in claim 6, wherein said capacitive path is constituted at least in part by the anode-to-grid interelectrode capacitance of the tube.

9. In a cathode follower vacuum tube stage, a vacuum tube including an anode, a cathode and a control grid, a tuned input circuit con-

nected to said grid and said cathode, an anode supply circuit connected to said anode and said cathode, a load resistor of substantial value connected to said cathode, there being a tendency of such stage to oscillate due to feedback through the interelectrode capacities of the tube, an impedance in said anode circuit for developing a

neutralizing voltage, and a capacitor connected between said impedance and said grid, said resistor and said capacitor having such values of resistance and capacitance, respectively, as to provide a desired gain in said stage while preventing undesired oscillation thereof.

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