Sept. 19, 1933. J. E. CORBIN 1,927,082

AMPLIFIER

Filed June 30, 1932

FIG. 1

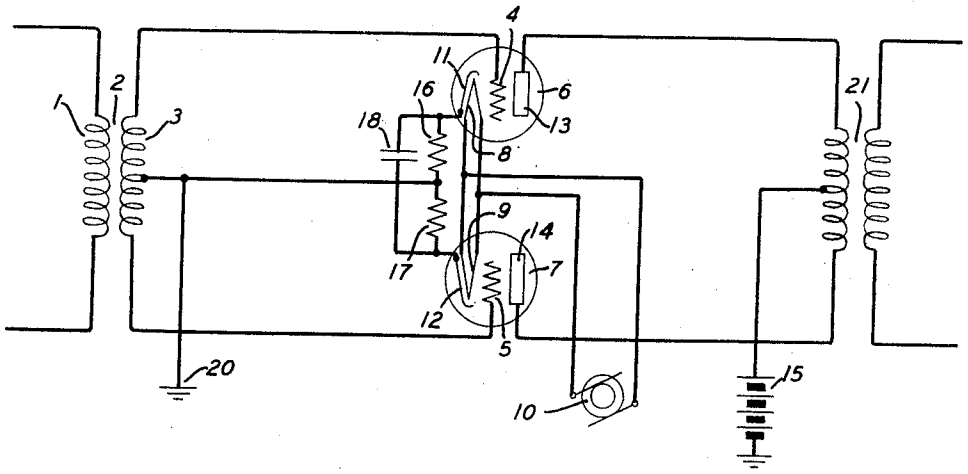
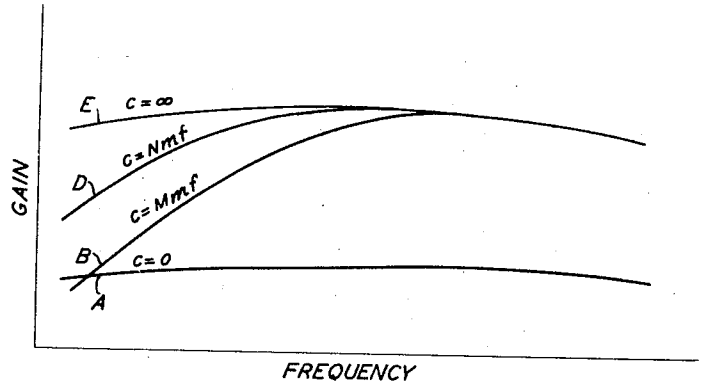


FIG. 2



INVENTOR
J. E. CORBIN
BY H. A. Burgess
ATTORNEY.

Patented Sept. 19, 1933 1,927,082

UNITED STATES PATENT OFFICE

1,927,082

AMPLIFIER

Joseph E. Corbin, Jackson Heights, N. Y., assignor to Bell Telephone Laboratories Incorporated, New York, N. Y., a corporation of New York

Application June 30, 1932. Serial No. 620,087

2 Claims. (Cl. 179—171)

This invention relates to amplifiers using space discharge devices and more especially to amplifiers in which the devices are arranged in push-pull or balanced relation.

In amplifiers using space discharge devices including grid, cathode and anode, the grid bias is often obtained from an impedance inserted in the anode circuit of the device. McNally Patent 1,848,187, March 8, 1932, shows how independent resistors in the anode circuit improve the operation and balance of such circuits when applied to devices arranged in push-pull or balanced relation. Heretofore, the bias resistors have been shunted by condensers whereby a filter is formed which tends to eliminate variations in grid bias due to signal or noise variations.

The present invention has as an object the improvement of the operation of amplifiers involving circuits of the type noted.

More specifically it is an object of this invention to improve the response of balanced amplifiers at low frequencies.

Another object is to reduce even order products of modulation or parallel singing in amplifiers of the balanced type.

A feature of the invention is a single capacity connected between the cathodes of the space discharge devices of a balanced amplifier in shunt to the bias resistors.

The invention together with additional objects and features will be better understood from the following description and attached drawing forming a part thereof in which

Fig. 1 is a diagrammatic sketch of one form the invention may take; and

Fig. 2 is a graph showing the response of the amplifier with different variations of capacity connected between the cathodes of the devices.

Referring now to Fig. 1 a transformer 2 having a primary winding 1 and a divided secondary winding 3 is shown with the outside terminals of the secondary winding connected to the grids 4 and 5 of space discharge devices 6 and 7.

The primary winding 1 of transformer 2 may be connected to any source, the output of which is to be amplified such as a preceding amplifier stage, a microphone, a telephone line, a radio receiving system, etc.

Devices 6 and 7 are illustrated as being of the well-known heater type having filaments 8 and 9 connected to a suitable source of current 10, cathodes 11 and 12 and anodes 13 and 14. It is to be understood, however, that the invention is not limited to tubes of the heater type but may be applied regardless of the type of cathode.

Anode current is obtained from source 15 shown as a battery but it may be any direct current source such as rectified alternating current.

Individual bias resistors are shown at 16 and 17 shunted by condenser 18.

An output transformer 21 has a divided primary winding connected in the well-known manner to the anodes 13 and 14 and its mid-point connected to source 15. The secondary winding of transformer 21 may be connected to any utilization circuit.

The input circuits of the amplifier may be traced from the mid-point of secondary winding 3 through either half of the winding to grids 4 or 5, cathodes 11 or 12, resistors 16 or 17 to the mid-point of winding 3.

The anode circuits may be traced from grounded source 15 to mid-point of primary winding of transformer 21, anodes 13 and 14, cathodes 11 and 12 to ground at 20. The IR drop through the resistors 16 and 17 provides the bias for grids 4 and 5 in the well-known manner.

It will be noted that the resistors are common to the grid and anode circuits of each of the devices 6 and 7. They are also common to the input and output circuits of the amplifier considered as a unit. Now, since the signal voltage in the anode circuit is in phase opposition to the signal voltage in the grid circuit, if condenser 18 were not present the signal currents in passing through the resistors would cause voltages to be applied to the grids opposing the signal voltages and hence cause a reduction in the amplifier gain. Condenser 18, however, effectively short-circuits the bias resistors at signal frequencies and hence this negative regeneration does not occur except at such frequencies that condenser 18 is not an adequate short circuit.

The effect of different capacity values for condenser 18 is shown in Fig. 2. Maximum gain at all frequencies is obtained by making the capacity theoretically infinite. That is, making it so large that its impedance to low frequencies is very low compared to that of the resistors. This is shown in curve E where it is seen that the amplifier gain is substantially uniform throughout the frequency range of the amplifier. Curves D and B illustrate amplifier response with lower capacity values for the shunting condenser and curve A the response with capacity zero or the condenser eliminated. Here the negative regeneration reduces the amplifier gain throughout the entire range.

It is desired to point out that an inductance

may be used with capacity 18 either in series or in parallel to provide a circuit resonant or anti-resonant at certain frequencies whereby the gain of the amplifier at such frequencies may be increased or decreased as desired.

The second function of condenser 18, that is, the reduction of even order products is closely allied with the function just described. As previously pointed out the individual resistors are common to both the grid and anode circuits and also to the input and output circuits of the amplifier as a whole. It is also well known that currents arising from even order modulation or parallel singing exist in the common branches of both circuits.

If condenser 18 were made up of two parts, each part shunting only its individual resistor, the even order products currents would be shunted through these condensers and hence not pass through the resistors. However, with condenser 18 connected from cathode to cathode the even order products must pass through resistors 16 and 17 and hence the drop through the resistors due to these currents is impressed on the grid circuits in such phase as to oppose their production. Negative regeneration of these even order components, therefore, occurs with a substantial decrease in amplitude if not complete elimination. Further, the negative regeneration is constant at all frequencies and no adjustment is necessary regardless of the frequency of the disturbing currents.

It is to be understood that whereas the invention has been described in connection with but one embodiment it is to be limited only by the scope of the appended claims.

What is claimed is:

1. An amplifier comprising space discharge devices arranged in push-pull relation, input and output circuits for said amplifier, a resistance element associated with each said device and common to both the input and output circuits thereof, whereby currents of even order modulation products set up a voltage in the input circuit which tends to neutralize such currents and a single condenser shunting both said resistance elements.

2. An amplifier comprising space discharge devices arranged in push-pull relation, input and output circuits for said devices, a branch common to both the input and output of each said devices, a resistance connecting the cathode of each said device to said common branch, a condenser in shunt to both said resistances forming a by-pass around said resistances for desired waves, said resistances forming an impedance to currents of even order modulation products to thereby set up a voltage tending to neutralize said even order products.

JOSEPH E. CORBIN.