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AMPLIFIER

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FIG. 1

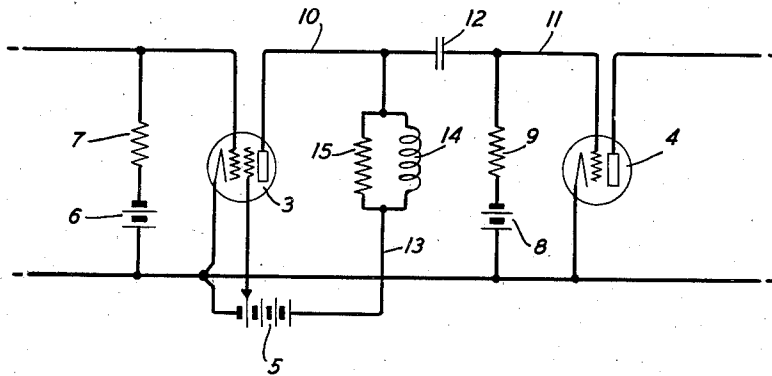
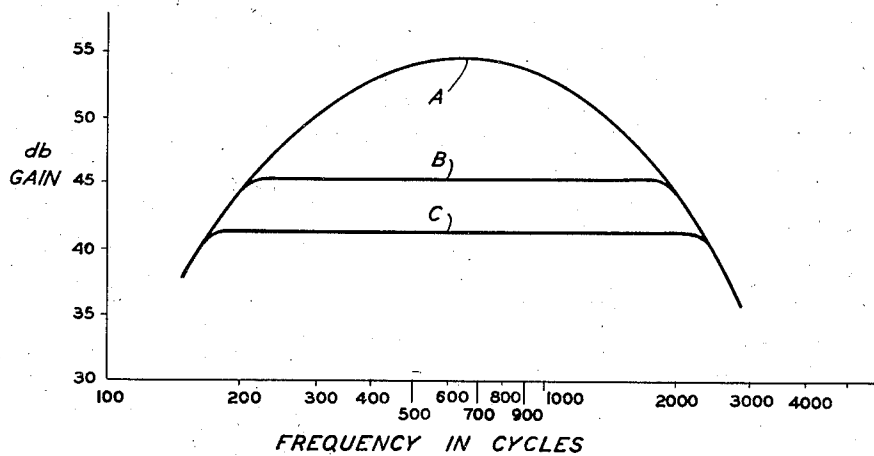


FIG. 2



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AMPLIFIER

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1 Claim. (Cl. 179—171)

This invention relates to amplifier circuits and more especially to such circuits involving the use of space discharge devices having a high internal output impedance.

It is well known that for most efficient power transfer, any device, including space discharge devices, should work into an impedance equal to the internal output impedance of the device. For maximum voltage amplification the load impedance should be high compared to the output impedance of the device. Thus, for most amplifier designs, it is desirable to work the vacuum tubes into load impedances equal to or greater than the internal plate impedance of the tubes.

In many cases it is possible to fulfill these specifications by means of suitably designed transformers, but in other cases, especially where tubes of very high plate impedance are employed, it may not be possible to construct satisfactory transformers. In these cases resort may be had to resistance or impedance coupling but with space discharge devices such as screen grid tubes having plate impedances of the order of one million ohms, even the use of impedance or resistance coupling gives rise to difficulties which are not readily overcome when uniform amplification over a wide band of frequencies is desired.

In the case of impedance coupling it is practically impossible to construct an inductance, the reactance of which is high compared to the tube impedance over a wide band of frequencies. This is due to both physical and electrical limitations. Physically, the number of turns of wire and the size of the core required are prohibitive. Electrically, the presence of distributed capacity in the winding produces resonance at some frequency and limits the impedance at frequencies above this resonance.

In the case of resistance coupling the IR drop of the plate current through the resistance becomes prohibitive. This can readily be seen by assuming a screen grid tube which requires 180 volts plate potential, draws 4 milliamperes of plate current and has a plate impedance of one million ohms. If the coupling impedance be chosen equal to the tube impedance, there will be a drop of 4000 volts across the resistance and if the coupling resistance be high compared to the plate impedance, the drop would be correspondingly greater. Such a situation, of course, cannot be considered for most purposes.

An additional difficulty is encountered when broad-band or high frequency amplification is desired with resistance coupling. This difficulty

arises because of the shunt output capacity of the tube whose output is fed through the coupling resistance, and the shunt input capacity of the tube into which this output is fed. Either or both of these shunt capacities introduce shunt capacitive reactances which decrease the effective load impedance as the frequency increases and thereby progressively reduces the gain for higher frequencies.

An object of the present invention is an amplifier comprising space discharge devices having high plate impedances involving resistance and impedance coupling in which the amplification is substantially uniform over a comparatively wide range of frequencies.

Another object of the invention is an amplifier such as that described in which a high degree of efficiency is obtained.

These and other objects are obtained by using a coupling consisting of a combination of inductive impedance and resistance; the impedance preferably having a characteristic such that it has a resonant peak, due to distributed capacity and the shunt capacities of the preceding and succeeding tubes, at the geometric midpoint of the band of frequencies to be amplified and the resistance in shunt to the impedance having such a value that the impedance of the combination is substantially uniform for the band to be transmitted.

This invention will be better understood from the following description and accompanying drawing forming a part thereof in which

Fig. 1 is a schematic circuit of one form which the invention may take; and

Fig. 2 is a graph of gain versus frequency in such an amplifier for different values of resistance.

Referring to Fig. 1 a two-stage amplifier is illustrated comprising space discharge devices 3 and 4 in the first and second stages, respectively. Device 4 is the ordinary three-electrode type, while device 3 is a four-electrode type commonly known as a screen grid tube. The amplifier is illustrated as battery operated for simplicity, but as the invention has no relation to the type of sources of current and potentials, this feature is unimportant.

Device 3 being of the screen grid type may have an internal output impedance of the order of one million ohms. The anode and screen grid potentials are obtained as shown from battery 5. The control grid is biased by battery 6 through resistance 7.

The control grid of device 4 is biased by a

battery 8 through resistance 9. The anode of device 3 is connected to the control grid of device 4 by means of leads 10 and 11 and condenser 12.

- 5 In the lead 13 connecting the positive terminal of battery 5 to lead 10 and hence to the anode of device 3, there is inserted an inductance 14 and in shunt thereto a resistance 15.

10 Referring now to Fig. 2 which is the graph of the gain characteristic of the stage containing device 3 alone, curve A represents the characteristic when the inductance 14 was used without the shunting resistance. This inductance resonated at about 1400 cycles which is approximately the geometric midpoint of the band of frequencies to be amplified and at resonance had a resistance of 18 megohms and an inductance of 2400 henries. The band of frequencies extended from about 50 cycles to 7500 cycles per second.

- 15 Curve B illustrates the characteristic when the shunt resistance had a value of 200,000 ohms and curve C the characteristic when the resistance had a value of 100,000 ohms. These curves were made from a variable oscillator input and a continuous indicator on the output.

It will be noted that the gain of the amplifier decreases with decreasing values of shunt resistance, but that the resonant peak disappears when the shunt resistance is present, so that the characteristic is flat. In other words, the shunt resistance prevents resonance of the inductance and shunt capacities from affecting the gain characteristic and hence produces uniform gain over the band of frequencies which it is desired to amplify.

10 It is to be understood that the circuit shown and described is purely illustrative and that the invention is to be limited only by the scope of the appended claim.

15 What is claimed is:

In combination, a space discharge device having an internal output impedance of the order of one million ohms and a circuit into which said device works comprising an inductance of the order of as great as 2000 henries, and a resistance of above 100,000 ohms in shunt thereto to produce substantially uniform gain over the entire band.

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