

Jan. 11, 1938.

G. JOBST ET AL

2,105,081

AMPLIFYING TUBE AND CIRCUIT

Filed Oct. 27, 1933

2 Sheets-Sheet 1

Fig. 1

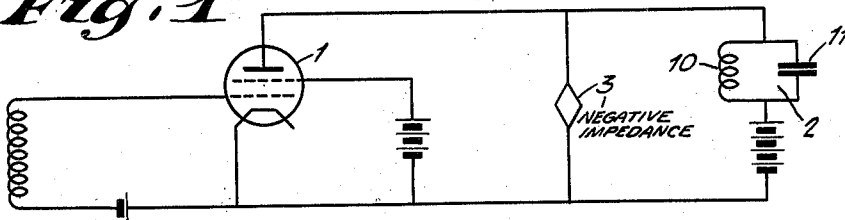


Fig. 2

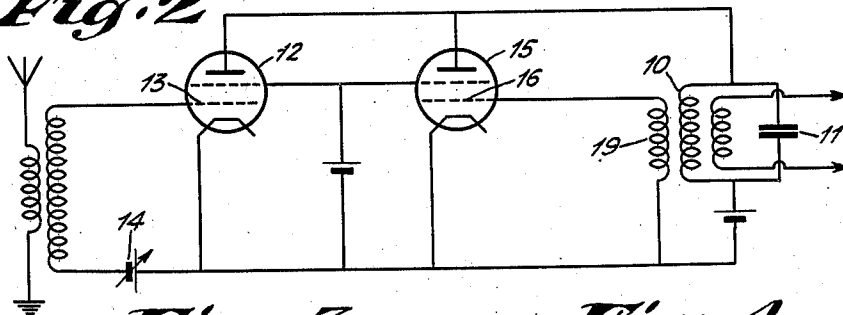


Fig. 3

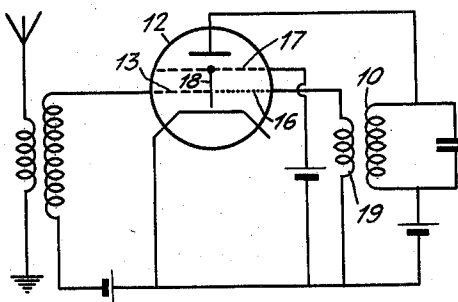


Fig. 4

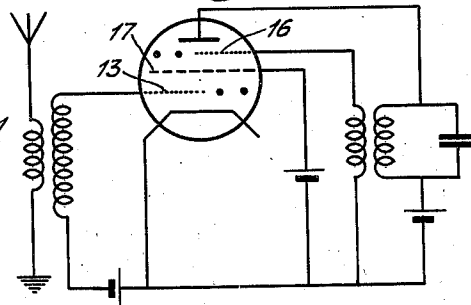
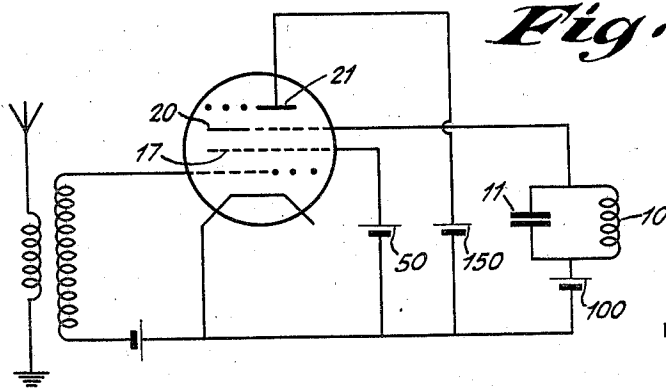


Fig. 5



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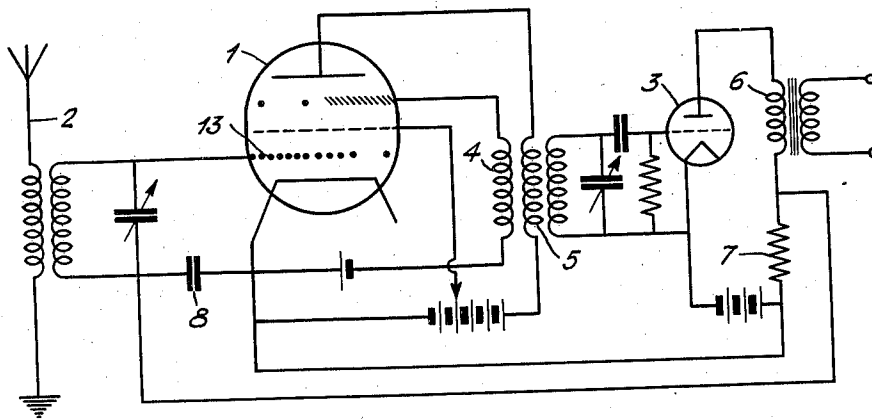
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Fig. 6.



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AMPLIFYING TUBE AND CIRCUIT

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5 Claims. (Cl. 179—171)

An object of this invention is to provide an amplifier arrangement in which the damping of a load circuit connected in or coupled to the anode circuit may be fully or partly compensated for, preferably by the use of a certain type of vacuum tube as a negative resistance.

A further object is to provide an amplifier arrangement in which the degree of amplification and the amount of damping compensation applied are independent of each other and may be independently controlled.

A still further object is to provide an amplifying tube and arrangement in which the same tube not only serves as amplifier but has elements arranged therein to provide the desired negative resistance effect in the load circuit. Further objects of the invention will become apparent to those skilled in the art as the description thereof proceeds. For a better understanding of the invention, however, reference is made to the accompanying drawings in which,

Figure 1 shows schematically the general amplifying arrangement according to the invention;

Figure 2 shows an amplifier providing negative resistance by a feed-back method;

Figures 3 and 4 show amplifiers in which the negative resistance is provided by elements in the amplifying tube;

Figure 5 shows a tube arrangement for providing the negative resistance effect desired according to our invention; and

Figure 6 shows an embodiment of our invention as applied to an automatic volume control system.

The damping of a useful impedance placed in the anode circuit of an amplifier tube stage such as an oscillatory circuit, influences the selectivity of this stage. The selectivity can be increased by operating the tube in such manner that it represents a negative impedance thus effecting a total or partial damping reduction in the load circuit. Besides the ordinary back coupling circuits, in particular, screen grid tubes of special construction are considered for this purpose having a perforated anode and also an auxiliary grid and auxiliary anode disposed in back of the anode. Either by means of space charge concentration or by means of dynamic back coupling this auxiliary grid may be utilized for producing a negative inner impedance. In all these cases however, the value of the negative inner impedance is dependent upon the bias of the control grid. This signifies that at a change of the degree of amplification of a tube, obtained for instance by displacing the working point upon the characteristic curve by selecting a corresponding grid bias, the damping reduction of the anode circuit and thus the selectivity will also be subject to change. The present inven-

tion provides a circuit and several elements suitable for carrying out the same in which the degree of amplification and the damping reduction of an amplifier stage can be regulated entirely independent of each other.

The fundamental idea of this solution will be noted from Figure 1 in which 1 designates an ordinary screen grid tube having a positive inner impedance, 2 represents a load circuit involving losses and shown as comprising an inductance 10 and capacity 11 which may be tuned to a desired frequency and numeral 3 represents a negative impedance connected in parallel thereto. In place of 3 a back coupled electron tube can be used in the simplest case as shown in Figure 2 for a circuit including two screen grid tubes. At the left is indicated a receiver amplifying tube 12 the amplification of which depends on the working point of the characteristic and thus on the control grid 13 biasing potential which may be an adjustable battery source 14. The right hand tube is back coupled and serves for the damping reduction of the connected circuit 10, 11 and consequently for increasing the selectivity of the receiver.

It will be noted that the cathodes, screen grids and anodes of tubes 12 and 15 have the same potential and this condition can be made useful by structurally combining the two tubes within the same bulb. However, care must be taken that the two grids 13 and 16 are not relatively disturbed in their function and that the control of the electron currents takes place independent of each other.

A suitable tube structure is schematically represented in Figure 3. The action of the two control grids 13, 16 is separated to a full extent by means of the T-shaped screen grid 17, the body 18 of the T extending between the grids. In another embodiment, the same problem can be solved by selecting the grids for the various purposes i. e., the supporting columns thereof of the same length as that of the cathode but shaping the two halves, as conditions may require, differently from each other (for instance by changing the pitch of the grid winding, or omitting the same entirely) so as to control the different parts of the current path or electron stream from the common cathode in various manners. In this manner a three grid tube according to Figure 4 is obtained, the structure of which can be produced in a simpler manner than the electrode system of Figure 3. The width of the meshes of the first grid 13 and third grid 16 is extremely varied in the direction of the length of the cathode so that the closely wound portion only of the grid has a controlling action. As can be readily seen the left half of the tube operates as screen grid tube, whereas the right half functions as space charge grid tube. In Fig. 4 the negative resist-

ance is obtained the same as in Fig. 2 in the analytic sense. The simplification afforded by Fig. 4 obtains by so combining tubes 12 and 15 that the single tube in Fig. 4 contains a third grid 16 so disposed that back coupling to it results in a negative resistance across the tuned plate circuit; that is, Fig. 4 can be electrically substituted for Fig. 2 by simply adding another grid in the tube.

In Fig. 4 the control grid 13 may have its bias controlled to regulate the amplification, just as the grid 13 of Fig. 2 may be controlled for the same purpose. The grid 16 is so disposed spacially and its half towards the left has such a wide mesh as to render the electronic action of grids 13 and 16 substantially independent of each other. The screen grid 17 being located between them also assists in preventing reaction between them.

As previously pointed out other effects may also be utilized for producing the negative impedance. Also in these cases there exists the possibility of a simple structure in the form of multi-grid tubes having electrodes extending therethrough the shape of which varies along the length of cathode.

Figure 5 for instance, shows a tube the left half of which serves as an ordinary screen grid tube for the amplification of radio frequency energy. The right hand part of the anode 20 is perforated and a further electrode 21 is disposed in back of the anode and placed at a higher potential than the latter thereby receiving the secondary electrons from the anode. Due to the secondary emission a dynatron effect with falling characteristic and thus a damping reduction of the load circuit 10, 11 is obtained.

In other words the right half of the anode forms with the cathode a negative resistance which is shunted across the load circuit. As shown the screen grid 17 which screens the control grid from the anode may have a potential of about 50 volts applied to it, the anode 20 about 100 volts and the outermost electrode 21 about 150 volts. As shown the left hand half of 21 opposite the solid portion of 20 may be cut away or perforated.

Arrangements of the above described type can be used with particular advantage in receiver circuits in which a regulation of the amplification is carried out automatically for the purpose of eliminating fading effects.

Figure 6 shows such an embodiment by way of example. Numeral 1 designates herein a combination tube the left half of which operates as a screen grid tube amplifying the signal oscillations supplied by the antenna 2 and supplying the same to the grid circuit of the rectifier tube 3. The right half of tube 1 functions as a space charge grid tube and is back coupled by means of coil 4 to inductance 5 inserted in the common anode circuit. The damping reduction of the anode circuit and thus also the selectivity of the stage is thereby entirely independent of the control grid 13 circuit of tube 1. In the anode circuit of rectifier 3 a resistance 7 is placed in series with the audio-frequency transformer 6. The direct voltage drop produced in this resistance provides the grid bias of the control grid 13 of tube 1 and thereby regulates the degree of amplification of this tube. Condenser 8 serves as a short circuit path for the high-frequency and determines at the same time the time constant of the volume control performance. In order to avoid, due to the regulation of the amplification, distortion as well as change of selectivity, the left half of the

tube 1 is to be constructed as screen grid tube with a logarithmic characteristic so that the inner resistance of this electron current path assumes a constant positive value. This may be secured by a variable spacing between the successive turns of the grid wire.

We claim:

1. An amplifying arrangement comprising a vacuum tube having a cathode, a control grid, an anode and a screen grid located between said control grid and anode, an input circuit connecting said cathode and control grid, a circuit connecting said cathode and anode including a resonant circuit comprising a coil and condenser connected in parallel, means for applying a high positive potential to said screen grid, means for causing at least a portion of the electron path between cathode and anode to form a negative resistance connected in shunt with said resonant circuit comprising a second control grid and means coupling said last named grid to the circuit connecting said cathode and anode to thereby control the value of said negative resistance.

2. In an amplifying device, the combination of a vacuum tube having a cathode, an anode, a control grid located between said anode and cathode and constructed so as to control the electron current between one-half only of said cathode and anode, a second grid located between said anode and cathode and constructed so as to control the electron current between the other half only of said cathode and anode, means for varying the voltage of said control grid in accordance with a desired signal frequency, an output circuit connected to said anode and cathode, and means for varying the voltage of said second grid.

3. The combination defined in claim 2 in which a screen grid is located between said control grid and second grid and means for applying a steady positive potential to said screen grid.

4. An amplifying arrangement comprising a vacuum tube having a cathode, a control grid arranged parallel to said cathode and an anode, an input circuit connecting said control grid and cathode, an output circuit connecting said cathode and anode, a second grid between said control grid and anode and arranged substantially parallel to said control grid, said control grid having a wire of fine mesh at one end of said cathode and of coarse mesh at the opposite end thereof and said second grid having a wire of coarse mesh at said one end of said cathode and of fine mesh at the opposite end thereof and means coupling said output circuit to said second grid.

5. In an amplifying arrangement, the combination of a vacuum tube having a cathode, a control grid and an anode, an input circuit connecting said control grid and cathode, a second grid located between said control grid and anode, said second grid being constructed and arranged to control the electron stream from one end only of said cathode and said control grid being constructed and arranged to control the electron stream from the other end only of said cathode, means connected to said second grid for varying its potential at a high frequency, a screen grid located between said control grid and said second grid, means for applying a high positive potential to said screen grid and an output circuit connected between said anode and cathode.

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