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HIGH-FREQUENCY AMPLIFYING CIRCUIT ARRANGEMENT

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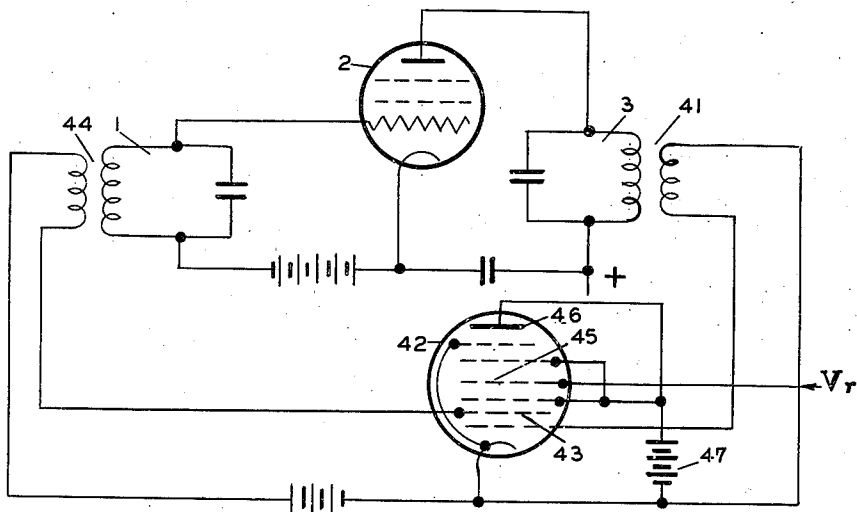


FIG. 1

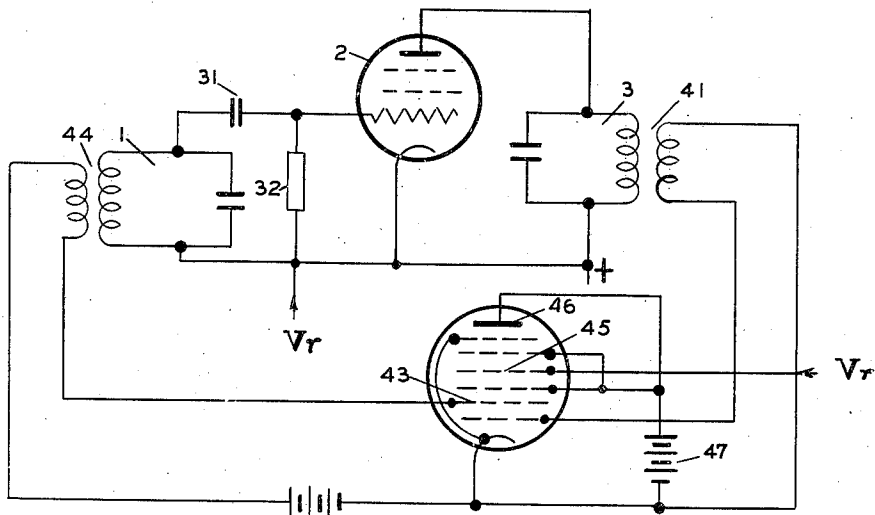


FIG. 2

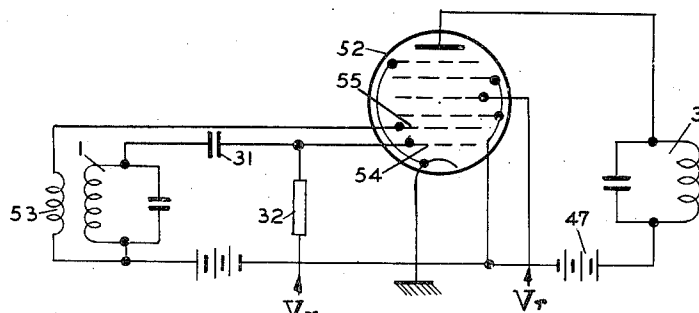


FIG. 3

BY
AGENT *Max M. J. J. J.*
MAXIMILIAAN JULIUS OTTO STRUTT
ALDERT VAN DER ZIEL
INVENTORS

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HIGH-FREQUENCY AMPLIFYING CIRCUIT
ARRANGEMENT

Maximiliaan Julius Otto Strutt and Aldert van
der Ziel, Eindhoven, Netherlands, assignors, by
mesne assignments, to Hartford National Bank
and Trust Company, Hartford, Conn., as trustee

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9 Claims. (Cl. 179—171)

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The specification of U. S. Patent No. 2,352,956,
issued July 4, 1944, jointly to the present inven-
tors and Cornelis Jan Bakker, describes a circuit
arrangement for the transmission of high-fre-
quency electrical oscillations which comprises
at least one controlled discharge tube and is
equipped with a resonant input circuit which is
so proportioned that the natural losses of this
circuit involve a smaller damping than is neces-
sary and the required damping is at least sub-
stantially brought about by withdrawing energy
from the circuit by means of negative back cou-
pling, the backcoupling current or voltage being
taken from the circuits of one or more current
carrying electrodes which are so chosen that the
negative backcoupling at the same time reduces
the noise current in the output circuit.

It is the object of the invention to provide novel
methods for controlling the amplification of cir-
cuits of the type above-described.

In the circuit arrangement according to the
above-mentioned patent the problem of control-
ling the amplification of the circuit arises. In
effect, when controlling the amplification in the
usual way by modifying the bias of the control
grid the degree of negative backcoupling de-
creases with a decrease in amplification, due to
which the control is not effective on the one hand
and the selectivity increases on the other hand,
so that in receiving strong signals, with which the
amplification is small, the selectivity is very high.

According to the invention this drawback is
obviated since the amplification is controlled by
variation of the degree of negative backcoupling.
Preferably the bias of the input electrode of the
discharge tube is varied at the same time in such
manner that this bias becomes more negative
with an increase in negative backcoupling.

The invention will be more fully explained by
reference to the accompanying drawing in which:

Figure 1 is a schematic diagram of a circuit
arrangement in accordance with the invention,

Figure 2 is a schematic diagram illustrating
another embodiment in accordance with the in-
vention, and

Figure 3 is a schematic diagram illustrating a
further embodiment in accordance with the in-
vention.

Fig. 1 shows a high-frequency amplifying cir-
cuit which may be used, for instance, in a first
stage of a radio receiver. A resonant circuit 1
tuned to the signal to be transmitted is inserted
in the control grid circuit of a tube 2. The anode
circuit of the tube comprises a circuit 3 which
is tuned to the same frequency and from which

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the amplified voltage is taken. The circuit 1 is
so constructed that its natural damping is smaller
than is necessary in conjunction with the band-
width to be transmitted. A part of the energy
set up in the anode circuit 3 is supplied through
a coil 41 to the first control grid of an octode
42. The voltage thus set up at the first anode
43 of this tube is supplied through a coil 44 to
the circuit 1 in such a phase that the latter is
damped thereby and the selectivity of this cir-
cuit is consequently decreased. The second anode
46 of the octode is connected to the cathode
through the intermediary of a source of poten-
tial 47. To the second control grid 45 of the
octode is supplied a control voltage V_r whose
value depends on the average amplitude of the
oscillations to be transmitted. The electrode 45
controls the distribution of current between the
second anode 46 and the first anode 43 in such
manner that the current to the electrode 43 and
consequently the degree of negative feedback in-
creases with an increase in negative control vol-
tage. Due to this the amplitude of the signal ap-
pearing in the output circuit 3 decreases thus
ensuring effective gain control. At the same time
the range of transmission of the input circuit in-
creases on account of the increasing damping
thereof so that the selectivity decreases. Conse-
quently, the selectivity of the circuit will decrease
with an increase in signal voltage.

Although this relationship between selectivity
and amplification frequently offers advantages it
may sometimes be undesirable and often the at-
tempts are directed to obtaining a substantially
constant damping of the input circuits. Accord-
ing to the invention this can be achieved by mod-
ifying the degree of negative backcoupling and
in addition the value of the control grid bias of
the tube for controlling the amplification. Fig.
2 represents a circuit in which this method is
used. The circuit shown in Fig. 2 substantially
corresponds to that shown in Fig. 1. However, it
comprises a grid condenser 31 and a leakage re-
sistance 32 through which the control voltage V_r
is supplied also to the control grid of tube 2. The
operation is as follows:

With an increase in negative bias applied
through the resistance 32 the voltage set up
across the output circuit 3 of the tube 2 is reduced
so that a lower voltage is applied to the first con-
trol grid of the auxiliary tube 42. The negative
bias supplied to the control grid 45 of the auxil-
iary tube increases at the same time as a result
of which the mutual conductance towards the
electrode 43 is increased. Thus the voltage in-

duced in the coil 41 decreases on the one hand, but on the other hand the amplification of that part of the tube 42, which is constituted by the cathode, the first control grid and the anode 43, increases with an increase in negative bias of the grid 45, so that by giving the circuit elements suitable proportions the voltage set up in coil 44 will be substantially independent of the control voltage. Owing to this the damping of the circuit 1 and consequently its selectivity remain constant and yet the voltage set up in the circuit 3 decreases with an increase in control voltage. Fig. 3 represents another embodiment of the invention in which the use of an auxiliary tube is eliminated. In this case use is made of an octode 52 to whose first control grid 54 is connected a circuit 1 which is tuned to the oscillations to be transmitted. The natural damping of this circuit is deliberately chosen too low in proportion to the desired range of transmission, and the additional damping thus required is brought about by coupling in a correct manner a coil 53, which is inserted in the external circuit of the second grid 55, with the coil of the circuit 1. The anode circuit comprises a circuit 3 which is tuned to the frequency of the oscillations to be transmitted and from which the amplified voltage is taken. A variable negative bias V_r is supplied both to the first control grid 54 and to the second control grid 55.

The operation of the circuit is as follows: with an increase in negative bias V_r on the first control grid 54 the current having the signal frequency through the coil 53 and consequently also the negative feedback will decrease in the first instance. Since, however, the second control grid 55, which acts as a current distribution grid, also becomes more negative the current traversing the coil 53 will just tend to increase. With a suitable ratio of the control voltages supplied to the two control grids in conjunction with the mutual conductances of the two grids it can be achieved that the current in the coil 53 and consequently the damping of the circuit is at least substantially independent of variations of the control voltage, whilst nevertheless obtaining a very effective gain control.

What we claim is:

1. A circuit arrangement for transmitting a band of electric oscillations, comprising an electron discharge tube having a cathode, a first control grid, a perforated anode, a second control grid and a second anode, a resonant input circuit having a natural damping smaller than necessary for the width of said band of electric oscillations, means to apply said electric oscillations to said input resonant circuit, means to apply said electric oscillations to said first control grid, means coupling said perforated anode to said input resonant circuit in negative feedback relationship, and means to apply a control voltage varying in amplitude proportional to the amplification of said circuit arrangement to said second control grid to vary the degree of feedback and to increase the damping of said input circuit and thereby control the amplification of said circuit arrangement.

2. A circuit arrangement for transmitting a band of electric oscillations, comprising an electron discharge tube having a cathode, a first control grid, a perforated anode, a second control grid and a second anode, means to apply operating potentials to said electron discharge tube, a resonant input circuit having a natural damping smaller than necessary for the width of said band

of electric oscillations, means to apply said electric oscillations to said resonant input circuit, a resonant output circuit, means coupling said first control grid to said resonant output circuit, means coupling said perforated anode to said resonant input circuit in negative feedback relationship, and means to apply a control voltage varying in amplitude proportional to the amplification of said circuit arrangement to said second control grid to vary the degree of feedback and to increase the damping of said input circuit and thereby control the amplification of said circuit arrangement.

3. A circuit arrangement for transmitting a band of electric oscillations, comprising an electron discharge tube having a cathode, a first control grid, a perforated anode, a second control grid and a second anode, a resonant input circuit having a natural damping smaller than necessary for the width of said band of electric oscillations, means to apply said electric oscillations to said resonant input circuit, a resonant output circuit, means coupling said first control grid to said resonant output circuit, means coupling said perforated anode to said resonant input circuit in negative feedback relationship, and means to apply a control voltage varying in amplitude proportional to the amplification of said circuit arrangement to said first and said second control grids to vary the degree of feedback and to increase the damping of said resonant input circuit and thereby control the amplification of said circuit arrangement.

4. A circuit arrangement for transmitting a band of electric oscillations, comprising an electron discharge tube having a cathode, a first control grid, a perforated anode, a second control grid and a second anode, a resonant input circuit having a natural damping smaller than necessary for the width of said band of electric oscillations, means to apply said electric oscillations to said resonant input circuit, a resonant output circuit, means coupling said first control grid to said resonant output circuit, means coupling said perforated anode to said resonant input circuit in negative feedback relationship, and means to apply a control voltage varying in amplitude proportional to the amplification of said circuit arrangement to said first and said second control grids to vary the degree of feedback and to increase the damping of said resonant input circuit and thereby control the amplification of said circuit arrangement, said first control grid being negatively increased with increasing negative feedback.

5. A circuit arrangement for transmitting a band of electric oscillations, comprising an electron discharge tube having a cathode, a first control grid, a perforated anode, a second control grid and a second anode, a resonant input circuit having a natural damping smaller than necessary for the width of said band of electric oscillations, means to apply said electric oscillations to said resonant input circuit, a resonant output circuit, means coupling said first control grid to said resonant output circuit, means coupling said perforated anode to said resonant input circuit in negative feedback relationship, and means to apply a control voltage varying in amplitude proportional to the amplification of said circuit arrangement to said first and said second control grids to vary the degree of feedback and to vary the damping of said resonant input circuit and thereby control the amplification of said circuit arrangement, said first control grid being negatively increased with increasing negative feed-

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back to maintain the damping of said resonant circuit substantially constant over the width of said band of electric oscillations.

6. A circuit arrangement for amplifying a band of electric oscillations, comprising an electron discharge amplifier tube having a cathode, a signal grid and an output electrode, an electron discharge control tube having a cathode, a first control grid, a perforated anode, a second control grid and a second anode, a resonant input circuit having a natural damping smaller than necessary for the width of said band of electric oscillations, means to apply said electric oscillations to said input resonant circuit, means coupling said resonant input circuit to said signal grid, a resonant output circuit coupled to said output electrode, means coupling said output resonant circuit to said first control grid, means coupling said perforated anode to said input resonant circuit in negative feedback relationship, and means to apply a control voltage varying in amplitude proportional to the amplification of said circuit arrangement to said second control grid to vary the degree of feedback and to increase the damping of said resonant input circuit and thereby control the amplification of said circuit arrangement.

7. A circuit arrangement for amplifying a band of electric oscillations, comprising an electron discharge amplifier tube having a cathode, a signal grid and an output electrode, an electron discharge control tube having a cathode, a first control grid, a perforated anode, a second control grid and a second anode, a resonant input circuit having a natural damping smaller than necessary for the width of said band of electric oscillations, means to apply said electric oscillations to said input resonant circuit, means coupling said resonant input circuit to said signal grid, a resonant output circuit coupled to said output electrode, means coupling said output resonant circuit to said first control grid, means coupling said perforated anode to said resonant input circuit in negative feedback relationship, and means to apply a control voltage varying in amplitude proportional to the amplification of said circuit arrangement to said signal grid and to said second control grid to vary the degree of feedback applied to said amplifier tube and to increase the damping of said resonant input circuit and thereby control the amplification of said amplifier tube.

8. A circuit arrangement for amplifying a band of electric oscillations, comprising an electron discharge amplifier tube having a cathode, a signal grid and an output electrode, an electron discharge control tube having a cathode, a first control grid, a perforated anode, a second control grid and a second anode, a resonant input circuit having a natural damping smaller than

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necessary for the width of said band of electric oscillations, means to apply said electric oscillations to said input resonant circuit, means coupling said resonant input circuit to said signal grid, a resonant output circuit coupled in said output electrode, means coupling said output resonant circuit to said first control grid, means coupling said perforated anode to said resonant input circuit in negative feedback relationship, and means to apply a control voltage varying in amplitude proportional to the amplification of said circuit arrangement to said signal grid and to said second control grid to vary the degree of feedback applied to said amplifier tube and to vary the damping of said resonant input circuit and thereby control the amplification of said amplifier tube, said signal grid being increasingly negative with increasing negative feedback to maintain the damping of said resonant input circuit substantially constant.

9. A circuit arrangement for amplifying a band of electric oscillations, comprising an electron discharge amplifier tube having a cathode, a signal grid and an output electrode, an electron discharge control tube having a cathode, a first control grid, a perforated anode, a second control grid and a second anode, a resonant input circuit having a natural damping smaller than necessary for the width of said band of electric oscillations, means to apply said electric oscillations to said input resonant circuit, means coupling said resonant input circuit to said signal grid, a resonant output circuit coupled in said output electrode, means coupling said output resonant circuit to said first control grid, means coupling said perforated anode to said resonant input circuit to couple the same to said resonant output circuit in negative feedback relationship, and means to vary the amplification of said control tube to vary the degree of feedback from the output circuit to the input circuit of said amplifier tube to vary the damping of said resonant input circuit and thereby control the amplification of said amplifier tube to maintain the damping of said resonant input circuit substantially constant.

MAXIMILIAAN JULIUS OTTO STRUTT.
ALDERT VAN DER ZIEL.

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