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AMPLIFYING CIRCUIT FOR ULTRA SHORT WAVES

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Fig. 1

Fig. 2

Fig. 3

Fig. 4

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AMPLIFYING CIRCUIT FOR ULTRA-SHORT WAVES

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In the copending application, Serial No. 340,514, filed June 14, 1940, there has been described an amplifying-circuit arrangement for ultra-short waves in which use is made of a push-pull arrangement of two amplifying systems each comprising at least one cathode, one control-grid, one screen-grid and an anode and in which the cathodes of the two systems are interconnected through as short a lead as possible, each of the screen-grids being connected for high-frequencies to the corresponding cathode through an inductance of such a size that the input-damping of the circuit is zero or negative.

For a clear understanding of the invention reference will be had to the several figures of the accompanying drawing in which Fig. 1 is a circuit of the above prior application and over which the present invention is an improvement, and Figs. 2 to 4 are various circuits which embodies the invention.

Referring first to the circuit arrangement of Fig. 1, the input-voltage originating, for instance, from a dipole antenna is supplied to the terminals 1 and 2 and inductively transmitted to the input-oscillatory circuit 3. The ends of the oscillatory circuit 3 are connected in push-pull arrangement to the control-grids of the push-pull amplifying tube 4. This tube comprises two amplifying systems each consisting of a cathode, a control-grid, a screen-grid, a suppressor grid connected to the cathode and an anode. Between the anodes is interposed the output-oscillatory circuit 5 from which the amplified voltage can be taken at the terminals 6 and 7.

The cathodes of the amplifying systems are interconnected through as short a lead as possible. The screen-grids are each separately led out of the tube and connected for high frequencies to the cathode through inductances 8 and 9. These inductances are so proportioned that the input-damping of the tube 4 is zero or negative so that the circuit 3 is not damped or even undamped by the tube. The value of the self-induction of coils 8 and 9 required therefor is of the order of magnitude of 10-1 henries.

The circuit arrangement set out above has the drawback that the ratio between the signal current and the noise-current in the anode circuit is very unfavourable.

According to the invention this drawback is obviated by connecting the anode of each of the amplifying systems through the corresponding part of the output-impedance for high frequencies either to the end, facing the screen grid, of the inductance inserted in the corresponding screen-grid circuit, in other words, the screen grid end of the inductance, or to a point of this inductance located between the ends, that is, an intermediate point.

The invention is based on the recognition that the unfavorable signal-noise ratio in the circuit disclosed in the principal application is due to over-compensation of the distribution noise, which may be explained as follows by reference to Fig. 1.

The distribution noise results from variations in the current-distribution between the anode and the screen-grid. In this case a random increase of the anode-current involves an equal decrease of the screen-grid current so that the distribution noise-current in the anode circuit and the screen-grid circuit are in phase opposition with respect to one another. When the screen-grid circuit includes an inductance, for instance the inductance 8 shown in Fig. 1, the distribution noise-current will set up a noise-voltage across this inductance which voltage leads in phase by 90° with respect to the distribution noise-current flowing in the screen-grid circuit and which consequently lags by 90° relatively to the distribution-noise current flowing in the anode-circuit. This voltage evolves a current through the center of the input-impedance 3 connected to the cathode, the part of the input impedance located between this center of the control-grid of the amplifying system in question, and the control-grid screen-grid capacity designated by 18 in the drawing, whose phase is mainly determined by the control-grid/screen-grid capacity and which consequently leads in phase by about 90° relatively to the said noise-voltage. Hence this current will substantially be in phase with the distribution noise current flowing in the anode-circuit and set up a voltage across the part of the input-circuit 3 located between the center and the control-grid, which voltage is also in phase with the distribution noise-current flowing in the anode-circuit. It is to be remarked that only those frequencies of the distribution-noise spectrum are of importance which are transmitted by the circuit and to which consequently the circuit 3 practically constitutes an ohmic resistance. Frequencies towards which the circuit 3 no longer behaves as an ohmic resistance and which thus might give rise to voltages of another phase between the center and the control-grid may be left out of consideration.

For the frequencies of the distribution noise spectrum transmitted by the circuit there will be set up, a voltage at the control grid, as appears
from what has been said above, which is corre-
lated with the distribution noise and in phase-
opposition with the distribution noise current
flowing in the anode-circuit and which conse-
quently contributes to the anode-current which
is also in phase-opposition with the distribu-
tion noise current in the anode current. Thus
the distribution noise in the anode circuit might
be entirely avoided by giving the inductance 8 suit-
able proportions.
If, however, the inductances 8 and 9 are so pro-
portioned that the input-damping is zero or nega-
tive the values of current in the inductance 8
higher than were necessary for compensation of
the distribution noise. Hence the distribution
noise is far over-compensated and the circuit is
liable to more noise than were the case in the
absence of the inductances 8 and 9.

The distribution noise-current in the anode
circuit and the screen-grid circuit being in phase
opposite will cancel out each other in that part
of the connection between screen-grid and cath-
odc which is common to the screen-grid circuit
and the anode-circuit. So there does not flow
distribution noise-current in this part of the
screen-grid circuit. Now the invention consists
in that over-compensation of the distribution
noise is avoided by inserting at least a part of
the inductance required for removing the input-
damping in this common part of the anode-cir-
cuit and the screen-grid circuit.
The invention will now be more fully explained
by reference to Figures 2 to 4.
The circuit represented in Fig. 2 differs from
that shown in Fig. 1 in that the output-imped-
ance 5 is split up into two parts 5' and 5"; the
anode of the upper amplifying system being con-
ected through the circuit 5' to the end, facing
the screen grid, of the inductance 8 inserted in
the corresponding screen-grid circuit, and the
anode of the bottom amplifying system being
connected through the circuit 5" to that end of
the inductance 9 which faces the screen-grid.
The distribution noise-current now flows in the
two amplifying systems from the anode through
the circuit 5', 5"; respectively to the corresponding
screen-grid, but does not pass through the inductance
8, 9 respectively so that over-compensation of the
distribution noise can no longer occur. In this
case the inductances 8 and 9 are traversed only
by the signal-current of the screen-grid, but
also by that of the anode. As a result of this
the coils 8 and 9 for removing the input-damp-
ing may have a much lower self-induction than
in the circuit shown in Fig. 1.
In amplifying very short waves the distribution
noise-current may sometimes involve a high
noise voltage across the inductance of the part
of the supply lead of the screen-grid extending
inside the tube so as to cause over-compensation
of the distribution noise. In this case it is ad-
vantageous to make use of the circuit shown in
Fig. 3 in which the screen-grids are each fur-
nished with two separated supply leads. In this
arrangement each screen-grid is connected
through one of the said supply leads and the cir-
cuit 5', 5" respectively to the corresponding
anode circuit and through the other supply lead and
the inductance 8, 9 respectively to the cathode.
In this case there is no coupling at all between
the circuit traversed by the distribution noise-
current and the screen-grid cathode circuit so
that over-compensation of the distribution noise
is entirely obviated.

On the other hand it may be that the induct-
ance of the part extending within the tube is
smaller than is necessary for compensation of the
distribution noise, in which case complete re-
moval of the distribution noise can be achieved
by means of the circuit represented in Fig. 4.
In the circuit shown in Fig. 4 the anodes are
connected through circuits 5', 5" respectively
to tappings of the inductances 8 and 9. In this
case the self induction of part 5', 5" respectively
which is located between the tapping and the
screen-grid and consequently traversed by the
distribution noise-current is chosen so as exactly
to compensate and as much as possible the
more the part 5', 5" respectively between the
tapping and the cathode is so chosen that under
the joint action of parts 8', 8" and 9', 9" respec-
tively the desired undamping of the input-circuit
is obtained.
The same effect can be obtained in the circuit
shown in Fig. 3 by providing that a part of the
two supply leads of each screen-grid coincides
within the tube.
What we claim is:
1. A self-compensating circuit arrangement for
ultra-short waves including a push-pull circuit
of two amplifying systems each of which com-
prises at least one cathode, one control-grid, one
screen-grid and one anode and in which the
cathodes of the two systems are interconnected
through as short a lead as possible so as to pro-
vide negligible impedance, each screen-grid being
connected for high frequencies to the corre-
responding cathode through an inductance which
is so proportioned that the input-damping of the
circuit is zero or negative, and the anode of each
amplifying system being connected for high fre-
quencies through the corresponding part of the
output-impedance to the end of the inductance
connected to the corresponding screen-grid.
2. An amplifying circuit arrangement as claimed
in claim 1, in which the screen-grid of each
amplifying system is furnished with two
separated supply leads, the screen-grid being
connected through one of these supply leads to
the anode and through the other supply lead to
the cathode.
3. An amplifying circuit arrangement for
ultra-short waves including a push-pull circuit
of two amplifying systems each of which com-
prises at least one cathode, one control-grid, one
screen-grid and one anode and in which the
cathodes of the two systems are interconnected
through as short a lead as possible so as to pro-
vide negligible impedance, each screen-grid being
connected for high frequencies to the corre-
responding cathode through an inductance which
is so proportioned that the input-damping of the
circuit is zero or negative, and the anode of each
amplifying system being connected for high fre-
quencies through the corresponding part of the
output-impedance to an intermediate point on the inductance connected to the corre-
sponding screen-grid.
4. An amplifying circuit arrangement as claimed
in claim 3, in which the anode of each
amplifying system is connected through the
current input-circuit to such a tapping point of the inductance con-
ected to the corresponding screen-grid that
the inductance located between the screen-grid
and the tapping point has the value required for
complete compensation of the distribution
noise.
5. A circuit for the amplification of ultra-short
waves comprising a push-pull tube provided
with two electrode systems each of which has at least a cathode, a signal control grid, a screen grid and an anode, the cathodes being directly connected together within the tube, an input circuit connected to the signal control grids, an output circuit connected to each anode, an inductance connected between each screen grid and the common cathode lead, and a connection from the low potential end of each output circuit to one of the screen grid inductances, said screen grid inductances being of such value as to compensate for the damping of the input circuit.

6. A circuit for the amplification of ultrashort waves comprising a push-pull tube provided with two electrode systems each of which has at least a cathode, a signal control grid, a screen grid and an anode, the cathodes being directly connected together within the tube, an input circuit connected to the signal control grids, an output circuit connected to each anode, an inductance connected between each screen grid and the common cathode lead, and a connection from the low potential end of each output circuit to the screen grid end of the inductance connected to the corresponding screen grid, said screen grid inductances being of such value as to compensate for the damping of the input circuit.

7. A circuit for the amplification of ultrashort waves comprising a push-pull tube provided with two electrode systems each of which has at least a cathode, a signal control grid, a screen grid and an anode, the cathodes being connected together by a path of minimum impedance, an input circuit connected to the signal control grids, an output circuit connected to each anode, an inductance connected between each screen grid and the common cathode lead, and a connection from the low potential end of each output circuit to an intermediate point on the inductance connected to the corresponding screen grid, said inductances being of such value that the common portions included in the screen grid and anode circuits compensate for the damping of the input circuit, and the remaining portions are adapted to increase the signal to noise ratio in the output circuits.

8. A circuit for the amplification of ultrashort waves comprising a push-pull tube provided with two electrode systems each of which has at least a cathode, a signal control grid, a screen grid and an anode, the cathodes being connected together by a path of minimum impedance, an input circuit connected to the signal control grids, an output circuit connected to each anode, two supply leads connected to each screen grid, an inductance connected between one supply lead of each screen grid and the common cathode lead, and a connection from the low potential end of each output circuit to the other screen grid supply lead, said inductances being of such value as to compensate for the damping of the input circuit.

9. A circuit as defined in claim 8 wherein the connections from the screen grid supply leads are high frequency connections.

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