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CIRCUIT ARRANGEMENT ADAPTED TO EQUALIZE WORKING
VOLTAGE FLUCTUATIONS IN AMPLIFIERS
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Fig. 1

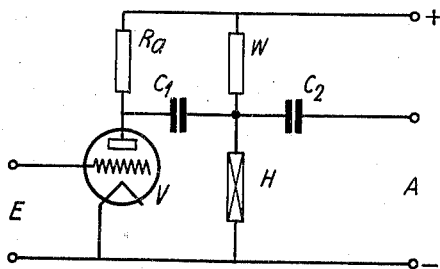


Fig. 2

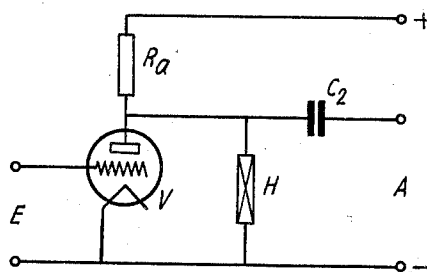


Fig. 3

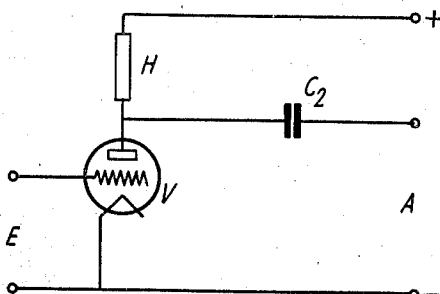


Fig. 4

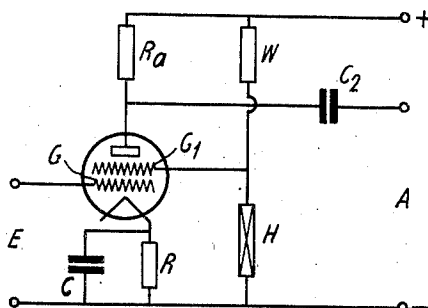
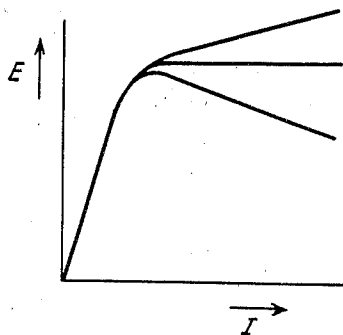


Fig. 5



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CIRCUIT ARRANGEMENT ADAPTED TO
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TUATIONS IN AMPLIFIERS

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It is known that the electrical properties of an amplifier, and primarily its amplification factor, is markedly affected by the working potentials. Especially fluctuations of the plate potential and the grid biasing potential cause alterations in the amplification factor. The situation is similar in the case of rectifier arrangements, for example, dry copper type rectifiers and all other transmission or transducer means in which the transmission measure is a function of the working voltages. If these latter are derived from mains by way of power units, the voltage fluctuations are liable to become so great that appreciable distortion ensues. Particularly sensitive to changes in the working voltages are amplifier circuit organizations which comprise automatic regulator means inasmuch as the regulating characteristic depends to a large degree upon the prevailing working voltages. In the case of amplifiers which are included in large numbers of telephone lines, with a view to stabilizing operating conditions, it is necessary to insure the prescribed amplification factor inside very narrow limits; in other words, variations of voltage would here cause serious consequences.

A great number of circuit schemes are known from the prior art the purpose of which is to insure stabilization of the voltage sources. In these, circuit elements are interposed between the source of potential and the consuming devices (load) whereby the voltage fluctuations are diminished. Arrangements of this sort generally involve considerable expenditure and equipment without being capable of completely eliminating voltage fluctuations.

According to this invention, a fundamentally different procedure is followed. Instead of stabilizing the working voltages supplied to a consuming device, say, an amplifier, voltage- or current-dependent resistances which are subject to the action of the working voltages are so combined with the consuming device that they will compensate such alterations in the transmission measure as may arise. By this compensation method it is feasible to eliminate practically completely all variations in transmission measure due to fluctuations of the working voltage. Among the voltage-dependent resistances which are suited for the present purpose there may primarily be used resistances whose voltage-dependence is predicated upon thermal properties, say, the so-called "hot" conductors consisting of uranium oxide. These resistances moreover possess this favorable merit that they are linear in action so far as the useful frequencies to be transmitted are

concerned. Hence, there happens no increase in the distortion or "blur" factor as a result of the adoption of these resistances.

There are quite a number of different ways and means of including the voltage-dependent resistance in the circuit organization in which the transmission measure is to be made independent of the fluctuations of working voltage. For instance, in the case of amplifier arrangements, these voltage-dependent resistances could be connected (to act) as plate resistances. Also a combination of these resistances with other constant resistances to result in voltage dividers is suitable to carry the invention into practice. It may also be convenient to insert the resistances in the circuit of auxiliary grids, the voltage of the latter being shifted in this manner as a function of working variations in such fashion that no change in the transmission measure will occur. Finally, the resistances could be employed also in the form of variable attenuation means (networks) between two amplifier stages.

Inside the scope of the invention it is not absolutely necessary to use resistances which will exhibit a linear behavior for the useful frequencies. If the resistances are included at where the amplifiers are operated far below the overrunning point then the ensuing non-linear distortions will be acceptably small. By such inertialess resistances, rapid changes in the working fluctuations (sic) can then be equalized, for instance, A. C. superposed upon the line potential.

A number of exemplified embodiments of the basic idea of this invention are illustrated in Figs. 1 to 4. Fig. 5 shows the characteristic of a hot conductor.

Referring to Fig. 1, the amplifier tube V is fed with plate potential by way of plate resistance R_a . Coupling with the following stage is insured by way of the two condensers C1 and C2. In order that variations in amplification factor or gain caused by fluctuations in the plate-potential source may be compensated, there is connected in parallel relation to the internal resistance of the tube a hot conductor H to which the plate potential is applied by way of the series resistance W. The graphs shown in Fig. 5 which show the dependence of voltage E upon the current I for various hot conductors will make it clear that the resistance of such a hot conductor, above a certain voltage, is liable to assume extremely low values which, under certain circumstances, may even be negative. If the series resistance W has been chosen properly, the resistance of the hot conductor can be made such a function of the

variations in the plate potential source, that the transmission measure (gain) between input E and output A is stabilized. The resistance of the hot conductor here counteracts the fluctuations of the amplification factor by having the same play the part of a variable damping means. Figure 5 shows the D. C. voltage across several specimens of hot conductor as a function of the D. C. current therethrough.

When a certain D. C. current is forced through such a hot conductor, the alternating current resistance to superposed small variations is given by the slope of the characteristic of Figure 5 taken at the point corresponding to the D. C. current component. It will be seen that this slope changes rather rapidly over a portion of each characteristic, and that the effective A. C. resistance diminishes rapidly with increasing current throughout such portion. Now in Figure 1, for example, it is seen that an increase of plate supply voltage will increase the current through conductor H and hence if W is so chosen as to make the normal current through H such as to correspond to the curved portion of the characteristics of Figure 5, then an increase of the plate supply voltage results in a decrease in the alternating current resistance of H. Since H is in parallel with anode resistor R_a with respect to alternating currents, the effective load resistance and, hence, the amplification of the stage is reduced, other things being equal. However, the assumed increase in plate voltage tends to increase the amplification so that the two effects offset each other. The offsetting can be made close by choosing resistance W so as to bring the operating point of conductor H onto a part of the characteristic of Figure 5 that has just the right amount of change in A. C. resistance per volt change in plate supply to offset the change in amplification that would take place per volt change in plate supply in the absence of variation of resistance in the A. C. plate circuit.

Fig. 2 shows, fundamentally speaking, the same organization, though the hot conductor is in this instance so proportioned that it may be applied to the same potential as the plate of the amplifier tube V. The series resistance W and the blocking condenser C1 are here omitted.

Fig. 3 illustrates a further simplification of the circuit scheme in that the hot conductor H here takes the place of the plate resistance.

Whereas in the circuit organizations shown in Figs. 1 to 3 the non-linear resistance influenced directly the transmission measure of the circuit arrangement, in the scheme shown in Fig. 4 the non-linear resistance is employed to produce a voltage at the auxiliary grid of the amplifier tube that is a function of the fluctuations of the plate potential source. What is here shown is an amplifier tube comprising two grids G and G1. The biasing voltage for the normal control grid G is obtained by the aid of the resistance R included in the plate circuit, said resistance R being shunted by a condenser C. The auxiliary grid G1 receives its biasing potential from the voltage divider comprising the series resistance W and the hot conductor H, said voltage divider being arranged in parallel relation to the plate current source. If, for instance, by a rise in the plate

potential, the amplification factor of the tube experiences an increase, there happens a shift of the potential at the auxiliary grid G in the negative sense as a consequence of a decrease in resistance of the hot conductor. In this manner the transmission measure between the input E and the output A can be rendered independent of the fluctuations of the plate potential. In this circuit organization it would also be feasible to use an inertialess non-linear resistance inasmuch as this resistance is not contained in the circuit of the useful frequency.

The foregoing circuit arrangements illustrate the use of non-linear resistances in the plate circuit of amplifier tubes. However, these resistances may with equal success be employed also at any other convenient point of the circuit organization whose transmission measure or gain is to be stabilized. What is necessary in these circuit arrangements is that the non-linear resistances should be subject to the action of working voltages whose harmful effect upon the transmission measure is to be compensated.

I claim:

1. In amplifying apparatus and the like, an electronic tube having an anode, a cathode and a control electrode, a pair of terminals for connecting the tube to a source of space current, a connection between one of the terminals and the anode, said connection including an anode impedance element, a connection between the other of said terminals and the cathode, a circuit connected between said first terminal and the second terminal, said last named circuit including a series resistance and a hot conductor, an output terminal, means for connecting the anode of said tube to a point of the last-named circuit intermediate the series resistance and the hot conductor, said connection including a capacitive device, and means for connecting the last-named point to the output terminal including a capacitive device.

2. In a relay circuit, an electronic tube having an anode, a cathode and a grid electrode, a pair of terminals for connecting the tube to a source of anode potential, means including an impedance element for connecting the anode to one of said terminals, means connecting the cathode to the other of said terminals, an output terminal, a connection including a capacity between the anode and said output terminal and a hot conductor connected between said last named connection and the cathode.

3. In a relay circuit, an electron tube having an anode, a cathode, and a grid electrode, an input circuit connected to said grid and said cathode, an output circuit connected to said anode and said cathode, an anode resistor and a source of anode potential connected across said output circuit, a circuit connected across said source of potential and including an element whose resistance is a function of the voltage thereacross, said element being also connected in parallel with said output circuit, whereby variations in voltage of said source produce changes in the resistance of said element such that changes in transmission resulting from said voltage variations on said electron tube are compensated.

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