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AMPLIFYING SYSTEM

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FIG. 1

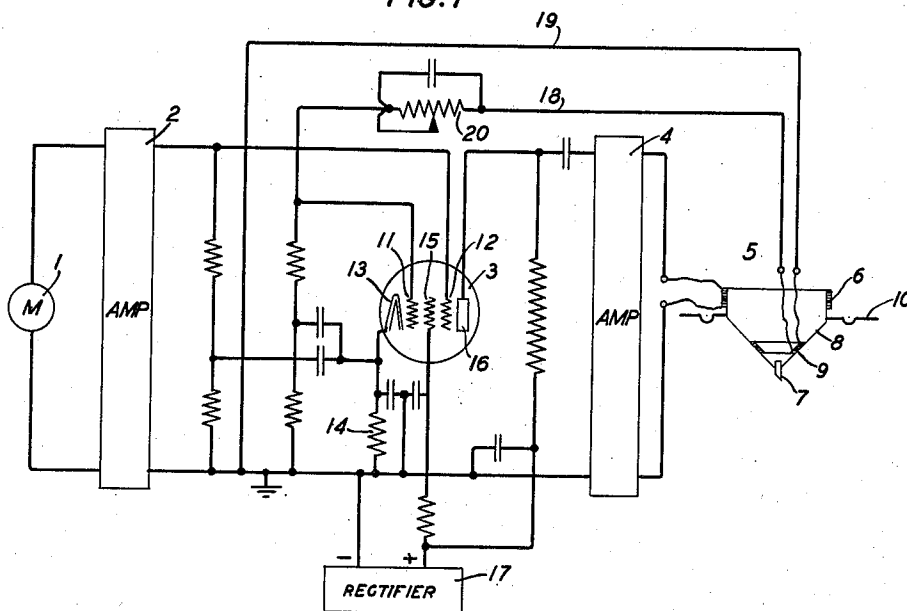
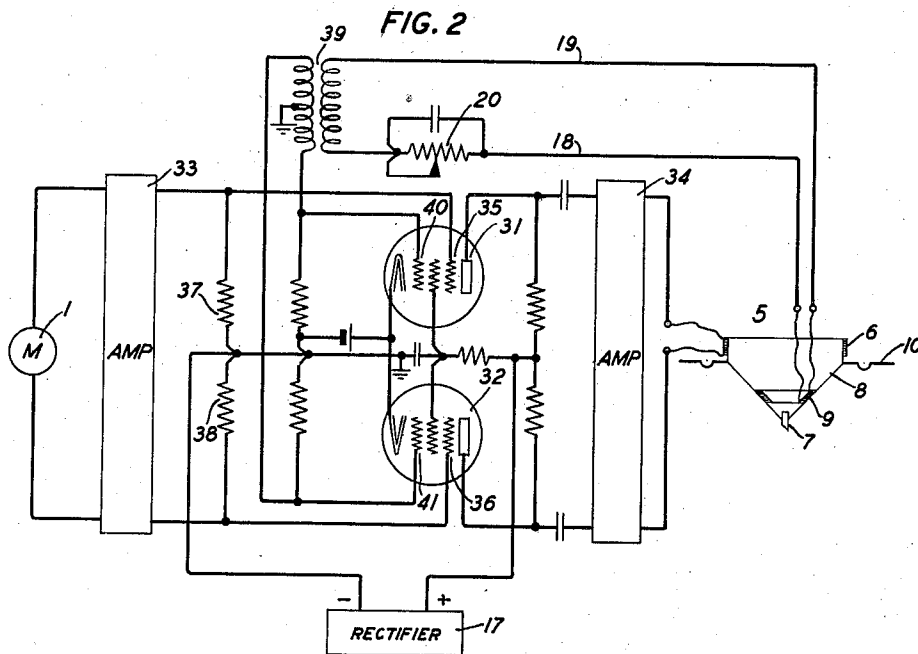


FIG. 2



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AMPLIFYING SYSTEM

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5 Claims. (Cl. 179—171)

This invention relates to amplifying systems and particularly to such systems in which negative feedback is used to obtain a flat response characteristic.

5 In negative feedback amplifiers it is sometimes desirable to provide a gain around the feedback loop which is high as compared with the gain required in the main signal path. This is particularly true of systems in which the voltage
10 avallage for feedback is limited as it is, for example, in a system using negative feedback to obtain a uniform response in an electromechanical receiving device. In the case of a phonograph recording system, for example, a constant
15 vibratory velocity is required at the stylus point so that the potential fed back must be proportional to the actual stylus velocity. This requires that a generating element, such as a small coil in a magnetic field, be mounted as closely
20 as possible to the stylus and due to the double conversion of energy from electrical to mechanical and back to electrical energy in the feedback coil, the output of the coil is at a very low level and must be highly amplified in order to produce
25 the necessary correcting effect.

When such a system is operating at high gain over a wide range of frequencies it becomes very difficult to obtain the amount of feedback required and at the same time to control the phase
30 shift around the feedback loop in such a way that the feedback is kept negative for all frequencies in the operating range. Since the phase shift in the signal path in many cases is very near the maximum permissible, the introduction
35 of additional amplifier stages in the feedback path to obtain high gain is very apt to result in an unstable system. In most systems, however, there is usually ample gain available in the signal path and attenuation pads are often used
40 to reduce the signal level to the value required in a particular portion of the system.

According to this invention, the feedback potential from the output of the system is applied in reversed phase to the control or high
45 mu-factor grid of a tube in the driving amplifier and the signal is applied to an auxiliary grid of lower mu-factor such as the suppressor thereby obtaining a relatively high gain around the feedback loop without the use of additional amplifier
50 stages which would increase the phase shift in the feedback potential.

In the drawing:

55 Fig. 1 shows a recording system with negative feedback according to the invention; and

Fig. 2 shows the negative feedback circuit as applied to a push-pull stage.

In the system of Fig. 1, a microphone 1 or other source of currents representing signals is connected to the input of an amplifier 2 the
6 output of which passes through the gain controlling stage 3 to a second amplifier 4 which drives a phonograph recorder or other receiving device 5.

The receiving device shown is a diagrammatic
10 representation of the vibratory system of the electrodynamic recorder disclosed in a copending application of L. Vieth, C. F. Wiebusch and G. R. Yenzer, Serial No. 167,708, filed October 7, 1937. The driving coil 6 is rigidly connected to
15 the cutting stylus 7 by the conical member 8 which carries a driven or feedback coil 9 mounted near the stylus. This assembly is resiliently mounted for vibration with the coils 6 and 9 in air-gaps of a magnetic circuit (not shown) by the
20 diaphragm 10.

The gain control stage 3 comprises a multiple grid tube, such as a pentode, resistance-capacity coupled to the amplifiers 2 and 4 in the conventional manner except as explained below.
25 The control grid 11 and the suppressor grid 12 are suitably biased with respect to the cathode 13 by the potential drop in the cathode resistor 14 and suitable potentials are supplied to the screen grid 15 and plate 16 by the power supply
30 unit 17.

Since the output of amplifier 2 is impressed on the suppressor grid 12 the gain in the signal level in this stage will be relatively small, but the amplifier 4 may have as many additional
35 stages as are necessary to provide adequate power for driving the recorder. As the moving system of the recorder vibrates under the control of the output of amplifier 4 to drive the stylus 7 and cut a record, the coil 9 will generate a voltage which is proportional to the velocity of the stylus.
40 Since this voltage is derived by a double conversion of the signal energy from electrical to mechanical and back to electrical energy in the coil, which due to various design considerations is ordinarily very small, the voltage obtained may be of the order of
45 35 decibels lower in level than the signal applied to the coil 6.

These small voltage variations, however, are applied as a negative feedback over conductors
50 18 and 19 and a suitable phase shift adjusting network 20 to the control grid 11 which has a much higher gain ratio than the grid 12. In this way the feedback voltage is amplified of the order of
55 35 decibels more than the signal

in this stage. At the input to the amplifier 4 the amplified feedback voltage modifies the signal and the modified signal is raised to the desired output level in the amplifier 4.

5 In the circuit of Fig. 2 negative feedback from the recorder is applied to a push-pull volume
controlling stage comprising pentode tubes 31
and 32 resistance-capacity coupled to conven-
tional amplifiers 33 and 34 which may also be
10 of the push-pull type or may have one or more
stages of single side amplification as desired.
The volume controlling stage of this circuit is
in general of conventional design except that
the signal output of amplifier 33 is applied to
15 the suppressor grids 35 and 36 which are con-
nected in push-pull relation by the coupling
resistors 37 and 38. Since the feedback circuit
from the coil 9 on the recorder is of the single
20 side type some suitable connecting element such
as a transformer 39 must be used to couple this
circuit to the push-pull control grids 40 and 41.
While the transformer will introduce into the
feedback loop some additional phase shift which
25 is objectionable for the reasons already stated,
it has the advantage of providing a step-up in
feedback voltage of the order of ten to one and
by proper design its phase shift over the high
quality range of 20 to 15,000 cycles can be limited
30 to about 10 degrees. Although the phase shift
of the transformer increases materially above
this range, this does not produce an unstable
system since the gain around the feedback loop
falls off rapidly above the audible range.

It will be understood that a transformer may
35 be used if desired in the feedback path of a single
side amplifier system when this can be done
without unduly complicating the phase shift
problem and that in the push-pull system the
feedback coil may be connected directly to the
40 grids of the tubes through suitable series resistors.

While the invention has been described for
purposes of illustration with reference to a
phonograph recording system, it will be obvious
45 that it is equally applicable to any other system
in which electrical waves are translated into another
form of energy or to purely electrical feedback
systems in which a large amount of feedback
controlled in phase is required. In the system
50 illustrated the signal is applied to the suppressor
grid and the feedback to the control grid since
this circuit gives the greatest excess gain in
the feedback path, but it will be understood

that applicant's invention consists broadly in applying feedback to a grid having a higher mu-factor than the grid to which the main signal voltage is applied.

What is claimed is:

5 1. In an amplifying system including a vacuum tube having two grids, one of which has a higher mu-factor than the other, means for negatively biasing both grids, a signal path through
10 the system including the grid of lower mu-factor, and a feedback path from the output of the system to the grid of higher mu-factor.

2. In a multistage amplifying system, input and output translating devices therefor, a vacuum tube in an intermediate stage of the system
15 having two grids with different mu-factors, means for negatively biasing both grids, a signal path through the system including the grid of lower mu-factor, a voltage generating element in the output device, and a feedback path from the
20 element to the grid of higher mu-factor.

3. In a multistage amplifying system, input and output translating devices, a vacuum tube in an intermediate stage of the system having
25 two grids with different mu-factors, means for negatively biasing both grids, a signal path through the system including the grid of lower mu-factor, a vibratory system in the output device having a single resonance within its operating
30 range of frequencies, and means for controlling the vibration of the system comprising voltage generating means on the system and a circuit for applying the generated voltage as a
35 negative feedback to the grid of higher mu-factor.

4. In an amplifying system, a tube having a control grid and at least one auxiliary grid, means for negatively biasing both grids, a signal path through the system including the auxiliary
40 grid of the tube, and a negative feedback path extending from a point in the system beyond the output of the tube to the control grid.

5. In an amplifying system, a stage comprising two tubes each having a control grid and at least one auxiliary grid, means for negatively
45 biasing both grids, and push-pull connections between the tubes, a signal path through the system including the auxiliary grids of the tubes, and a negative feedback path extending from a point in the system beyond the output of the
50 tube to the control grids.

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