Dec. 21, 1948. R. C. MOORE 2,457,062

QUENCHED AMPLIFIER SYSTEM

Filed Aug. 2, 1944

FIG. 2.

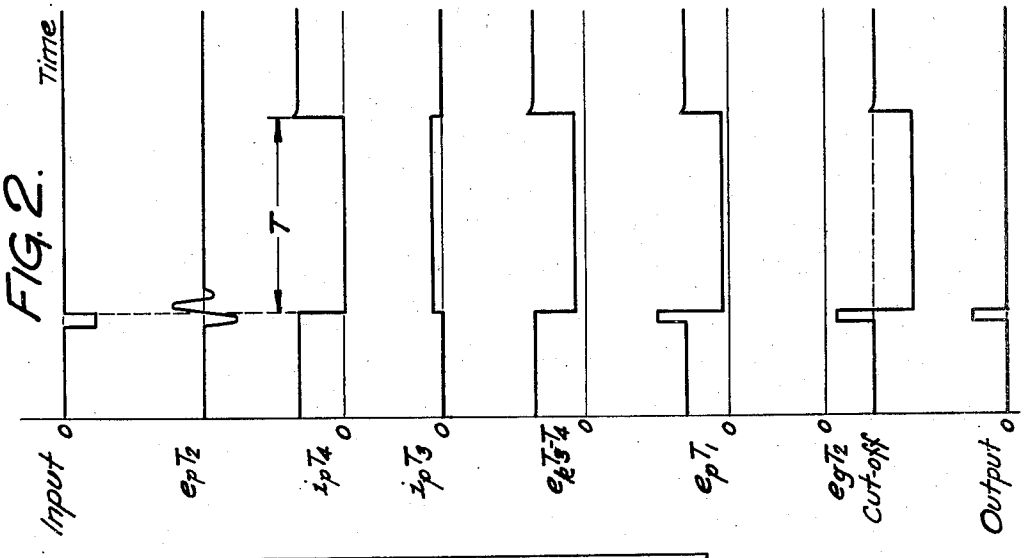
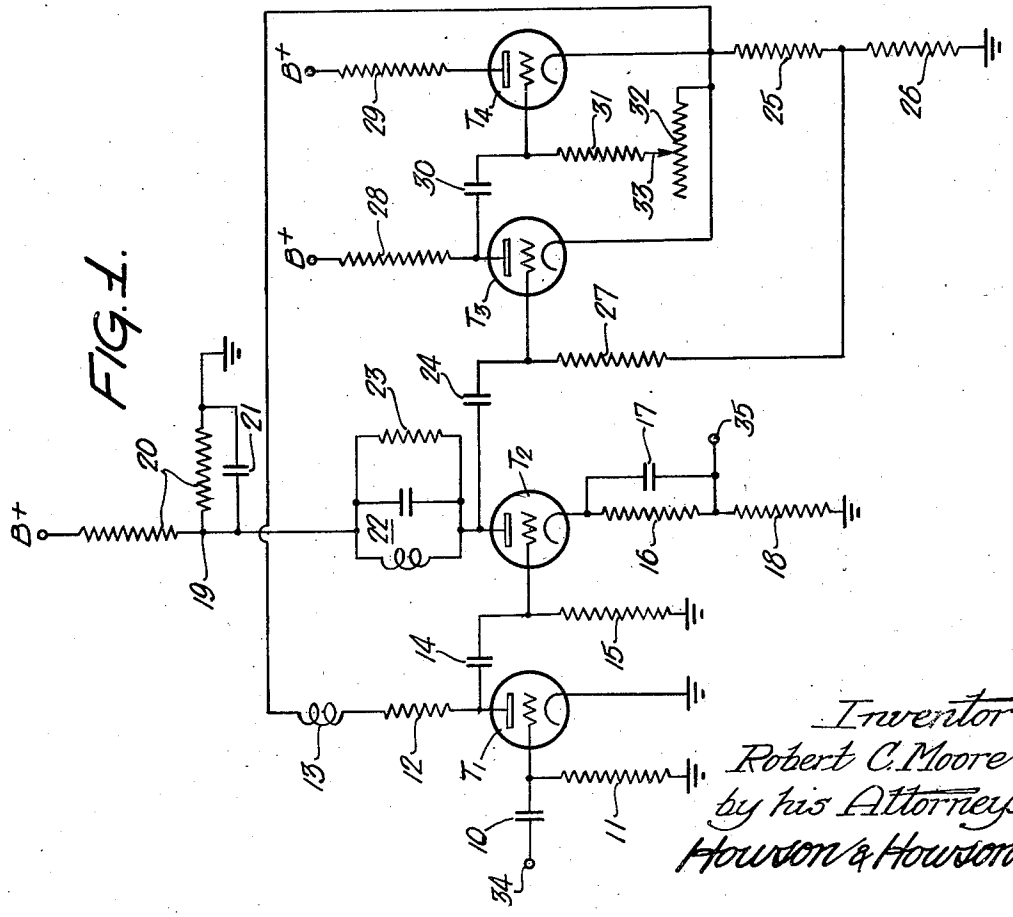


FIG. 1.



Inventor:
Robert C. Moore
by his Attorneys
Howson & Howson

Patented Dec. 21, 1948

2,457,062

UNITED STATES PATENT OFFICE

2,457,062

QUENCHED AMPLIFIER SYSTEM

Robert C. Moore, Philadelphia, Pa., assignor, by mesne assignments, to Philco Corporation, Philadelphia, Pa., a corporation of Pennsylvania

Application August 2, 1944, Serial No. 547,720

7 Claims. (Cl. 250—27)

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This invention relates to quenched amplifier systems and particularly to quenched amplifying systems in which the duration of the quenching period is adjustable.

In some applications of amplifying systems, it is desirable to employ an amplifier which is non-responsive to incoming signals for some predetermined interval after the response to a desired signal. For example, this characteristic is particularly desirable in pulse-actuated amplifiers employed to initiate certain events in other parts of an electronic system. For example, such amplifiers may be employed to trigger wave shaping circuits, timing pulse generators, oscillator circuits, or the like. In order that the triggered circuit may complete the desired operation initiated by a pulse signal, it is desirable to prevent any subsequent incoming signals from interfering with this desired operation of the triggered circuits. To accomplish this protection, some means may be provided to place the input signal amplifying system in an inoperative condition for an interval of time approximately equal to the time required for the triggered circuit to complete its desired function. After completion of the desired events in the triggered circuit, the input signal amplifier may be returned to its normal condition ready to respond to another pulse signal.

Furthermore, it is desirable that the inoperative or protection period of the input signal amplifying system be easily varied between limits in order to accommodate any desired changes in the operating period of the triggered circuit.

The principal object of this invention is to provide a high efficient quenching system for a pulse-responsive amplifier.

Another object of the invention to provide a quenching system in which the quenching period is readily adjustable.

A further object of the invention is to provide a quenching system employing a single-cycle oscillatory circuit, e. g. a multivibrator, to effect the quenching action.

Other objects and advantages of the present invention will become apparent during the course of the following description with reference to the accompanying drawing, in which

Fig. 1 is a diagrammatic illustration of an embodiment of the invention; and

Fig. 2 is an explanatory illustration of the operation of the system.

Referring first to Fig. 1, there is shown a pulse amplifying circuit, comprising vacuum tubes T_1 and T_2 and their respective circuit elements,

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capacitively coupled to a quenching circuit comprising vacuum tubes T_3 and T_4 arranged in a modified common cathode loaded multivibrator circuit. As will be seen later, the multivibrator is adapted for single cycle operation, i. e. it operates only for a single cycle when triggered by an applied potential. While separate triodes are shown in the drawing, it is to be understood that duplex type tubes may be used, and other multielectrode tubes may be substituted for the triodes, utilizing the appropriate circuit modifications.

In accordance with the embodiment of the invention shown in the drawing, vacuum tube T_1 is arranged in conventional amplifier fashion, with an input circuit comprising coupling condenser **10** and grid resistor **11**, and a plate load or output resistor **12**. An inductance **13** may be connected in the plate circuit of tube T_1 to improve the high frequency response of the amplifier. The anode supply voltage for tube T_1 is obtained from the common cathode connection of tubes T_3 and T_4, which, being a relatively low voltage source, permits tube T_1 to be operated with zero grid bias. The output of tube T_1 is applied in a conventional manner, by means of coupling condenser **14** and grid resistor **15**, to the grid of the self-biased cathode loaded amplifier tube T_2. Resistor **16** with by-pass condenser **17** forms a conventional self-biasing means for the grid of tube T_2. The bias on the grid of this tube should preferably be such that tube T_2 is operated approximately at cut-off. Resistor **18** in the cathode circuit of tube T_2 is the cathode load resistor across which the output signal of the amplifier is developed. The anode potential for tube T_2 is derived from tap **19** on a voltage divider **20** connected across a suitable anode voltage source B^+. A bypass condenser **21** is connected between tap **19** and ground. The potential at tap **19** is applied to the plate of tube T_2 through the tuned circuit **22** which is designed to be resonant at a frequency such that the time of one half cycle of oscillation is equal to the duration time of the applied pulse. A damping resistor **23** is preferably connected across resonant circuit **22**. By means of coupling condenser **24** the plate of tube T_2 is coupled to the grid of tube T_3.

The common cathode connection of tubes T_3 and T_4 is grounded through a common load resistance composed of resistors **25** and **26** in series. It is to be understood that a single tapped resistor may be used in place of the two resistors **25** and **26**. The anodes of tubes T_3 and T_4 are con-

nected through resistors 28 and 29 respectively to the anode voltage source B+. The plate of tube T_3 is coupled to the grid of tube T_4 by means of coupling condenser 30. The grid of tube T_3 is connected through grid resistor 27 to the junction of resistors 25 and 26. The grid of tube T_3 is therefore biased by the voltage drop developed across resistor 25 due to plate currents of tubes T_3 and T_4 flowing through this resistor. The circuit constants of tubes T_3 and T_4 are so chosen that the plate current of tube T_4 is greater than that of tube T_3 thereby biasing tube T_3 beyond cut-off during the time tube T_4 is conducting. The grid of tube T_4 is connected to the common cathode connection of tubes T_3 and T_4 through the total resistance of fixed resistor 31 in series with a variable resistance 32. Movable contact arm 33 permits adjustment in the value of the input circuit resistance of tube T_4.

The operation of the system will now be explained with reference to the explanatory illustration of Fig. 2.

With the system in a normal condition, that is, ready to receive a negative pulse at input terminal 34, vacuum tubes T_1, and T_4 are conducting. As previously stated, tube T_2 is biased approximately to cut-off thereby permitting the amplifier to respond to negative signals only, and tube T_3 is biased beyond cut-off by the relatively high plate current of tube T_4 flowing through resistor 25. This plate current also develops sufficient voltage across resistors 25 and 26 for the plate potential of tube T_1 to permit the tube to function. In Fig. 2, the various voltages and currents are represented.

When a negative pulse (top of Fig. 2) is applied to input terminal 34, it is amplified in a normal manner by amplifier tubes T_1 and T_2 resulting in a positive pulse (bottom of Fig. 2) at the output terminal 35. There is also developed by the resonant circuit 22 a negative signal voltage (curve e_pT_2 of Fig. 2) on the plate of tube T_2 at the instant the negative input pulse is applied. Since the time of one half cycle of the oscillating voltage set up in tuned circuit 22 is equal to the duration time of the applied pulse the signal voltage on the plate of tube T_2 will begin to go positive at the end of the applied pulse. This positive signal voltage on the plate of tube T_2, due to the transient oscillating voltage set up in resonant circuit 22, is applied through coupling condenser 24 to the grid of tube T_3 thereby raising its potential above the cut-off value. At this instant the quenching circuit regenerates, that is, tube T_3 becomes conducting and tube T_4 is cut-off due to the negative potential applied to its grid from the plate of tube T_3 by means of coupling condenser 30. See curves i_pT_3 and i_pT_4 of Fig. 2.

Now since the plate current of tube T_4 has been cut-off and since the plate current of tube T_3 is much less than the conduction current of tube T_4, the potential (e_kT_3—T_4) of the common cathode connection is so reduced that the plate voltage is practically removed from the input tube T_1 of the amplifier, as shown by curve e_pT_1 of Fig. 2. This drop in potential of the plate of tube T_1 is applied to the grid of tube T_2 through condenser 14 and places the grid of tube T_2 well below cut-off, as shown by curve e_gT_2 of Fig. 2. Thus, with an exceedingly low plate voltage on tube T_1 and the grid of tube T_2 well beyond cut-off, the amplifier is non-responsive to incoming signals.

The system will remain in this condition until condenser 30 has discharged sufficiently, through resistors 31 and 32, to bring the potential on the grid of tube T_4 up to its cut-off value, at which time the quenching system will again regenerate in multivibrator fashion to cause tube T_4 to conduct and thereby restore the system to its normal condition ready to respond again to another negative pulse. In Fig. 2, the time during which the amplifier is quenched is represented by time interval T.

The length of time the amplifier is insensitive depends upon the time that tube T_4 remains in a non-conducting state. This interval is controlled by the time constant of the resistance-capacitance input circuit of tube T_4, which comprises condenser 30 and the total resistance of fixed resistor 31 and variable resistor 32. Adjustment of the setting of movable contact arm 33 varies the time constant of the input circuit of tube T_4 thereby permitting variation in the quenching interval of the system.

It will be realized by those skilled in the art that in order to maintain the grid of the second amplifier tube T_2 well below cut-off during the quenching period, the time constant of the condenser-resistor combination 14 and 15 should be long in comparison to the time constant of condenser 30 and resistors 31 and 32. Also the damping resistor 23 should be of such value that the transient alternating voltages set up in tuned circuit 22 is quickly attenuated.

From the foregoing description, it will be seen that tubes T_3 and T_4 and their associated elements form a single-cycle multivibrator whose period of operation is controllable by means of variable resistor 32, and means are provided to effect quenching of the amplifier during the operation of the multivibrator.

In the embodiment of the invention as illustrated, the resonant circuit 22 is utilized to provide an impulse which initiates operation of the oscillatory circuit comprising tubes T_3 and T_4 without interfering with the amplification of the input pulse and the derivation of the amplified output pulse. However, the initiation of operation of the said oscillatory circuit may be accomplished in any other suitable manner without using the resonant circuit 22. For example, the output pulse appearing at terminal 35 may be applied to a suitable pulse-forming circuit whose output pulse may then be applied to tube T_3 by way of the coupling condenser 24. Various methods of accomplishing the desired operation will be apparent to those skilled in the art.

In practicing this invention in accordance with the embodiment shown in the drawing, with a 250 volt anode potential source and with vacuum tubes T_1 and T_2 each a section of type 7N7 and tubes T_3 and T_4 each a section of a type 7N7, the circuit elements were as follows:

Condensers 10, 24 and 30	micro-microfarads	500
Condensers 14 and 17	microfarads	0.005
Condenser 21	do	0.1
Resistors 11 and 27	ohms	470,000
Resistor 12	do	6,800
Resistors 15, 16, 28 and 32	megohms	1
Resistor 18	ohms	2,200
Resistor 20	do	218,000
Resistors 23 and 29	do	22,000
Resistors 25 and 26	do	3,900
Resistor 31	do	68,000
Inductance 13	millihenrys	1

The inductance and capacity of tuned circuit

22 was 2 millihenrys and 100 micro-microfarads respectively. The tap 19 on voltage divider 20 was at a position 68,000 ohms from the grounded end of the voltage divider.

Although the present invention has been described with particular reference to the embodiment shown in the drawing, it will be understood that the invention is capable of various forms of physical expression and is limited only by the scope of the appended claims.

I claim:

1. In combination, a pulse-responsive amplifier comprising an input tube having an anode and a cathode loaded output tube having an anode circuit, a single-cycle multivibrator coupled to the anode circuit of said output tube, a resonant circuit in the anode circuit of said output tube for producing a transient potential capable of triggering said multivibrator, and means responsive to operation of said multivibrator for reducing the anode potential of said input tube so as to render said amplifier substantially inoperable during the operation of the multivibrator.

2. In combination, a pulse-responsive amplifier including an input tube having an anode, a single-cycle multivibrator including a first tube coupled to said amplifier and a second tube coupled to said first tube, said multivibrator tubes having anodes and having a common cathode circuit including an impedance across which a voltage is produced by the anode current of said tubes, means for applying said voltage to the anode of said input tube, said multivibrator being so constructed and arranged that its first tube is normally non-conductive and its second tube is normally conductive and the amplitude of said voltage is normally sufficient to maintain operation of said input tube but becomes insufficient to maintain such operation when the multivibrator operates, and means operable by said amplifier in response to a pulse signal for initiating operation of said multivibrator, whereby the amplifier is quenched for a predetermined period corresponding to the period of operation of the multivibrator.

3. In combination, a pulse-responsive amplifier including an input tube having an anode and a cathode loaded output tube having an anode circuit, a single-cycle multivibrator including a first tube coupled to the anode circuit of said output tube and a second tube coupled to said first tube, said multivibrator tubes having anodes and having a common cathode circuit including an impedance across which a voltage is produced by the anode current of said tubes, means for applying said voltage to the anode of said input tube, said multivibrator being so constructed and arranged that its first tube is normally non-conductive and its second tube is normally conductive, and the amplitude of said voltage is normally sufficient to maintain operation of said input tube but becomes insufficient to maintain such operation when the multivibrator operates, and means in the anode circuit of said output tube for producing a transient potential in response to a pulse signal thus initiating operation of said multivibrator, whereby the amplifier is quenched for a predetermined period corresponding to the period of operation of the multivibrator.

4. In combination, a pulse-responsive amplifier including an input tube having an anode and a cathode loaded output tube having an anode circuit, a single-cycle multivibrator including a first tube coupled to the anode circuit of said output tube and a second tube coupled to said first tube, said multivibrator tubes having anodes and having a common cathode circuit including an impedance across which a voltage is produced by the anode current of said tubes, means for applying said voltages to the anode of said input tube, said multivibrator being so constructed and arranged that its first tube is normally non-conductive and its second tube is normally conductive, and the amplitude of said voltage is normally sufficient to maintain operation of said input tube but becomes insufficient to maintain such operation when the multivibrator operates, and a resonant circuit in the anode circuit of said output tube for producing a transient potential in response to a pulse signal thus initiating operation of said multivibrator, whereby the amplifier is quenched for a predetermined period corresponding to the period of operation of the multivibrator.

5. In combination, a pulse-responsive amplifier including an input tube having an anode and a cathode loaded output tube, a normally-inoperative electron tube device adapted to operate for a predetermined period in response to a triggering potential applied thereto, means operable by said amplifier in response to a pulse signal for triggering said device, and means responsive to operation of said device for reducing the anode potential of said input tube and for simultaneously biasing said output tube below cut-off, so as to render said amplifier substantially inoperable during the operation of said device.

6. In combination, a pulse-responsive amplifier, a trigger-type device characterized in that it is adapted to produce a relatively long pulse of predetermined duration in response to a short triggering pulse, means for triggering said device in response to a short pulse supplied to said amplifier, said triggering means comprising a resonant circuit arranged to be shock-excited by the operation of said amplifier and to apply a transient triggering pulse to said device, and means controlled by said device for rendering said amplifier substantially inoperable during the occurrence of said long pulse, whereby said device functions to quench said amplifier for a predetermined time interval following said short pulse, said time interval corresponding to the duration of said long pulse.

7. In combination, a pulse-responsive amplifier comprising an input tube having an anode and a cathode-loaded output tube having an anode circuit, a trigger-type device characterized in that it is adapted to produce a relatively long pulse of predetermined duration in response to a short triggering pulse, means connected in the anode circuit of said output tube for triggering said device in response to a short pulse supplied to said amplifier, said triggering means comprising a resonant circuit arranged to be shock-excited by the operation of said amplifier and to apply a transient triggering pulse to said device, and means controlled by said device for reducing the anode potential of said input tube to render said amplifier substantially inoperable during the occurrence of said long pulse, whereby said device functions to quench said amplifier for a predetermined time interval following said short pulse, said time interval corresponding to the duration of said long pulse.

ROBERT C. MOORE.

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