Sept. 13, 1932. O. T. FRANCIS 1,877,165

ELECTRIC CONTROL CIRCUIT

Filed Dec. 27, 1928

Fig.1.

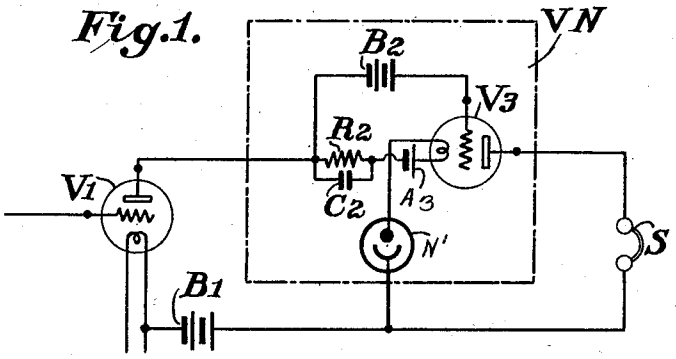


Fig.2.

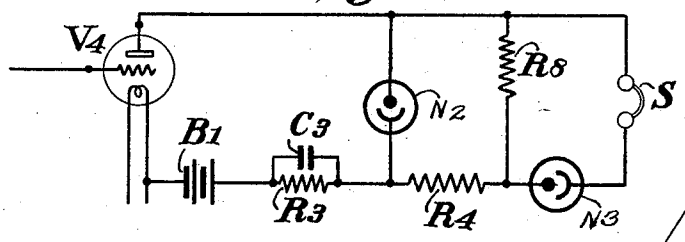


Fig.3.

Inventor:

Oliver T. Francis,

by Spear, Middleton, Donaldson & Hall

Attys.

Patented Sept. 13, 1932 1,877,165

UNITED STATES PATENT OFFICE

OLIVER T. FRANCIS, OF QUANTICO, VIRGINIA

ELECTRIC CONTROL CIRCUIT

Application filed December 27, 1928. Serial No. 328,662.

This invention relates to regulators of electric current and potential, and more particularly to means for regulating the current and potential derived from a varying source of direct current, and still more particularly to regulating potentials impressed on the elements of vacuum tube amplifiers and of the potentials impressed on the loads in the output circuits of amplifiers.

It is well known that crashes of static, local disturbances and blasting signals from a fading station cause surges of current in the output circuit of electric amplifiers.

It is the object of this invention to so control these surges that signals of above a predetermined limit impressed on the input circuit shall be eliminated entirely from the output circuit. Another object is to so regulate the plate voltage impressed on the vacuum tube amplifier that signals of above the desired strength such as those caused by a blasting station shall be no louder than the weaker signals received from said station.

With these and other objects in view, the invention may be more readily understood by a reference to the following description in connection with the drawing which shows diagrammatically several of the embodiments of the invention.

Figure 1 shows a stage of amplification employing the circuit breaker VN in accordance with the invention.

Fig. 2 shows a modification thereof.

Fig. 3 shows diagrammatically the functioning of the circuit.

Referring to Fig. 1 in the output circuit of V1 has been inserted the element VN, which consists of a vacuum tube V3 the filament of which is heated by A3, resistance R2, condenser C2, and a resistance N1, which latter is characterized by having a very high resistance until a certain voltage is impressed thereon, at which time it breaks down and has a very small resistance. Such a resistance is a neon lamp, a voltage regulator tube, a Geisler tube, a small spark gap. The function of VN is to break the circuit when surges of current above a predetermined limit such as crashes of static are impressed thereon, and further to suppress blasting signals from a fading station by increasing the impedance of V3 during the time that blasting signals would ordinarily occur, resulting in reducing the plate voltage impressed on the amplifier V1.

To more clearly illustrate the functioning of this circuit, let us assume a specific example. Assume B1 to be 180 volts, N1 to be the ordinary neon lamp which starts functioning when one hundred and forty volts is impressed thereon and becomes inoperative when the voltage impressed thereon drops to one hundred. Assume that four milliamperes are flowing through the translating device S. The negative grid bias on V3 would then be minus sixty eight volts as R2 is taken as seventeen thousand ohms. C2 may be four microfarads. To counteract this excessive negative grid bias a C battery B2 of sixty-eight volts has been inserted in the grid circuit of this tube so that the actual grid bias on the tube is zero.

By a reference to Fig. 3, I find that when Eg is zero and four milliamperes are flowing in the circuit, the IR drop through this element V3 will be of order of sixty-eight volts. Disregarding the impedance of the translating device at this time, the voltage impressed on V1 would therefore be 112 volts. If now due to the blasting signal, the current through the translating device is increased by one-half a milliampere the tube V3 would be given eight and one-half volts more negative bias due to the additional IR drop through R2 and by a reference to Fig. 3, I find that there will then be an IR drop of 135 volts of B1 across V3, where under the previous condition with four milliamperes, there was but sixty eight volts IR drop across V3. It is obvious that the amplification of V1 will be much less when the plate voltage impressed thereon is forty-five volts than when it is one hundred and twelve volts. When, however, the strength of the incoming signal increases beyond the desired limit such as that caused by a crash of static the difference in potential between the positive terminal of B1 and the filament of V3 will then be over 140 volts, as shown in Fig. 3, which will cause resistance N1 to break down

and so greatly increase the negative bias on V3 as to virtually break the circuit thru the translating device, or load S. Thus the crash of static will not be recorded in the translating device.

Fig. 2 illustrates a modification in which two resistances are used, each of which has the characteristic of greatly decreasing its resistance as the voltage impressed thereon is increased. Under the ordinary operating condition N2 is inoperative, and non-conductive, the voltage impressed on N2 not being sufficient to break down the resistance thereof. If on the other hand the current in the circuit tends to increase so that the IR drop through resistance R4 and the translating device is greater than the break down voltage of N2, it will break down, become operative and conductive, and short circuit the translating device entirely.

At the time N2 breaks down, the voltage impressed on N3 is not sufficient to continue the conductive operation of N3 due to the large current passing through R3 and the consequent large IR drop through R3, and consequently N3 will become inoperative and non-conductive. When the crash of static has passed the resistance of V4 is increased and voltage on N2 will not be sufficient to continue its conductive operation, and N2 will become inoperative, consequently N3 will again break down and come into conductive operation.

R8 has the function of reducing the voltage impressed on N3 during the time that N2 is operative by means of by-passing a portion of the current past N3 and S, thereby producing a small IR drop through R4.

C3 has the function of aiding in breaking down N3 and also decreasing the impedance of the circuit to audio frequency currents. The translating device circuit being completely broken during the period of time when the crash occurs, the crash will not be recorded therein. In one case, R3 and R4 were each ten thousand ohms. The conductive and non-conductive voltage of N3 was 110 volts, while the operative or conductive voltage of N2 was 125 volts and the inoperative or non-conductive voltage was 95 volts.

When signals are passing through load S, N3 is operatively and conductively functioning and is broken down. When a crash of static occurs, N2 breaks down and functions to by-pass the crash with respect to the load S, N3 becoming temporarily inoperative, as above stated.

While the device VN is shown as connected in the last stage of amplification, it is obvious that it can be used even more effectively in a previous stage of amplification, and especially with a means of coupling wherein the current through the coupling device is small, such as with resistance coupling, or variable resistance coupling due to the fact that the current to be bypassed around the load in such circuits is less than the current in the output stage of the amplifying systems.

The invention has been disclosed in combination with particular types of circuits, and it is not considered that the invention is limited to the specific forms or means shown, the invention being described in the following claims.

It will be understood that where vacuum tube amplifier is referred to in the claims it will include within its meaning thermionic tube amplifier or any equivalent tube amplifier.

What is claimed is:

1. In an electric circuit, a vacuum tube amplifier having an input and an output circuit, a source of signals for said input circuit, a source of voltage for said output circuit, a load in said output circuit, means for controlling the plate voltage impressed on said vacuum tube in accordance with the envelope of said signals, said means comprising a second vacuum tube having an anode, a cathode and a control electrode, said anode and said cathode being connected in said output circuit in series with said load, and an impedance connected between said cathode and said control electrode and common to said output circuit.

2. In an electric circuit a vacuum tube amplifier having an input and an output circuit, a source of electrical variations for said input circuit, a source of voltage for said output circuit, a load in said output circuit, means for controlling the plate voltage impressed on said vacuum tube in accordance with the envelope of said electrical variations, said means comprising a second vacuum tube having an anode, a cathode and a control electrode, said anode and said cathode being connected in series with said load in said output circuit, and a resistance shunted by a condenser connected between said cathode and said control electrode and common to said output circuit.

3. In an electric circuit a vacuum tube amplifier having an input and an output circuit, a source of electrical variations for said input circuit, a source of voltage for said output circuit, a load in said output circuit, means for bypassing surges of current produced by said electrical variations above a predetermined value around said load, said means comprising a second vacuum tube having an anode, a cathode and a control electrode, said anode and said cathode being connected in series with said load in said output circuit, an impedance connected between said cathode and said control electrode, and common to said output circuit, a gas discharge device connected in parallel with said load, and the anode to cathode resistance of said second tube to a terminal electrically remote from said control electrode.

4. In an electrical circuit, a vacuum tube, having an input and an output circuit, a source of electrical variations for said input circuit, a source of voltage for said output circuit, a load in said output circuit, means for bypassing surges of current produced by said electrical variations above a predetermined value around said load, said means comprising a second vacuum tube having an anode, a cathode, and a control electrode, said anode and said cathode being connected in series with said load in said output circuit, a resistance shunted by a condenser connected between said cathode and said control electrode, and common to said output circuit, and a gas discharge device connected across said output circuit to a terminal electrically remote from said control electrode.

5. In a stage of vacuum tube amplification, a vacuum tube having an input and an output circuit, a load in said output circuit, and means to render the receiving gain of said stage appreciable less in response to large received current, than in response to currents corresponding to normal received signals, said means comprising a second vacuum tube having an anode, a cathode and a control electrode, an impedance connecting said cathode to said control electrode, and common to said output circuit, and a normally non-conductive shunt bridged across said output circuit, and connected to said impedance at a point electrically remote from said control electrode.

6. In an electrical circuit a vacuum tube, having an input and an output circuit, a source of electrical variations for said input circuit, a source of current for said output circuit, a path for said current to flow in said output circuit, said path comprising a second vacuum tube having an anode, a cathode, and a control electrode, said anode and said cathode being connected in said path, an impedance connecting said cathode to said control electrode, said impedance being common to said output circuit, means for rendering said path appreciably less conductive for said variations above a predetermined value than for said variations below said predetermined value, said means comprising a normally non-conductive glow discharge tube bridged across said output circuit connected to said impedance at a point electrically remote from said control electrode.

In testimony whereof I affix my signature.

OLIVER T. FRANCIS.