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ELECTRONIC TUBE ALARM CIRCUIT

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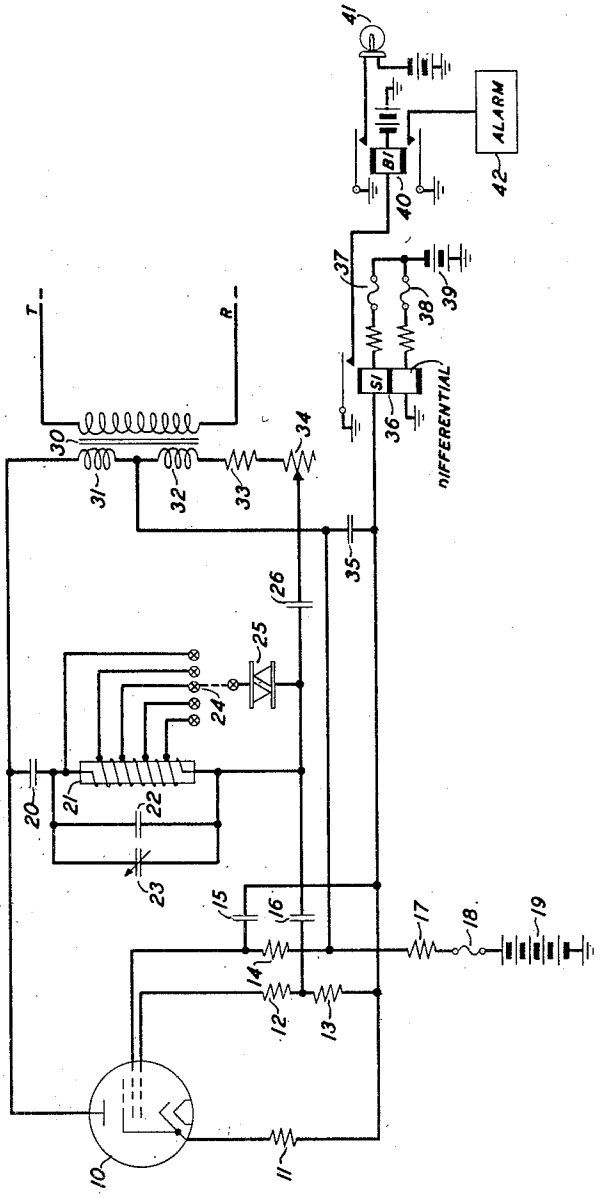

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ELECTRONIC TUBE ALARM CIRCUIT

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This invention relates to electronic devices and particularly to alarm means for indicating deterioration of continuously operating tubes such as amplifiers, rectifiers and oscillators.

Objects of the invention are the prevention of failure of continuously operating electronic devices such as amplifiers, rectifiers and oscillators and to this end the provision of alarm means for indicating deterioration sufficient to justify replacement of a device prior to failure.

It is known to provide alarm means operative upon failure of an electronic tube for anyone of various reasons such as a burned out filament or failure of a voltage source; and it is known to provide a relay which releases responsive to such a failure to close an alarm circuit. However, such alarm means lacks the capability of giving a warning of deterioration in advance of failure because there is a wide variation in the level to which the energizing current must be reduced to effect release.

This invention is a deterioration determining arrangement for continuously operating electronic devices comprising a differential relay having one winding included in an output circuit of an electronic device employed in continuously supplying an output current of desired value and a biasing winding energized to prevent operation as long as the desired output current is maintained within certain limits. The relay operates to close an alarm circuit as soon as the current in the output circuit which includes the one winding either increases or decreases an amount sufficient to indicate a trouble condition or deterioration to a point justifying replacement of the device before it fails entirely. It is further to be observed that this alarm arrangement is also operative when applied to an electronic tube in case of complete tube failure, in case the anode potential supply fails and also in case the voltage supply for the biasing winding fails.

A clear and complete understanding of the invention will be facilitated by description of one embodiment as shown schematically in the drawing. The invention is, however, not limited in its application to the arrangement disclosed in the drawing but is generally applicable to electronic devices employed in producing a continuous direct current output within certain limits of amplitude.

The drawing, which consists of a single figure, shows an electronic tube oscillator of the bridge-stabilized type for supplying current of a desired frequency within the voice band, together with alarm apparatus for giving an alarm not only in the case of tube failure but also whenever deterioration of the tube sufficient to justify tube replacement is indicated by a reduction of the output current below a predetermined value. This oscillator circuit, which is similar to that shown and described in detail both as to structure and theory of operation in Patent 2,303,485 granted to L. A. Meacham, December 1, 1942, comprises an electronic tube **10**, a retard coil **21**, a varistor **25**, an output transformer **30**, alarm relays **36** and **40** and a number of condensers and resistors hereinafter identified. The tube is a pentode having an indirectly heated cathode, the heater element being shown but not the source of

current for heating this element. The anode-cathode circuit of tube **10** is traced from the anode through the winding **31** of transformer **30**, resistor **17**, fuse **18**, battery **19**, ground, battery **39**, fuse **37**, upper winding of alarm relay **36** and resistor **11** to the cathode. The frequency and amplitude of the current are controlled by the bridge circuit in which windings **31** and **32** constitute adjacent arms, a third arm consists of resistors **33** and **34** and condenser **26**, and the fourth arm is the antiresonant network consisting of condenser **20**, retard coil **21**, condensers **22** and **23** and varistor **25** which is connected to shunt a desired part of the retard coil winding. The antiresonant network is tuned to the desired oscillation frequency, some adjustment of frequency being provided by variable condenser **23**. Variable resistor **34** enables adjustment of the output voltage. Blocking condensers **16**, **20** and **26** isolate the anode battery **19** from the antiresonant network and grid of the tube. The grid-cathode circuit includes resistors **12**, **13** and **11**, and resistor **14** supplies positive potential from battery **19** to the screen grid. The varistor **25** makes the impedance of the antiresonant network vary with voltage amplitude having a high effective resistance which decreases rapidly as the voltage increases. For frequencies above or below the antiresonant frequency to which the network is tuned, the network is respectively a capacitative or inductive reactance of a magnitude which decreases as the frequency departs further from antiresonance. The effect of frequency variation on the phase angle of the impedance near antiresonance and the effect of voltage amplitude variation on the magnitude of the antiresonant impedance are such as to stabilize the frequency and amplitude of the oscillations.

The differential alarm relay **36** is biased by energization of its lower winding so that normal anode-cathode current through the upper winding is ineffective to operate this relay. If and when the internal impedance of the tube increases sufficiently to indicate that the tube should be replaced although the output is within allowable limits, the decrease in energization of the upper winding of relay **36** results in operation of the relay by its biasing, lower winding. Furthermore, if and when the anode-cathode current increases beyond a normal maximum level due to some trouble condition, for instance a trouble ground on the grid or an open varistor **25**, the increase in the energization of the upper winding causes the operation of relay **36**. The operation of relay **36** closes a circuit for operating relay **40**; and the operation of relay **40** closes circuits for lighting alarm lamp **41** and for operating an audible alarm **42**. The tube may then be replaced prior to further deviation or failure of the output voltage. It should be noted that upon operation of either of fuses **18** or **37** in the anode-cathode circuit or any other failure of the anode-cathode circuit voltage supply, the alarm relay operates. Further, in case the fuse **38** in the biasing circuit of relay **36**, the continued operation of the oscillator causes operation of the alarm relay by its upper winding thus to operate the alarms indicating the need of maintenance attention.

The alarm relay when operated may cause transfer from the device with which the relay is associated to a standby device so that there is no interruption of the voltage supply while the defective device is being replaced.

What is claimed is:

1. In combination, an oscillator unit comprising an electronic tube, tube energizing means, a load element connected in the anode-cathode circuit of said tube, an alarm control relay, alarm means energized by operation of said relay, said relay comprising differential windings, one winding connected in series with said load element in the anode-cathode circuit of said tube, and means comprising a portion of said tube energizing means for energizing the other winding of said relay to cause operation

of the relay when current in said one winding falls to a value indicating tube deterioration sufficient to justify tube replacement.

2. In an oscillator unit comprising an electronic tube, tube energizing means, a load element connected in the anode-cathode circuit of said tube, an alarm control relay, alarm means energized by operation of said relay, said relay comprising differential windings, one winding connected in series with said load element in the anode-cathode circuit of said tube, and means comprising a portion of said tube energizing means for energizing the other winding of said relay for biasing the relay to prevent operation when the current in said circuit is within predetermined limits, an increase in the anode-cathode current beyond a certain value being effective to operate said relay.

3. In a circuit arrangement comprising an electronic tube, tube energizing means, a load element connected in the output circuit of said tube, an alarm control relay, alarm means energized by operation of said relay, said relay comprising differential windings, one winding connected in said output circuit of said tube, and means comprising a portion of said tube energizing means for energizing the other winding of said relay to a degree which prevents operation of the relay while the current in said circuit is within predetermined limits, a change in the amplitude of the current through said one winding beyond said limits being effective to operate said relay.

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