

Jan. 25, 1949.

J. W. ALDERSON

2,459,784

MILLIVOLT CONTROL UNIT

Filed Aug. 10, 1943

FIG. 1.

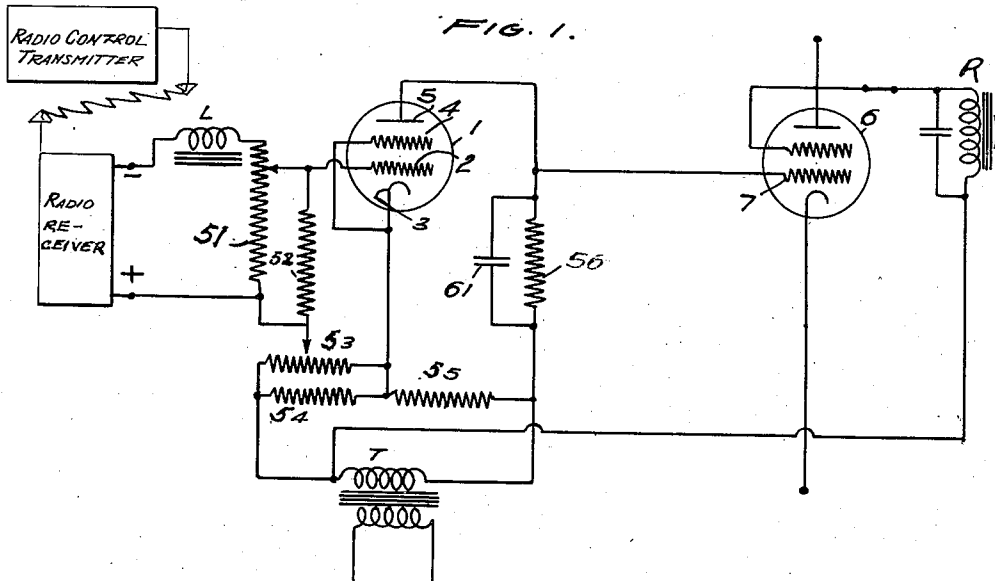
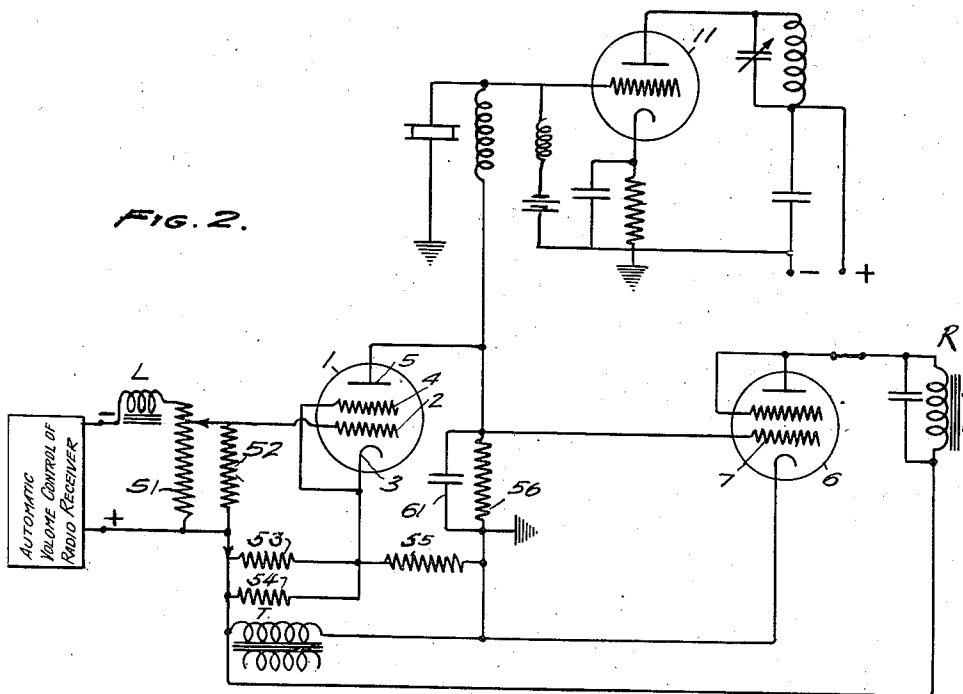


FIG. 2.



John W. Alderson

BY William D. Hall.

ATTORNEY.

UNITED STATES PATENT OFFICE

2,459,784

MILLIVOLT CONTROL UNIT

John W. Alderson, Oakland, Calif., assignor to the
United States of America, as represented by the
Secretary of War

Application August 10, 1943, Serial No. 498,049

4 Claims. (Cl. 315—116)

(Granted under the act of March 3, 1883, as
amended April 30, 1928; 370 O. G. 757)

1

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to remote control systems, and more particularly to improvements in such systems employing electron discharge devices.

Remote control devices for communication apparatus must be sensitive and at the same time unaffected by high amplitude noise transients. Sensitivity is desired for providing accuracy at high speed.

It is an object of this invention to provide a unit for remotely controlling positively and efficiently electrical systems including radio transmitters and receivers.

A further object is the provision of a remote control device for electrical apparatus and the like, which device includes a gas filled tetrode electron discharge tube which may be controlled by voltage received from an automatic volume control circuit of a radio receiver.

A further object is the provision of a remote control device of high sensitivity, unaffected by transient disturbances, and controllable by very small voltages.

In accordance with the specific example of the invention chosen for illustration in Fig. 1, a transmitter at a control site emits definite signals which affect the automatic volume control circuit of an ordinary radio receiver remotely positioned at the site of the apparatus being controlled. The automatic volume control circuit is connected and its output transmitted to the grid of a gas filled tetrode electron discharge tube, which is biased near its striking voltage, so that very slight variations in the voltage of the automatic volume control circuit will control the operation of the tube.

These and other objects are attained by the arrangement and combination of elements hereinafter described and illustrated in the accompanying drawings, forming a part hereof, and in which

Fig. 1 is a diagram of a circuit embodying the invention.

Fig. 2 is a diagram of another circuit showing an application of the invention.

Referring to the drawings, the remote control device is shown to include a gas filled tetrode tube 1, having a grid 2 connected through an inductance L to the negative terminal of an automatic volume control circuit of an ordinary radio receiver. The gas filled tetrode tube is of the hot cathode type, which requires a definite grid voltage, called the striking or starting voltage, in order to cause the flow of plate current. In the tubes herein described the plate voltage is supplied by an alternating current source, which

2

causes an interruption of the plate current flow for half-cycle periods of the alternating plate voltage. This type of tube as the parameters are here organized is sensitive to minute voltage changes in the grid circuit. The action of the tube is positive; the cathode anode circuit will conduct or cease to conduct depending on the polarity of the applied grid voltage.

Fig. 1 shows the circuits of one form of the invention which has been successful, and the following description thereof is given as an example of its embodiment, and not as defining its limits. Thus, while I have preferred to indicate the use of the output of an automatic volume control to supply the operating current and potentials for effecting the response of my control unit, it should be understood that the alternative use of the audio frequency output of a receiver may be utilized as the input to my control device if desired, by transmitting voice action or the like in such manner as to produce a definite volume output. Examples of use of an audio output are seen in patents to Edwards et al., 1,968,750, July 31, 1931; Tice, 2,356,364, August 22, 1944; and Frederickson, 2,158,809, May 2, 1939.

The disclosure herein is sufficient to indicate that by utilization of the automatic volume control a steady potential may be maintained by proper transmission to the receiver, with a resultant drop by a change signal keyed from a transmitter to the receiver. But likewise, if the tube 1 is arranged to be normally critically biased to non-conduction, the tube 6 may be normally conducting, holding a relay closed, and response effected by keying or otherwise producing a signal of raised voltage to the grid 2 whereby the tube 1 will be caused to conduct, and the tube 6 cut off by the resulting sharp drop at the gas tube plate due to the characteristic abrupt discharge action in a gas tube.

Bridging the lower and upper positive and negative terminals of the input circuit from the radio receiver to my remote control device there is a potentiometer high first resistance 51, about five megohms, and in parallel with the major lower part thereof from the brush of the potentiometer there is a second resistance 52 of about two megohms, its upper end connected to the brush of the potentiometer. This brush is connected directly to the control grid 2. The lower ends of the resistances 51 and 52 are connected to the brush of a variable resistance 53 of about 1,000 ohms, which is connected at its ends in series between the cathode 3 of tube 1 and the left end of the secondary of a transformer T, and similarly connected in parallel to this resistor there is a fourth resistance 54 of about 500 ohms, so that the resistances 53—54 form a series-parallel fixed resistance in the cathode lead from the transformer. The plate 5 of the tube 1 is con-

3

nected to the opposite end of the secondary with a fifth resistor 55 of about 25,000 ohms connected between the cathode lead and the plate lead of the secondary, while a sixth resistor 56 of about 50,000 ohms and a parallel capacitance 61 of .1 mfd. are connected in the plate lead from the transformer.

It will be seen from the foregoing that by means of the potentiometer resistance 51, the negative bias of the grid 2—due to the normal potentials of the AVC leads and the drop across resistors 51 and 52—may be controlled and adjusted to a required critical condition, and that throughout such adjustment the effective resistance across the line will never be less than one megohm, so that current consumption is measured in microamperes. These two resistors will also serve as a grid leak for any tendency for excess change of bias to build up on the grid. Resistors 53 and 55 with the brush contact from resistor 52, serving together as a potentiometer, enable adjustment there to utilize the transformer secondary output to aid in establishing a proper grid potential level in relation to the cathode and plate.

The arrangement is also such that small plate current will flow when the tube 1 is energized, but the potential fluctuations at the plate upon signal functioning of the grid 2 will be large and sufficient to produce wide extremes of conduction in the tube 6 when imposed on the grid of the latter. The resistance 56 serves additionally as a grid leak at tube 6.

A tube 6 which may be of the 6L6 type has its grid 1 biased by the plate circuit of tube 1, and the flow of current in the plate circuit of tube 6 operates a relay R.

In operation, keying or controlling potential from the automatic volume control applied to the input circuit of the tube 1 need not exceed one volt direct current, and for this reason the current consumption is measured in microamperes. The reactance L (which may be 15h in this instance) is provided to eliminate alternating voltage from the external control voltage circuit. Such voltage may be parasitic, originating in the receiver or otherwise.

In a first instance, the resistance 53 is adjusted to the point at which the striking or starting voltage is produced to cause ionization in the gas filled tube, and cause a uni-directional current to flow. This action results in a voltage drop across 56. Condenser 61 maintains the uni-directional current at a sufficient constant value keeping the tube 6 cut off. Controlling will result if a source of low voltage direct current properly polarized is applied to the input terminals of the gas filled tetrode tube 1, cutting off the latter and firing tube 6, with consequent pick up of the relay R.

In a second case, by adjusting resistance 51 to a certain value, the grid 2 of the tube 1 can be biased negatively to such an extent as to prevent initiation of the flow of the plate current in tube 1, with the result that there will be no voltage drop over resistance 56, thus removing the negative bias on the grid of tube 6 and allowing plate current to flow in tube 6 to actuate a relay, or other device. In this case, if a low voltage direct current of proper polarity, or amplitude higher in a small degree than that at which the normal grid operation is adjusted, is applied across the grid and cathode of tube 1, the latter will be fired, cutting off tube 6 and dropping the relay R.

In the second case, without the required oper-

4

ating grid voltage, during a half cycle when the alternating current voltage taken from the left end of the secondary of the transformer T and applied to grid 2 is negative, the right end of the secondary of the transformer T applies an alternating current voltage to the plate, which is positive. Since the grid 2 is negatively biased just below the striking voltage, no plate current will flow. However, by keying the transmitter so as to develop sufficient voltage from the automatic volume control circuit to bias the grid 2 to the striking voltage, a plate to cathode current will be caused to flow. On the next half cycle, the plate will be negative and flow of plate current will cease regardless of the grid bias during this half cycle.

In order to effect the application of the necessary control voltages by radio signals in the two cases of operation above mentioned, in the first case, the carrier would be adjusted to such amplitude as to maintain the output of the AVC at the stable condition of conduction at tube 1 for which the device has been adjusted with a critical potential on the grid. When it is desired to alter the condition and operate the relay, a signal is keyed at the transmitter causing the lowering of potential supplied to the grid 2 from the AVC and raising that of the cathode, with the result that tube 1 is cut off and the tube 6 is brought into conduction, its plate current picking up the relay.

If the tube 6 is to normally operate, keeping the relay picked up, the adjustment of the second case above described is made, the AVC output stabilized to maintain the tube 1 cut off, and to effect control action the signal transmitted would be of such nature as to cause the AVC to increase the potential at grid 2 relative to the cathode, when the tube 1 would be fired, cutting off tube 6 and dropping the relay.

In the device of Fig. 1, input terminals of the control unit should be wired directly to the output of the automatic volume control circuit of the receiver, as shown where, usually, filtering action has already taken place. The delayed action of the filtered automatic volume control will reduce high amplitude noise transients to a value that will not interfere with normal keying, and control can be accomplished through noise loud enough to render other control systems inoperative.

In Fig. 1 the unit is shown controlling a tube 6 which controls a relay. For fast keying resistance 56 should be not more than 50,000 ohms and capacitor 61 not more than .1 microfarad.

In Fig. 2 the unit is shown controlling a relay and an oscillator or buffer tube, or any kind of electron discharge tube. The controlled tube 11 receives its bias to cut-off directly from the voltage across resistance 56.

The transformer T applies an alternating current potential to the plate of tube 1, and as a result the potential of plate 5 is negative every other half cycle, which stops the operation of tube 1 during the half cycle period. However, due to the action of condenser 61, current flow to the grid of tube 6 will not be interrupted until current flow in tube 1 is discontinued by negative biasing of control grid 2 of tube 1. It will be seen that tube 1 can be adjusted by properly biasing to normally cause a continuous flow of unidirectional pulsating current, which flow is interrupted only by affecting the biasing by keying or voice action; or the tube can be arranged to be normally inactive, and placed in operation by keying

5

or voice action to bias the grid above the striking potential.

In practice, resistance 53 is adjusted to a point immediately above or immediately below the value which produces the "striking" biasing voltage on grid 2. Now, assuming that the radio receiver is receiving a carrier of a definite frequency transmitted from a remote control site, a potential change appears in the automatic volume control circuit of the radio receiver. An operator at the remote control site keys a transmitter to send out the carrier to vary the automatic volume control voltage and vary the grid bias voltage on tube 1 to obtain the striking voltage or to deviate from the striking voltage, as may be desired.

Where remote control by radio is desired the necessary keying voltage is obtained from a receiver tuned to the frequency of the controlling carrier. The automatic volume control circuit of the receiver provides more than sufficient voltage to operate the control unit on even the weakest of signals. The sensitivity of the control unit is less than one-half volt at a current drain of a few microamperes. The low voltage required and the extremely small current drain results in very little disturbance to the normal function of the automatic volume control system in the receiver.

Instead of employing the automatic volume control circuit of a radio receiver, the control unit can be connected directly by wires, such as wires of a telegraph system, to a remote control device operated by a key or the like. Systems already installed and operated by remote control wire lines can utilize the control unit to advantage. Several independent functions can be performed using only one pair of wires with positive results and with very low potentials. The device is adapted for use with radio or wire repeater apparatus, utilizing a single carrier or a carrier of multi-tone modulation. It can also be well used with high speed telegraphy or teletypewriting control of single or multiple apparatus for single or repeater operation. Other uses include high speed control of automatic tape recorders and senders, code or telegraph apparatus, electronic or mechanical control of apparatus of any kind, locally or by remote control, and use as an indicator or warning device or an overload or underload relay.

The above description is to be considered illustrative and not limitative of the invention. Obviously, numerous modifications and applications can be made without departing from the spirit of the invention as set forth in the appended claims. The invention having been described, what is claimed is:

1. In a remote control system comprising a radio transmitter, a remote radio receiver wherein incident modulated radiations from the transmitter are converted into a unidirectional current output, a device to be controlled remote from the transmitter and remote from the receiver, and a control device operative by variation in said unidirectional current output operatively connected to said device to be controlled; the improvement in said control device which comprises a gas-charged thermionic tube having at least an anode, a cathode and a control grid, first and second input leads from the unidirectional output of said receiver, a variable first resistor and a parallel second resistor of half the value of the first connected commonly between the grid and said first input lead, said first resistance bridging said leads and the grid having brush connection therewith, a variable third resistor connected in

6

series between the said first lead and the cathode whereby said second resistor and part of the third are additionally in series between the grid and cathode, a fourth resistor connected to the third resistor in parallel, a fifth resistor connected at one end between the third and fourth resistors and the cathode and in series with the cathode and the anode, and a sixth resistor and by-pass capacitor in series-parallel between the last-named fifth resistor and the anode, an alternating current anode supply having one terminal connected between the fifth and sixth resistors so that the sixth resistor and capacitor are in series parallel with the source and anode, another terminal of said source being connected at the outer ends of the said third and fourth resistors so that the latter are in series parallel with the source and cathode, and so that the third and fourth resistors at one side and the fifth resistor at the other are in series across the line with said source, a second thermionic tube having at least an anode, a cathode and a control grid, an anode-cathode current supply connected to said second tube, a current-operated part of the said device to be operated being connected in said anode-cathode circuit, the grid of the second tube being connected to the anode of the first tube, said variable resistors being adjusted to establish a grid-cathode relation critically near the potentials for firing the tube.

2. In a remote control system comprising a radio transmitter, a remote radio receiver wherein incident modulated radiations from the transmitter are converted into a unidirectional current output, a device to be controlled remote from the transmitter and remote from the receiver, and a control device operative by variation in said unidirectional current output operatively connected to said device to be controlled; the improvement in said control device which comprises a gas-charged thermionic tube having at least an anode, a cathode and a control grid, first and second input leads from the unidirectional output of said receiver, a high potentiometer resistance across the line of said unidirectional current, a brush connection between the grid and said resistance, an alternating current anode source connected at one terminal with the anode, an anode resistance and a condenser in series parallel between the source and anode, a resistance bridging the output of said source, a tap connection between the last named resistance and the cathode, a brush contact between the grid and the last name resistance, a second thermionic tube having at least an anode, a cathode and a control grid, an anode-cathode current supply connected to said second tube, a current-operated part of said device to be operated being connected in said anode-cathode circuit, the grid of the second tube being connected to the anode of the first tube, said connections between the grid of the first tube and resistors being adjusted to establish a grid-cathode-anode relation in the first tube critically near the potentials for firing of the tube.

3. The structure of claim 3, wherein a suppressor grid is included in said first tube having a permanent negative potential relative to the anode.

4. The structure of claim 3, wherein an inductance impedance is connected in series in one of said input leads of the control means.

JOHN W. ALDERSON.

(References on following page)

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,485,773	Espenschied	Mar. 4, 1924
1,947,189	Cockrell	Feb. 13, 1934
1,968,750	Edwards et al.	July 31, 1934

5

Number

2,061,011
2,111,736
2,156,809
2,281,693
2,299,330
2,316,902
2,356,364

Name

Date

Vingerhoets	Nov. 17, 1936
Roberts	Mar. 22, 1938
Frederickson	May 2, 1939
Holst et al.	May 5, 1942
Macnabb	Oct. 20, 1942
Trevor	Apr. 20, 1943
Tice	Aug. 22, 1944