Oct. 20, 1942. V. C. MACNABB 2,299,330

REMOTE CONTROL SYSTEM

Filed Nov. 7, 1941

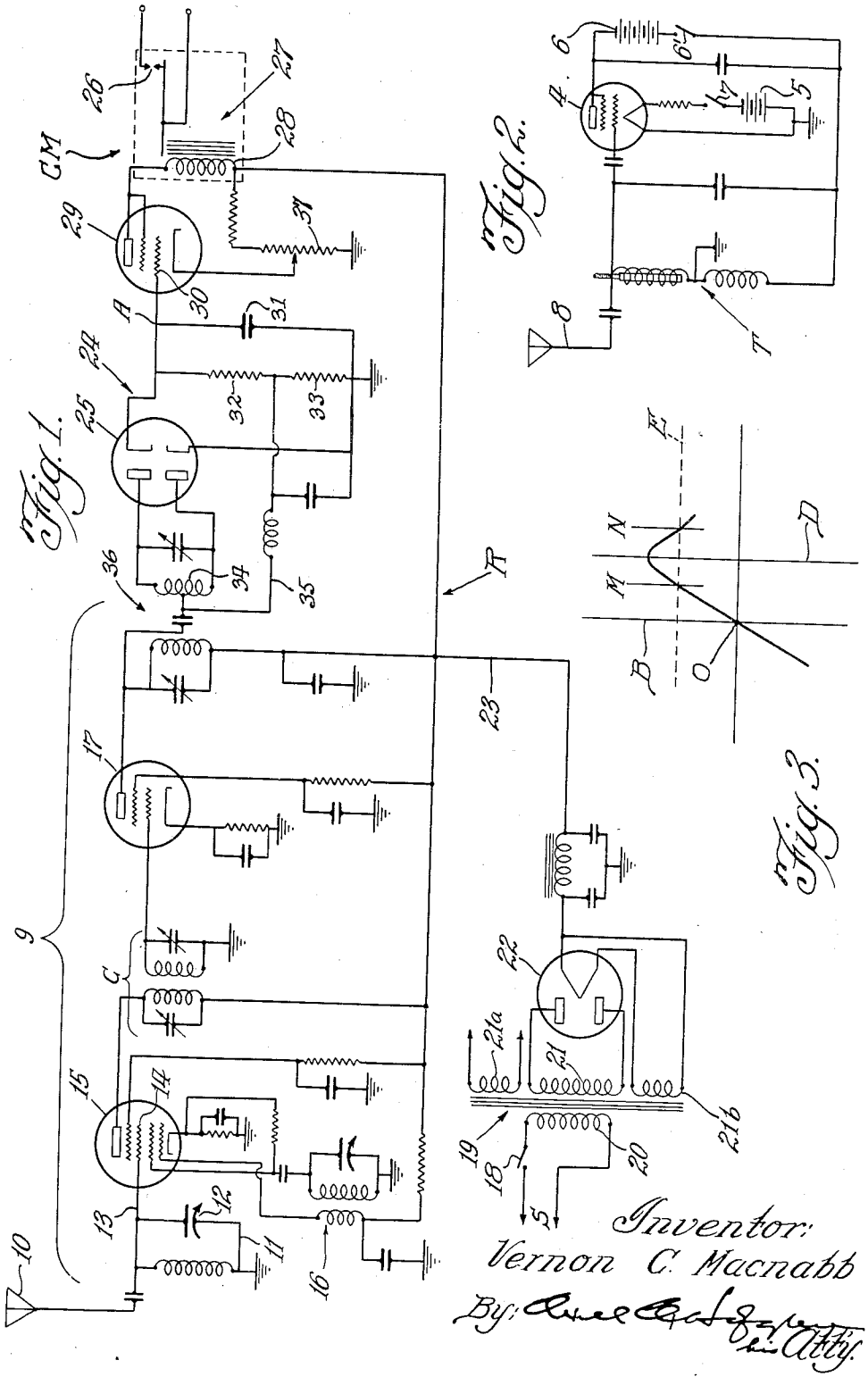

Fig. 1.

Fig. 2.

Fig. 3.

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Patented Oct. 20, 1942 2,299,330

UNITED STATES PATENT OFFICE

2,299,330

REMOTE CONTROL SYSTEM

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Application November 7, 1941, Serial No. 418,129

7 Claims. (Cl. 250—2)

The invention relates generally to remote control systems and more particularly to a radio signal controlled system capable of governing a device at a remote point.

The system is applicable to a large variety of installations including commercial as well as military uses. In the military field, the system might be employed to operate from a remote point a machine gun or other gun emplacement, discharge a mine or torpedo, or control other devices, such as searchlights and the like. Such control usually would be at substantial distances and, therefore, should be operable on a long wave signal which is not interfered with by hills, mountains, buildings, and the like obstructions to the same extent as those objects interfere with short wave signals.

Commercial installations could control an even greater variety of devices. By way of example, however, and purely for purposes of disclosure the invention will hereinafter be treated as applied to the control of a garage door. Under those circumstances, it would of course be undesirable to have a system of such character that each owner would have to have a license from the Federal Communications Commission to transmit a signal. Yet the present ruling of the Commission is such that a license would be required for any transmitter having a rating in excess of fifteen micro-volts at a distance from the transmitter equal to or in excess of

$$\text{wave-length}/2\pi$$

With that ruling, the employment of a short wave signal without a license would permit transmission of the signal such a short distance as to be wholly impractical.

Thus in the commercial installations, as well as the miliary installations, a signal of long wave length is dictated. This has normally the disadvantage that electrical disturbances, either natural, such as created by lightning, or man made, such as by other electrical devices, interfere with the system.

It is an object of the invention, therefore, to perfect a remote control system employing a radio frequency signal for operating devices remotely located, which system is not limited to a line of sight operation as would be a short wave signal, and which is not interfered with by electrical disturbances created either by natural phenomena or by man made devices.

Not only must the system be free from interference by electrical disturbances, but it should also be such that it is responsive only to a predetermined signal, in order that others may not intentionally or unintentionally cause the system to initiate operation of the device controlled.

It is another object of the invention, therefore, to provide a remote control system having a radio signal transmitter, a relay switch adapted to govern a device to be controlled, and a new and improved radio signal receiver operable to actuate the relay switch only upon receipt of a signal of a predetermined frequency.

Another object is to provide a remote control system having a radio signal transmitter and a radio signal receiver responsive only to a predetermined signal sent by the transmitter, and not responsive to damped waves, whether produced by natural phenomena or man made machines, and not responsive even to undamped waves of a frequency other than that of the predetermined signal.

A final and general object of the invention is to provide a new and improved remote control system employing radio signals as the controlling medium.

Other objects and advantages will become apparent from the following detailed description taken in connection with the accompanying drawing, in which:

Fig. 1 is a circuit diagram of a preferred form of receiver constituting part of a remote control system embodying the features of this invention.

Fig. 2 is a circuit diagram of a transmitter forming part of a remote control system embodying the features of this invention.

Fig. 3 is a graphic view showing the plate current variation with frequency variations of the final tube of the system.

While the invention is susceptible of various modifications and alternative constructions, it is here shown in the drawing and will hereinafter be described in a preferred embodiment. It is not intended, however, that the invention is to be limited to the specific disclosure made. On the contrary it is intended to cover all modifications and alternative constructions falling within the spirit and scope of the invention as defined in the appended claims.

As above stated, the invention is adaptable for the control from a remote point of a variety of devices, but particularly for the control of devices requiring initiation of operation only, the devices themselves containing suitable mechanism governing operation from that point forward, including arrest of the device, or devices operating so long as a signal is received. In the commercial field, such devices include, by way of

example, a garage door actuating device which upon initiation opens the garage door and, upon complete opening of the door, arrests operation of the device and at the same time conditions the device so that upon subsequent initiation the door will be closed. As a safety measure, some door actuating devices operate through the door closing portion of the cycle only so long as a button is held depressed, or so long as a signal is received. In the military field, these devices may include, by way of example, machine guns, mines, search lights, or the like, the operation of which is to be initiated from a remote point and which, as in the case of mines, are consumed in such single operation, or may, the same as commercial devices, include mechanism for governing and arresting operation once the same has been initiated, or may operate so long as a signal is received.

Generally, the remote control system herein disclosed comprises a transmitter T for sending a signal of radio frequency, a receiver R, adjusted to receive a predetermined signal transmitted by the transmitter T, and intended to be located remotely from the transmitter along with the device to be controlled, and control means CM governed by the receiver and in turn controlling the remotely located device to be governed. The transmitter T, as herein shown, is a simple and conventional transmitter employing a single one and a half volt battery tube 4 commonly known in the trade by the designation 1Q5G. The tube is lighted from a battery 5 which, in the employment of the control system to operate a garage door, may be the car battery, while the "B" power is supplied by a small "B" battery 6 or by a "B" battery eliminator of any well known construction. Connected in series with the battery 5 is a switch 7 and connected in series with the battery 6 is a switch 6'. The switches 7 and 6' are connected to be operated simultaneously. Radiation of the signal is obtained through an antenna 8 of a character making it suitable for the conditions under which the system is to be employed. The transmitter being conventional, it is believed unnecessary to describe the various condensers and inductances and their manner of connection.

The receiver R comprises a conventional superheterodyne circuit, generally designated 9. This circuit includes an antenna 10 connected to a tuning circuit 11 which includes an adjustable condenser 12. The circuit 11 is tuned to receive long waves and constitutes a first means by which the receiver may be adjusted to respond only to a predetermined signal. This circuit may, by way of example, be tuned to a frequency of 400 kc. A lead 13 connects the tuning circuit 11 to the grid 14 of a tube 15 of a type known in the trade by the designation 6K8. Also connected in circuit with the tube 15 in conventional manner so as to modulate the frequency of the incoming signal received over the antenna 10 to some intermediate frequency is an oscillator, generally designated 16. Completing the superheterodyne circuit is a second tube 17 of a type commonly known in the trade by the designation 6K7. This tube and its circuit is connected with the portion of the super-heterodyne circuit already described through a coupling C.

Power for the super-heterodyne circuit is obtained from a suitable electrical source, herein shown as an alternating current source S. Connected to the source S through a switch 18 is a transformer 19 having a primary winding 20, a main secondary winding 21, and auxiliary secondary windings 21*a* and 21*b*. The main secondary winding 21 is connected to a dual plate, dual filament rectifier tube 22, the filaments of which are heated by energy derived through the auxiliary secondary winding 21*b*. The tube is of the type commonly known in the trade by the number 5Y4. The rectified current is conducted to the superheterodyne circuit through a lead 23. The auxiliary secondary winding 21*a* is employed to heat the filaments of the tubes 15, 17, 25 and 29.

In order that the receiver may be responsive only to the predetermined signal sent out by the transmitter T, and in order that it may not be affected by damped waves to which it may be subjected, there is included in the receiver a discriminator, generally designated 24. The discriminator is of conventional construction, being used in radio receivers containing automatic frequency control, providing a balanced circuit including a tube 25 commonly known in the trade by the designation 6H6. More particularly, the discriminator includes a condenser 31 connected in parallel with series connected resistors 32 and 33 of equal value. The point between the resistors is by a lead 35 connected to the midpoint of a coil 34 forming the secondary of a double-tuned, loosely-coupled transformer 36. Because of the 90° phase difference which exists between the primary and secondary voltage of such a loosely-coupled, double-tuned transformer, and because of the fact that the voltages at opposite ends of a secondary winding are 180° out of phase with respect to a center tap, the discriminator operates in well known manner at the tuned frequency to apply equal but opposite voltages across the resistors 32 and 33. As a result the voltage at the critical point A of the discriminator is zero for the tuned frequency. By way of example, let it be assumed that herein this particular tuned frequency is 262 kilocycles. With a departure of the frequency from this tuned frequency, the phase relationship of the voltages in the primary and secondary windings also departs from the 90° phase difference with the result that the voltage applied to one of the resistors is greater than that applied to the other, resulting in the creation of a potential at the point A. This operation of the discriminator is herein utilized to govern the control means CM by some critical frequency above or below the tuned frequency as will hereinafter be more particularly described.

While certain specific undamped waves may thus actuate the receiver, damped waves will not cause the voltage at point A to vary from its predetermined or no-signal value. Damped waves, such as those created by lightning, an electric circuit arcing, or the arcing of a commutator type motor, and so forth, include all frequencies to infinity. The receiver, being tuned to a comparatively narrow band of frequencies, will, of course, receive only a narrow band of the damped wave frequencies. Over this narrow range or band of frequencies which are accepted by the selectivity of the receiver circuits, the waves may be assumed to be of constant amplitude.

Thus, though the band of damped wave frequencies accepted by the receiver may include the critical frequencies above or below the tuned frequency, herein 262 kilocycles, which will actuate the control means CM, actuation of the control means nevertheless fails to take place be-

cause the voltage at point A is maintained at zero. Inasmuch as damped waves include all frequencies to infinity, there will be present in the band of frequencies accepted by the receiver frequencies above as well as below the tuned frequency. Since the amplitude of the waves over this narrow band may be considered as substantially constant, the voltages across resistors **32** and **33** will still be equal but opposite, thereby maintaining zero voltage at the point A.

The control means CM herein comprises a switch **26** adapted to be connected in a circuit governing operation of the device to be controlled. The switch **26** constitutes part of a relay, generally designated **27**, having a coil **28**. The switch is normally biased to open position and is adapted to be closed by energization, to a sufficient degree, of the coil **28**. Completing the control mechanism is a relay tube **29** of a type commonly known to the trade by the designation 6F5. This tube has the coil **28** of the relay connected in its plate circuit and has its grid **30** connected to the point A of the discriminator so that the voltage on the grid will vary with the voltage at the point A of the discriminator. Also included in the plate circuit of the tube **29** is a 5000-ohm resister **37** which is adjustable and herein is adjusted to provide a plate current which is somewhat below the value required to operate the relay when the grid **30** of the tube **29** is at zero potential.

The tube **29** is critical to a certain voltage on its grid **30** and that fact is utilized herein to obtain closure of the relay switch **26** only upon receipt of a predetermined signal sent by the transmitter. The grid voltage, of course, varies with the frequency of the signal received by the discriminator. This, in turn determines the plate current and thus the plate current is a function of the frequency. The entire matter may best be understood by reference to Fig. 3 wherein plate current values for different frequencies are shown graphically. Ordinates represent plate current while abscissas represent frequency in kilocycles.

The line B represents 262 kilocycles, which produces zero voltage on the grid **30**. Point O thus is the value of the plate current at that frequency. This current, as previously stated, is adjusted to be somewhat below that required to operate the relay switch. Its actual value is not zero but its relative value may be considered as zero. Commencing with the point O, a decrease in frequency results in a decrease in the plate current. An increase in frequency, however, results in an increase in plate current until some critical frequency, such as that represented by the line D, is reached, whereupon the plate current again decreases as clearly shown in Fig. 3. This critical frequency may be designated as $F+F_0$, wherein F is the frequency producing zero voltage on the grid and F_0 is the value B to D. By way of example, this critical frequency herein is approximately 267.5 kilocycles.

The peak plate current attained at the frequency $F+F_0$ is enough to close the switch **26**. However, in order that the system may not be too critical the relay is adjusted to be actuated by a current somewhat less than the peak current, for example, a value represented by the dotted line E. This line crosses the current curve at the points M and N which indicate the frequency range in which the relay will be actuated. This range may of course be varied but herein, by way of example, is from 265 to 270 kilocycles.

It is believed apparent from the foregoing that I have perfected a vastly superior remote control system operable on a signal of radio frequency. I have provided a long wave system in order to obviate the necessity of a license for each user, yet have designed the system so that there is no operation thereof by extraneous electrical disturbances, such as set up by natural or man made phenomena. This system, moreover, can be operated to actuate the relay only upon the reception of a signal whose frequency falls within a comparatively narrow wave band. Should the transmitter send the signal through such a large radius as to be objectionable for commercial usage, this may be cut down simply by employing a less efficient type of antenna.

In order to avoid confusion, the critical frequency $(F+F_0)$ has throughout the specification been treated as a frequency higher than the frequency F. This need not necessarily be the case. By simply reversing the connections to the discriminator the critical frequency would be a frequency lower than the frequency F. In other words, F_0 would be a minus value relative to the frequency F. Thus, depending on the connection to the discriminator, the critical frequency might be above or below the value producing zero voltage at point A. For any given connection, however, it could not be either above or below but must be one or the other.

I claim as my invention:

1. A remote control system comprising, in combination, a transmitter of an undamped wave signal at radio frequency, a governing means for a device to be actuated including a relay and a relay tube supplying the current flowing through the relay and having a grid, said relay being adjusted to be actuated only by a current of a predetermined value, and a receiver including a discriminator having circuits balanced at a critical frequency and including a point of zero potential at the critical frequency connected to the grid of said relay tube to govern the plate current of said tube.

2. A remote control system comprising, in combination, a transmitter of an undamped wave signal at radio frequency, a receiver including a super-heterodyne circuit having a critical point and a discriminator circuit adjusted to maintain zero voltage at its critical point at a predetermined intermediate frequency received from the super-heterodyne circuit, and governing means for a device to be actuated including a relay having a switch and a coil operable when energized to a sufficient degree to actuate said switch and a relay tube including a plate circuit and a grid and having the coil connected in its plate circuit and having its grid connected to the critical point of said discriminator, said relay tube being adjusted to provide less than the required current for energizing the coil of the relay when its grid is at zero potential and operating throughout a small range of frequencies above the frequency at which the critical point of the discriminator is maintained at zero voltage to provide sufficient plate current to actuate said relay.

3. A remote control system comprising, in combination, a transmitter of an undamped wave signal at radio frequency, a receiver including a super-heterodyne circuit having a critical point and a discriminator circuit adjusted to maintain zero voltage at its critical point at a predeter-

mined intermediate frequency received from the super-heterodyne circuit and to produce a voltage at said point at certain other frequencies to one side of said pre-determined frequency, and governing means for a device to be actuated including a relay having a switch and a coil operable when energized to a sufficient degree to actuate said switch and a relay tube including a plate circuit and a grid and having the coil connected in its plate circuit and having its grid connected to the critical point of said discriminator, said relay tube being adjusted to provide less than the required current for energizing the coil of the relay when its grid is at zero potential and operating throughout a small range of frequencies to one side of the frequency at which the critical point of the discriminator is maintained at zero voltage to provide sufficient plate current to actuate said relay.

4. A remote control system comprising, in combination, a transmitter of an undamped wave signal at radio frequency, a receiver including a discriminator circuit having a critical point and adjusted to maintain zero voltage at its critical point at a predetermined frequency, and to produce a voltage at said point at certain other frequencies to one side of said pre-determined frequency, and governing means for a device to be actuated including a relay having a switch and a coil operable when energized to a sufficient degree to actuate said switch, and a relay tube including a plate circuit and a grid and having the coil connected in its plate circuit and having its grid connected to the critical point of said discriminator, said relay tube being adjusted to provide less than the required current for energizing the coil of the relay when its grid is at zero potential and operating at said certain frequencies to one side of the frequency at which the critical point of the discriminator is maintained at zero voltage to provide sufficient plate current to actuate said relay.

5. A remote control system comprising, in combination, a transmitter of an undamped wave signal at radio frequency, a receiver tuned to receive a predetermined band of frequencies and including a discriminator circuit adjusted to maintain zero voltage at its critical point at a particular frequency within the band of frequencies to which the receiver is tuned, and governing means for a device to be actuated including a relay having a switch and a coil operable when energized to a sufficient degree to actuate said switch, and means controlling the degree of energization of the coil connected to the critical point of the discriminator circuit, said last mentioned means maintaining the coil inoperative so long as the critical point is at zero potential and causing operation of the coil at certain frequencies, within the band of frequencies received by the receiver, to one side of the particular frequency at which the critical point of the discriminator is maintained at zero voltage.

6. A remote control system comprising, in combination, a transmitter of an undamped wave signal at radio frequency, a receiver including means responsive only to undamped waves of a predetermined frequency regardless of the intensity or duration of damped interfering waves, and a governing means for a device to be actuated including means operated by current flow therethrough, said means being adjusted to operate only upon the flow of current in excess of a predetermined value and means connected with said last mentioned means and with said receiver controlling the current flow through the current operated means in accordance with the variation in the frequency of the signal received by the receiver.

7. A remote control system comprising, in combination, a transmitter of an undamped wave signal at radio frequency, a receiver including means responsive only to the undamped waves of a predetermined frequency regardless of the intensity or duration of damped interfering waves, and a governing means for a device to be actuated including means operated by current flow therethrough, said means being adjusted to operate only upon the flow of current in excess of a predetermined value, and a thermionic tube including a plate circuit and a grid and having its plate circuit connected in series with said last mentioned means and with its grid connected with said receiver to control the current flow through the current operated means in accordance with the variation in the frequency of the signal received by the receiver.

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