

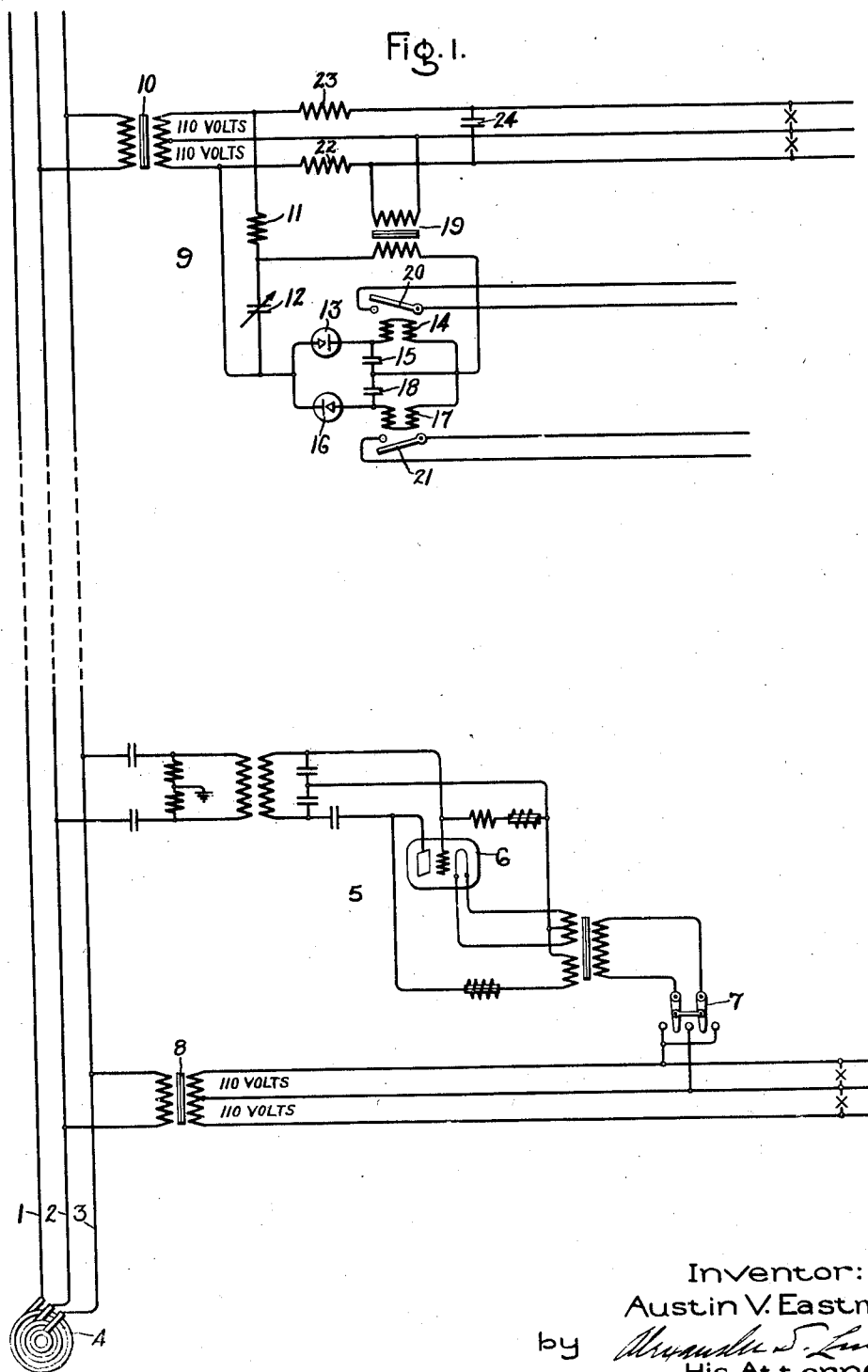
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1,834,771

REMOTE CONTROL APPARATUS

Original Filed Jan. 26, 1925 2 Sheets-Sheet 1



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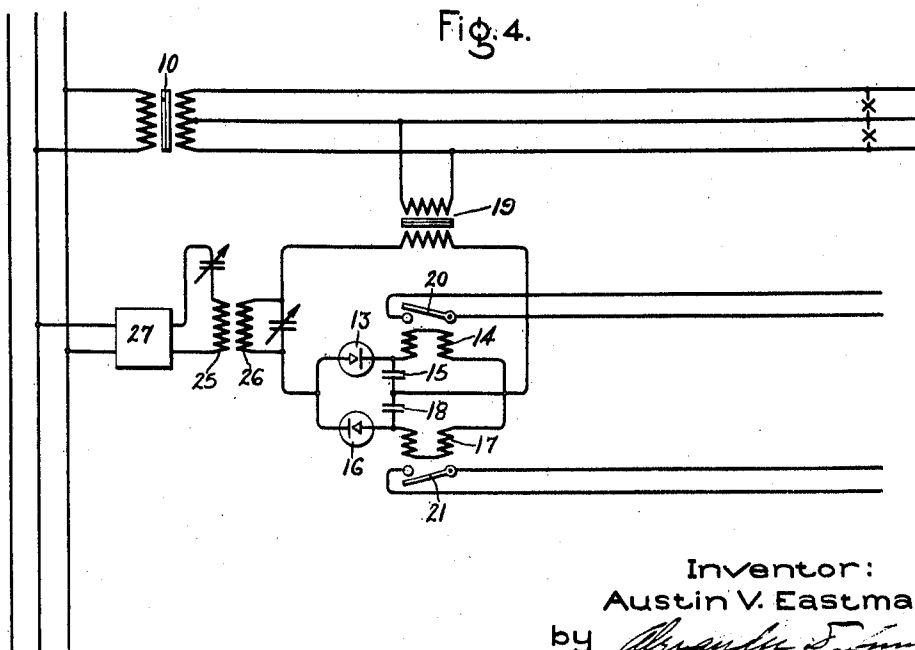
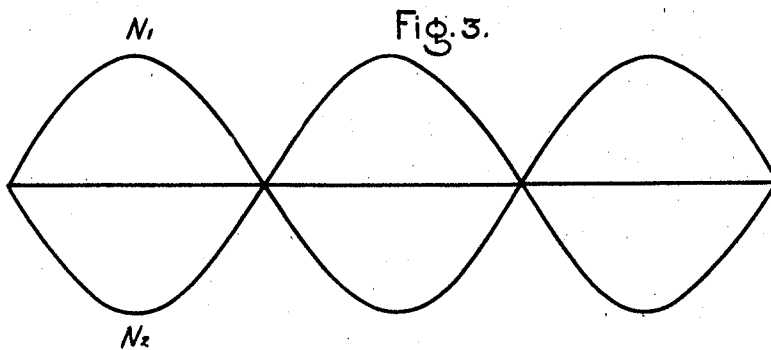
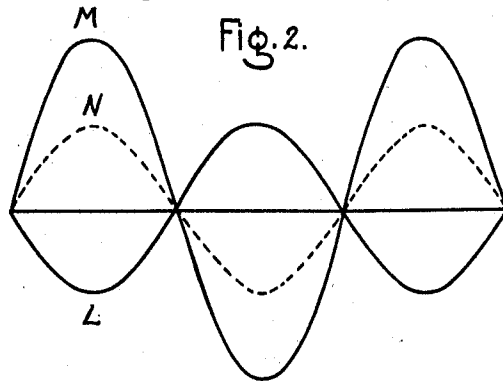
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REMOTE CONTROL APPARATUS

Original Filed Jan. 26, 1925 2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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REMOTE CONTROL APPARATUS

Application filed January 26, 1925, Serial No. 4,781. Renewed December 5, 1930.

The present invention relates to means for transmitting and receiving high frequency currents over a power distribution system.

One of the objects of my invention is to provide means for performing two individual operations at will on a single frequency carrier current control system. A further object is to provide a coupling unit for carrier current control over alternating current power distribution lines which will utilize apparatus already in service and which will eliminate special coupling units, for connecting the carrier current apparatus to the power line. A further object is to provide means whereby the operation of the carrier equipment will not be affected by any load which may be connected to the power supply line.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation will best be understood by reference to the following description taken in connection with the accompanying drawings, in which Fig. 1 shows diagrammatically a circuit used in connection with the utilization of my invention. Fig. 2 shows characteristic curves illustrating the voltages across different portions of the receiving apparatus. Fig. 3 shows curves representing the voltages at any instant across the glow tubes shown in Fig. 1, while Fig. 4 shows modified form of receiver.

I have shown in Fig. 1 a power line 1, 2, 3 supplied by a source of power 4. The transmitter 5 of Fig. 1 comprises a standard oscillator 6 of the required power and frequency and must be of the halfwave self-rectifying type operating from the service alternating current supply. It is coupled to the line over which control is desired in any suitable manner. A condenser coupling is here shown, but the type of coupling is non-essential. The supply to the oscillator is brought in through a double-pole double-throw switch 7, such that the polarity of the alternating current at any instant is reversed by throwing the switch to the other position.

The position of this switch will then determine which operation is to be performed at the receiver end. It is essential, however, that the 110 volt alternating current supply to the oscillator be either in phase or 180° out of phase with the voltage on the two wires on the high voltage line over which control is desired. The most convenient method to obtain this result is to supply the oscillator from the same two wires through a step-down transformer 8 as shown.

At the point where the high frequency currents thus supplied to the distribution system are to be utilized the receiver 9 is taken off the 220 volt winding of a step-down distribution transformer 10 which is connected to the same two wires of the high voltage line as the transmitter. By the expression "distribution transformer" I mean any core type transformer such as is generally used in distribution systems. The primary impedance of such a transformer is sufficiently low to permit a large enough current to flow through the primary with a reasonably high impressed voltage to cause a fairly large current to flow in the secondary when properly tuned. Yet, the impedance is high enough so that it does not affect line conditions enough to interfere with the operation of the other units from the same line.

Connected across the secondary of the transformer 10 is a series tuned circuit, comprising a tuning inductance 11 and a tuning condenser 12, which is tuned to receive the frequency sent out by the transmitter and to step up the voltage on the secondary side to operate the glow tubes 13 and 16. It has been found that better than a 1 to 1 ratio can be obtained between the carrier voltage across the line and the carrier voltage across the secondary condenser 12.

The circuits of the two glow tubes 13 and 16 are connected in parallel across the condenser 12. One of these circuits consists of glow tube 13, sensitive polarized relay 14 and relay by-pass condenser 15 which is used to pass the high frequency current around the relay winding. The other circuit is similar and comprises glow tube 16, sensitive polarized relay 17 and relay by-pass condenser 18.

The glow tubes or discharge devices 13, 16 comprise, generally, two dissimilar electrodes which are enclosed in a receptacle filled with a suitable gas, such as neon, at a definite pressure. The particular gas and the pressure are so chosen that if a certain, definite potential is impressed upon the electrodes a discharge will take place and current will flow between the two electrodes as long as the potential is maintained. Because of the dissimilar structure of the two electrodes, however, current will flow in one direction only. In the operation of these devices a constant potential is impressed upon them from the alternating current distribution system. The potential thus impressed is chosen at a value somewhat below the value at which a discharge will take place between the electrodes of the tube. When high frequency current is received and impressed upon the tube, the additional potential supplied by the received current is sufficient to produce a discharge through the device and cause a current to flow as long as the high frequency current is received.

It has been found that due to inherent characteristics of distribution transformers the amount of received signals is better with a higher voltage secondary than with a low voltage. The 220 volt secondary winding is therefore used to supply high frequency to the receiver unit. Since 220 volts will cause the glow tube to glow continuously, the secondary winding of a polarizing transformer 19 is inserted in series with the glow tube circuits as shown in Fig. 1. This transformer is so connected that its voltage opposes the 220 volts of the distribution transformer impressed upon the tubes through the tuned circuit. Any voltage less than 220 volts may then be obtained across the tubes. The two glow tubes are so connected that they present opposite polarity to any incoming signal, that is the cathode of tube 16 and the anode of tube 13 are tied together and connected to one side of the tuning condenser 12, while the anode of tube 16 and the cathode of tube 13 are connected through their respective relays and the polarizing transformer to the other side of tuning condenser 12.

In operating the system described, the output of the halfwave self-rectifying set 5 is modulated by half of the 60 cycle wave, that is the oscillator will only transmit high frequency energy during that portion of the positive half cycle of the alternating current supply that the voltage is high enough to cause oscillations. During the remainder of the positive half cycle and during the negative half of the cycle no energy is sent out by the oscillator. The transmitter output then consists of a series of impulses, one occurring during one half of each cycle.

At the receiver end each glow tube is polarized with a positive voltage on its anode

during half the cycle and with a negative voltage during the other half of the cycle. When the negative half of the wave is impressed on the anode, it will, of course, take slightly more than twice the polarizing voltage to cause the tube to glow, provided it was polarized to 80% or 90%. During the half cycle that the positive voltage is impressed on the anode, however, only a slight amount of incoming carrier voltage added to the polarizing voltage is required to cause the tube to glow. Therefore if the impulse of high frequency sent out by the transmitter 5 occurs during the half cycle that negative voltage is impressed on the anode of the glow tube, no glow will occur and no current will pass through the relay, unless the high frequency voltage is excessively large. On the other hand, if the impulses of high frequency sent by the transmitter occur during the half cycle that positive voltage is impressed on the anode of the glow tube, the tube will glow and pass current through the relay with only a very small value of received high frequency voltage. When either relay is energized, switch 20 or 21 is closed to complete a circuit to operate a signal, an auxiliary relay, or any type of equipment to be controlled.

Assuming that the tube should be polarized to 110 volts, the voltage across the secondary of transformer 19 should be 110 volts, since that across the condenser 12 is 220 volts. The resulting voltages across the two tubes would then be as shown in Fig. 2. The 220 volts A. C. impressed across the condenser 12 is represented by M, while L represents the 110 volts of the polarizing transformer 19 which is 180° out of phase with M. The resulting voltage N is 110 volts across both the tubes. However, since the tubes are oppositely connected, the voltages across the two tubes with respect to their anodes at any instant are represented by the curves N₁ and N₂ in Fig. 3.

If the switch 7 of the transmitter is thrown to the left of the position shown the impulse sent out by the transmitter will, say, occur during the half cycle that tube 16 has positive potential on its anode and tube 13 has negative potential on its anode. Tube 16 will then glow and tube 13 will not, unless the high frequency voltage is excessive. However, so little high frequency is required in the one case and so much in the other, that there is wide range of high frequency voltage values throughout which perfect selection takes place. In actual experience perfect selection has been obtained with this circuit with a value of impressed carrier considerably above the minimum value required to operate the tube which has positive voltage impressed on it at the time the carrier impulse is received. Similarly if the switch 7 is thrown to the right of the position shown,

tube 13 would glow and tube 16 would not.

With the arrangement thus far described the operation may be affected by other loads placed in shunt with the equipment across the secondary winding of transformer 10. This is due to the fact that the successful operation of the system depends upon a large current flowing through the tuned circuit. I have discovered, however, that if small choke coils 22, 23 are inserted in series with any additional load, this load will have no effect on the high frequency currents. These chokes may be very small, having a value of less than 1 millihenry, so that they are cheap and easy to build. A condenser 24 of about one microfarad capacity is connected across the 220 volt lines on the load side of the choke coils, so that if the load is removed, the choke coils are still connected by a relatively low impedance at high frequencies and will not detune the receiver which is tuned to the high frequency. This condenser has a relatively high impedance at 60 cycles and will not pass much current at the power frequency.

In the modification of my invention shown in Fig. 4, a two-circuit tuner 25, 26 is employed and any type of coupling 27 to the high voltage line may be used. The tubes are polarized to opposite polarities at any instant by connecting them as shown in Fig. 1. The transmitter is the same as that in Fig. 1 and like reference characters have been used to designate like parts in the two figures.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. In a control apparatus, a power supply line, a distribution transformer connected thereto having a substantial step-down ratio, a receiver including a series tuned circuit connected across the secondary winding of said transformer thereby to constitute a virtual short circuit to high frequency currents, a discharge device connected to respond to potential on a portion of said tuned circuit, a relay connected to respond to operation of said discharge device and means for supplying both a polarizing voltage and a high frequency voltage through said transformer to said discharge device.

2. In a control apparatus, a power supply line, a distribution transformer having a substantial step-down ratio connected thereto, a circuit including a discharge device and a relay connected to the secondary low voltage winding of said transformer, said discharge device having asymmetric conductivity when broken down, means for supplying an alternating potential through said transformer to said discharge device, the value of said potential being lower than that required to break down the discharge device and produce a flow of current in the circuit, and additional means for supplying through

said transformer to the discharge circuit currents received from a distant point and thereby impressing upon the discharge device a potential great enough to cause current to flow therethrough.

3. In a control apparatus, a power supply line, a distribution transformer having a substantial step-down ratio connected thereto, a circuit comprising a discharge device and a relay connected to the secondary low voltage winding of said transformer, said discharge device comprising a pair of separated dissimilar electrodes, surrounded by an attenuated gaseous medium and having asymmetric conductivity when broken down, means for supplying an alternating potential through said transformer to the discharge device, the value of the potential being lower than that required to break down the discharge device and produce a flow of current in the device, a series tuned circuit connected to the secondary winding of said transformer and to said discharge device and means for supplying current having a frequency corresponding to said tuned circuit through said transformer thereby to impress a potential upon said discharge device great enough to cause current to flow therethrough.

4. In a control apparatus, a power supply line, a distribution transformer having a substantial step-down ratio connected thereto, a circuit including a discharge device and a relay connected to the secondary low voltage winding of said transformer, said discharge device comprising a pair of separated electrodes surrounded by an attenuated gaseous medium, and having asymmetric conductivity when broken down, means for supplying an alternating potential through the transformer to the discharge circuit, the value of the potential being lower than that required to break down the discharge device and produce a flow of current in the circuit and additional means including a series tuned circuit connected to the secondary winding of said transformer and to said discharge device for supplying to the discharge device current received from a distant point and thereby impressing upon the discharge device a potential great enough to cause current to flow therethrough.

5. In a control apparatus, a power supply line, a distribution transformer having a substantial step-down ratio connected thereto, a circuit comprising a discharge device connected to the secondary low voltage winding of said transformer, means for supplying a polarizing electromotive force through said transformer and said circuit to said discharge device, means to impress an opposing electromotive force upon said discharge device, the resulting electromotive force being less than that required to break down the discharge device, and means for supplying an additional electromotive force through said

transformer and said circuit to the discharge device thereby to effect its operation and a relay connected to respond to operation of the discharge device.

5 6. In a control apparatus, a power supply line, a receiver connected thereto, comprising a plurality of oppositely connected asym-
metrically conducting discharge devices, means for supplying alternating potential
10 to said power line to polarize said discharge devices, means for impressing an additional electromotive force upon said discharge devices during either of the like half cycles of
15 the alternating potential thereby selectively to effect the operation of the discharge devices, and a relay connected to operate responsively to each discharge device.

7. In a control apparatus, a power supply line, a distribution transformer connected
20 thereto, a receiver including a circuit tuned for a certain frequency and connected to the secondary winding of said transformer, a load connected to said secondary winding and means to prevent the application of cur-
25 rent of said certain frequency to said load, and additional means to prevent variations in impedance of said load from effecting said tuned circuit.

8. In a control apparatus, a power supply
30 line, a distribution transformer connected thereto, a receiver including a circuit tuned for a certain frequency and connected to the secondary winding of said transformer, a load connected to said secondary winding,
35 means in circuit with said secondary winding to prevent the application of current of said certain frequency to said load, and a condenser connected to said secondary winding and arranged between said means and
40 said load.

9. The combination of an alternating current distribution system, and transmitting means for impressing currents of a different
45 frequency upon said system during alternate half cycles of the alternating current wave and for interrupting said currents during opposite half cycles, a receiver comprising a plurality of asymmetrically conducting discharge devices connected to said system and
50 having alternating potential impressed thereon from the system, said devices being reversely connected with respect to said potential, and means for controlling the operation of the transmitter to cause it to operate
55 during either half cycle thereby selectively to control the operation of said discharge devices.

10. The combination of an alternating current distribution system and a half wave self-
60 rectifying transmitter connected thereto for impressing current of a different frequency upon said system, a receiver comprising a plurality of asymmetrically conducting discharge devices connected to said system and
65 having potential of the frequency of said sys-

tem impressed thereon, said devices being reversely connected with respect to said potential and reversing means for controlling the operation of the transmitter and for selectively controlling the operation of the discharge devices.

11. The combination of an alternating current supply line and a single half wave self-
70 rectifying transmitting means for superimposing a series of impulses upon the potential of said line during a portion of a half cycle of the alternating current supply, and means for reversing the energization of said single transmitting means to vary the time relation of the impulses with respect to the polarity
80 of the potential in the supply system.

12. The combination of an alternating current supply line, and transmitting means energized from said line for transmitting a series of impulses over said line during a
85 portion of a half cycle of the alternating current supply, a receiver comprising a plurality of oppositely connected asymmetrically conducting discharge devices conductively connected to said system, and means
90 for controlling the time relation of the impulses with respect to the polarity in the supply system thereby selectively to control the operation of the discharge devices.

13. The combination of an alternating current distribution system, a transmitter connected to operate during a portion of like
95 half cycles of the alternating current wave to impress current of a different frequency upon said system, a receiver including a plurality of reversely connected asymmetrically conducting devices connected to respond to said currents of different frequency and means
100 for reversing the operation of said transmitter with respect to the alternating current wave of the distribution system and for selectively controlling said devices.

14. In combination, an alternating current distribution system, a plurality of asymmetrically conducting gaseous discharge devices, each of said devices being conductively
110 connected to the system in opposite relation, means whereby an alternating voltage is applied to said devices which is insufficient to cause the devices to break down, means for
115 adding additional voltage to either the positive or negative half cycle of the alternating current wave to cause one of said devices to break down dependent upon the half cycle to which the voltage is applied and means
120 associated with each device connected to operate in response to break down of the associated device.

15. In combination, a power distribution system, a plurality of asymmetrically conducting discharge devices, each of said devices being conductively connected to the system in opposite relation, means for applying
125 alternating potential to said devices the value of which is proximate to but less than

the value at which said devices break down and become conducting, means for applying an additional electromotive force during either the positive or negative half cycle of said alternating potential thereby to cause one of said devices to break down and become conducting dependent upon the half cycle during which the additional potential is applied, and means associated with each device and connected to operate in response to the break down of the associated device.

In witness whereof I have hereunto set my hand this nineteenth day of January, 1925.

AUSTIN V. EASTMAN.

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