

Feb. 22, 1949.

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2,462,343

REMOTE CONTROL SYSTEM

Filed Aug. 21, 1944

2 Sheets-Sheet 1

FIG. 1A

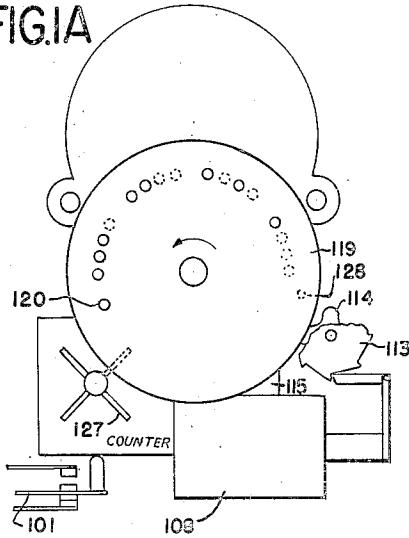


FIG. 1B

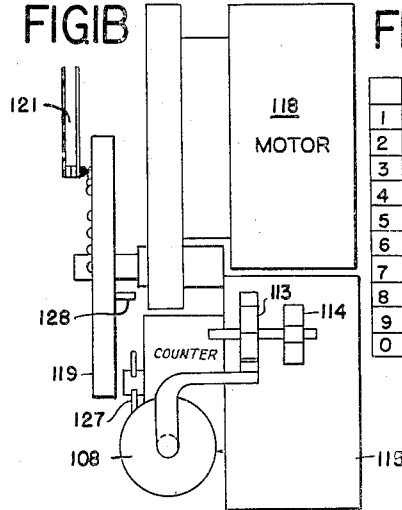
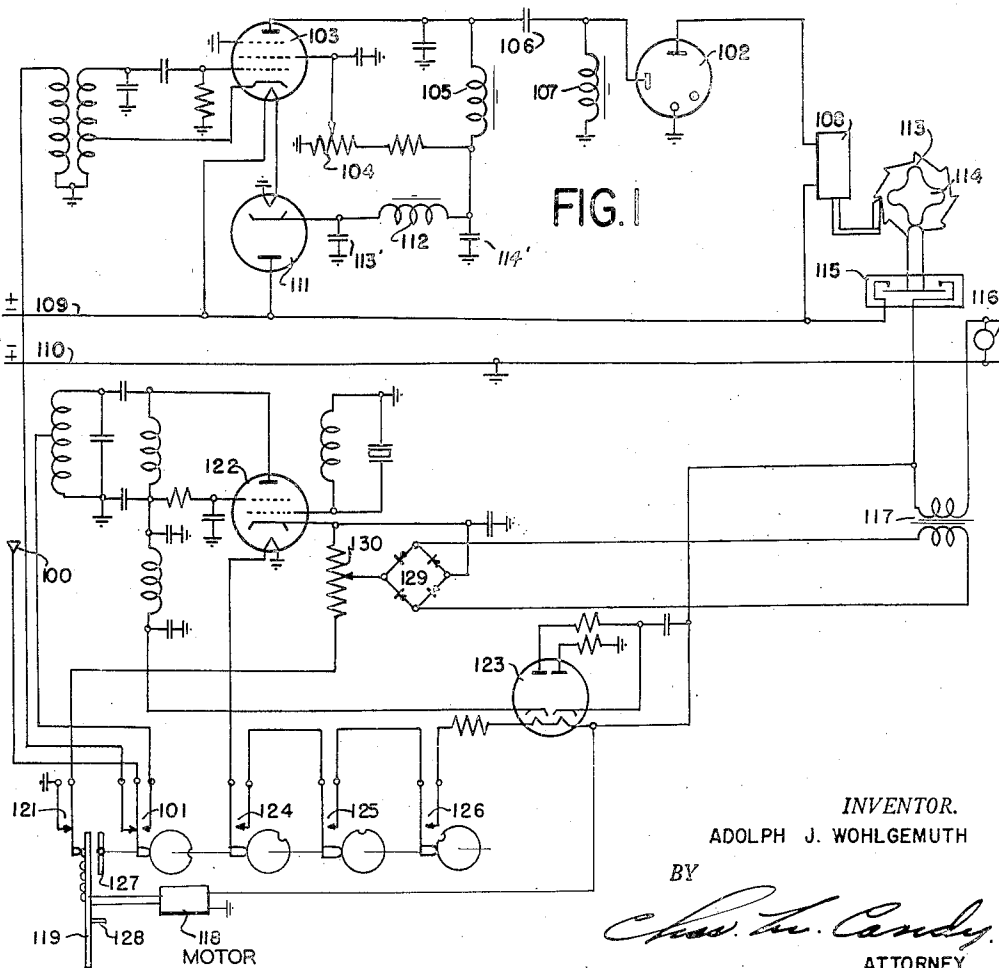


FIG. 4

|   | A | B | C | D |
|---|---|---|---|---|
| 1 | X | X | X |   |
| 2 | X | X |   |   |
| 3 | X |   | X |   |
| 4 | X |   |   |   |
| 5 |   | X | X |   |
| 6 |   | X |   | X |
| 7 |   | X |   |   |
| 8 |   |   | X | X |
| 9 |   |   | X |   |
| 0 |   |   |   | X |



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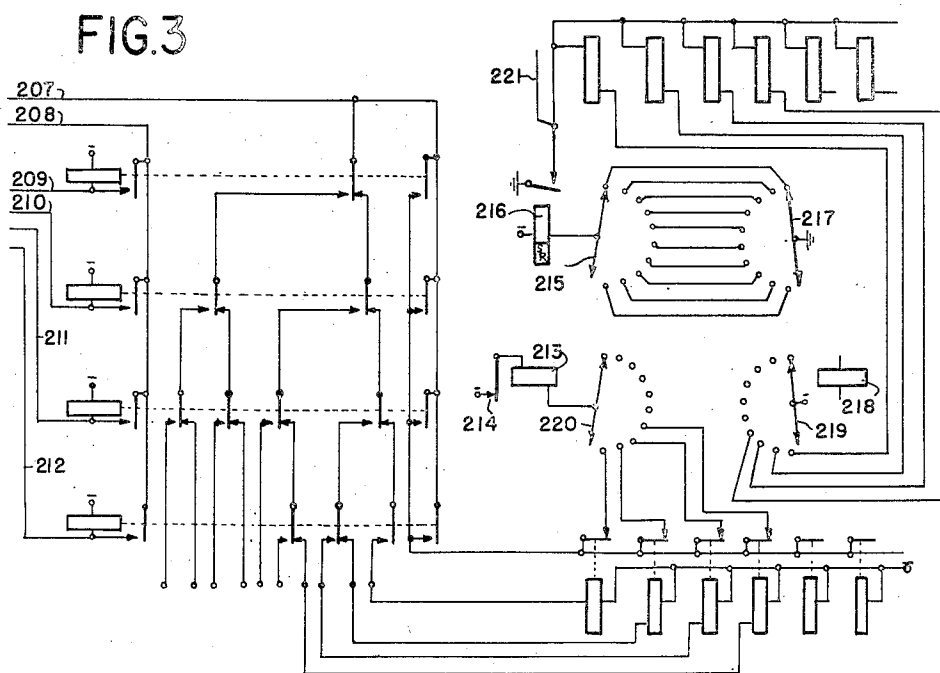
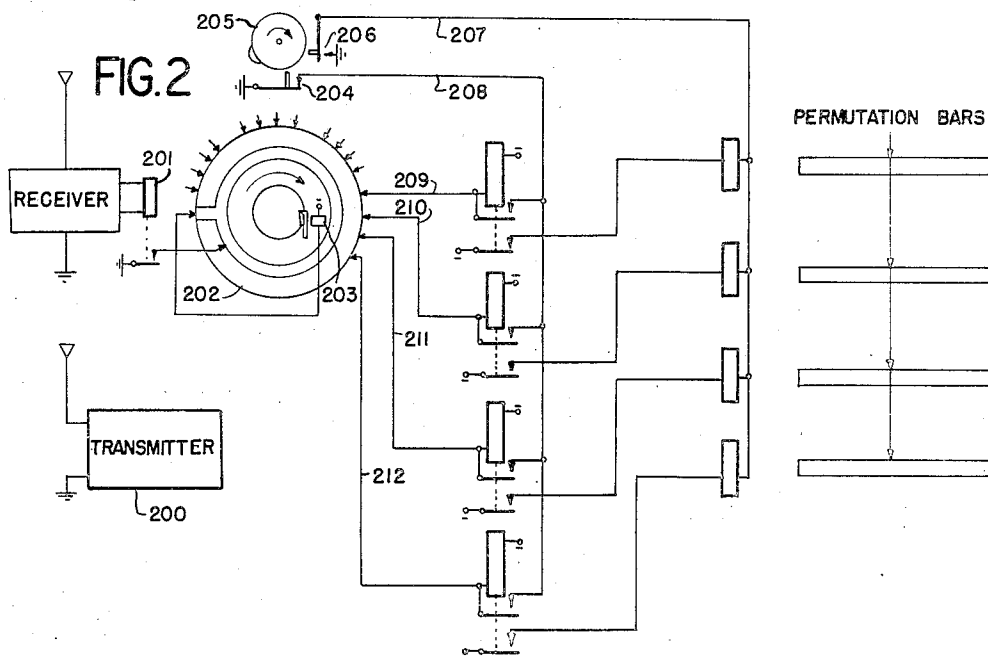
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REMOTE CONTROL SYSTEM.

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2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

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## REMOTE-CONTROL SYSTEM

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17 Claims. (Cl. 250—2)

1

The present invention pertains in general to remote control systems for controlling a number of isolated apparatus units and for monitoring the operation of each unit from a central control station, and more particularly to such a system that is adapted for the control of street lights.

There are several methods in common use for controlling the operation of street lights from a central location but none of these methods provides any indication at the control station of the proper operation of each light in the system. It is therefore necessary to patrol the entire lighting system at frequent intervals to detect the lights that are out of service due to burnouts or breakage. In a large municipality a considerable force is required for patrolling and maintaining the system.

The principal object of the present invention is to provide an improved street light control system that will permit the lights to be controlled from a central location by means of radio, and will also provide an indication at the control station of the proper operation of each light in the system to thereby eliminate the need for patrolling the system and to provide more efficient maintenance.

A further object of the invention is to provide a printed record at the control station at frequent intervals that will show which of the lights in the system are operating properly.

The object of a modification of the invention is to provide a printed record of only those lights in the system which are not operating properly.

The invention has been illustrated by the accompanying drawings, in which;

Fig. 1 is a schematic diagram of the equipment which is located at each of the remote stations.

Fig. 1A is a front view showing the mechanical arrangement of the timing mechanism and code sender located at each remote station.

Fig. 1B is a side view of the timing mechanism and code sender as seen from the right of Fig. 1A.

Fig. 2 is a schematic diagram of the control station equipment.

Fig. 3 is a schematic diagram of a modified form of recorder for use at the control station.

Fig. 4 is a chart of the code used for signaling.

The above objects are realized by providing a radio receiver and transmitter at the control station and at each remote location where a light or group of lights is to be controlled. The transmitter at the control station and the re-

2

ceivers at the remote stations are tuned to one radio channel, while the receiver at the control stations and the transmitters at the remote stations are tuned to a second radio channel. All of the lights are turned on simultaneously by momentarily energizing the radio transmitter at the control station. The radio receivers at each of the remote points operate a ratchet relay one step in response to each momentary operation of the control transmitter. Alternate operations of the ratchet relay turn the lights on or off. When the lights are turned on a timing mechanism driven by a synchronous motor is started at each of the remote stations. Each timing mechanism is arranged to energize its associated radio transmitter for a short interval a predetermined length of time after the lights are turned on. This predetermined length of time is different for each remote station so that each station is allocated a particular time for using the return signal radio channel. During the time that the transmitter at one of the remote stations is energized it sends a coded signal, which is individual to that station and corresponds to a number assigned to the station, if the lights controlled by that station are operating properly. If the lights are not operating properly the transmitter is disabled so that it will not be able to send any signal.

The coded signals sent by the radio transmitters at the remote stations are detected by the radio receiver at the control station which is arranged to operate an impulsing relay in accordance with the received codes. The impulsing relay controls a recording device which translates the coded signals into the numbers corresponding to the remote stations and prints them on a paper tape. Omission of any number on the printed record indicates a fault at the corresponding remote station. The number of the remote station will be apparent from the preceding printed number if the timing mechanisms are arranged to cause the remote stations to report in the same sequence as their assigned numbers. In the modified form of the recorder only the numbers of the remote stations which are out of order are printed.

The detailed operation of the apparatus at one of the remote stations will now be described with reference to the drawings. Referring to Fig. 1, the radio receiver which controls the street light, or group of street lights, associated with the remote station is shown at the top of the drawing. Immediately below the receiver is the trans-

mitter used to inform the control station of the proper operation of the associated street lights. At the bottom of the drawing the timing mechanism and code sender is shown. An antenna 100 is provided at each remote station and is normally connected to the radio receiver through contacts 101. The radio receiver consists of a conventional regenerative detector stage having its output coupled to the starting electrode of a cold cathode gaseous discharge tube 102. The degree of regeneration is controlled by varying the screen grid voltage of the detector tube 103 by means of potentiometer 104 so as to provide the required gain. When a modulated radio frequency signal is received the audio frequency component appears across the choke coil 105 in the plate circuit of the detector tube and also appears across the series combination of condenser 106 and choke coil 107 which are made series resonant to the audio frequency used for signaling so as to provide a relatively large voltage on the control electrode of the gaseous discharge tube 102 for a small audio signal when the audio signal is of the proper frequency. When such a signal is received the gaseous discharge tube 102 is rendered conductive during the half cycles that its anode is positive causing the operation of the solenoid 108. The anode current for the gaseous discharge tube 102 is obtained from the alternating current supply leads 109 and 110. The direct current voltage for the detector tube is also obtained from the A. C. mains but is first rectified by the thermionic rectifier 111 and then filtered by choke coil 112 and condensers 113' and 114'. Alternating current is used on the anode of tube 102 so as to cause solenoid 108 to be released when the audio signal is removed from its starting electrode. Each operation of solenoid 108 advances the ratchet 113 one step thus rotating the cam 114 through one-eighth of a revolution. A snap-action switch 115 is alternately operated and released by cam 114 for successive operations of solenoid 108. When switch 115 is operated it completes a circuit to the street light 116 from the A. C. mains 109 and 110 through the primary winding of current transformer 117. A momentary operation of the transmitter 200 at the control station (Fig. 2) thus causes the solenoids 108 at each of the remote stations to operate and simultaneously turn all of the street lights on or off. The operation of solenoid 108 also resets the counter mechanism associated with the transmitter to zero.

When the street lights are turned on a circuit is also completed to the synchronous motor 118 by switch 115. Motor 118 drives the disc 119 through suitable reduction gears. Disc 119 is provided with a series of projections arranged in a code which is individual to each station. The arrangement of these projections on the disc 119 is shown in Fig. 1A. All of the discs are provided with the first projection 120 which is used for synchronizing the recorder at the control station with the code senders at the remote stations. The projections succeeding 120 are located in the positions indicated in accordance with a prearranged code. For convenience each group of four positions following projection 120 may represent a digit in the number assigned to the remote station. The digits may then be formed by a code as shown in Fig. 4, where the letters A, B, C and D represent the four possible positions for the projections forming a digit. The digits 1 through 0 are then represented by providing projections as indicated in the chart. The code shown on

the disc 119 of Fig. 1A thus represents the number 1234 assigned to a particular remote station. A pair of contacts 121 are arranged to be operated by the projections on the disc 119 and are connected in series with the cathode circuit of the oscillator tube 122 to key the radio frequency carrier produced by the oscillator when it is operating. The oscillator tube 122 is normally disabled since its heater circuit and also the heater circuit for the rectifier tube 123 is opened by the series connected contacts 124, 125 and 126. Contacts 101, 124, 125 and 126 are associated with the units, tens, hundreds and thousands wheels, respectively, of a counter mechanism which is driven by a star-wheel 127 which is engaged by a pin 128 in disc 119 so as to cause the counter mechanism to advance one unit for each revolution of the disc 119. Indentations are provided in the counter wheels in accordance with the number assigned to the remote station. Therefore, at station 1234 for example, the only time that all four sets of contacts associated with the counter will be closed simultaneously will be during the 1234th revolution of the disc 119. During this particular revolution of the disc 119, the contacts 121 will key the radio frequency carrier produced by the oscillator tube 122 which is made operative for one revolution of the disc 119 by the completion of its heater circuit and by the transfer of the antenna 100 from the receiver to the transmitter at contacts 101. When contacts 124, 125 and 126 are closed the series heater circuits for vacuum tubes 122 and 123 is completed. Rectifier tube 123 is thus made operative and it supplies the D. C. voltage for the oscillator tube from the A. C. mains. Rectifier tube 123 is connected in a conventional half wave voltage doubling circuit. Power is actually supplied to the oscillator tube 122 throughout ten revolutions of the disc 119 but the transmitter does not produce any appreciable radiation except during the particular one of these ten revolutions when the antenna 100 is connected to it. The secondary winding of the current transformer 117 is connected to the A. C. terminals of a full wave dry disc type rectifier 129. The D. C. terminals of rectifier 129 are connected to resistor 130 which is included in the cathode circuit of the oscillator tube 122. The value of resistance 130 and the primary to secondary turns ratio of transformer 117 are chosen so that the proper grid bias will be applied to the oscillator tube when the street lights connected in series with the primary of transformer 117 are operating properly and so that the grid bias is such that the oscillator is prevented from oscillating when the street lights are not operating properly.

Referring now to Fig. 2, the coded signals transmitted in sequence by the remote stations are received at the control station where the radio frequency impulses are detected and used to control an impulsing relay 201. Contacts on the impulsing relay could be used to control a simple tape recorder directly, however this would require that the record be deciphered by means of the chart shown in Fig. 4 in order to determine the corresponding remote station numbers. The recording apparatus which is illustrated performs this deciphering automatically. To accomplish this decoding a selector disc 202 is arranged to be driven through a clutch synchronously with the pulsing discs at the remote stations. The selector is restrained by an electrically controlled stop which engages a detent in the hub of the selector disc. The first impulse of a series sent

by one of the remote stations causes a circuit to be completed to the magnet 293 by contacts of relay 201 through the selector wiper and the first stationary brush causing it to release the stop and permitting the selector to rotate in synchronism with the pulsing disc at the remote station. Sixteen fixed brushes, each corresponding to one of the possible locations of the projections on the pulsing disc 119 shown in Fig. 1A, are provided and each brush is connected to a relay, only the last four relays being shown. As the selector wiper passes each of the fixed brushes the relay associated with that brush will be operated only if there is a projection on the pulsing disc at the remote station in the corresponding position. If the relay is operated it closes its locking circuit to cam springs 204 and prepares a circuit to a magnet which is associated with a permutation bar similar to those used in printing telegraph machines. After the selector wiper has passed the last fixed brush the actuating cam 205, which is secured to the same shaft as the selector disc 202, momentarily operates cam springs 206 and 204 in succession. The operation of cam springs 206 causes each of the permutation magnets which have been selected by the selector relays to operate the permutation bars so as to cause the printer to record the received number in Arabic form. After the number has been recorded the selecting relays are released by the operation of cam springs 204 causing the permutation magnets to be released. When the selector disc has completed one revolution the stop controlled by magnet 293 engages the detent in the hub of the selector disc and prevents further rotation of the disc until the synchronizing pulse from the next station to report is received. If the lights at all of the stations are operating properly the numbers assigned to the stations will be recorded by the printer in consecutive order. However, if the lights are not operating properly at any one of the stations the radio transmitter at that station will be disabled thus causing a blank space to appear in the printed record at the control station. The number corresponding to the station which is out of order may readily be determined from the preceding or succeeding recorded number.

In order to record only the number of the stations which do not report, the modification shown in Fig. 3 may be used. The same selecting disc arrangement is used as in Fig. 2, the four relays at the left of Fig. 3 being connected to the last four fixed brushes of the selector the same as the selecting relays of Fig. 2. Instead of controlling the permutation magnets of a printer, the contacts of each group of four selecting relays are arranged to control ten auxiliary relays so that one and only one of the ten auxiliary relays will be operated when cam springs 206 are operated after the selecting relays have been set up by the received impulses. At the same time that cam springs 206 close a circuit to the selected auxiliary relay over lead 207 and through the contacts of the selecting relays, a circuit is closed to the stepping magnet 213 of a stepping switch through parallel connected make contacts on the selecting relays, the normally closed contacts of the auxiliary relays, the wiper and bank contacts of the stepping switch, and the contacts 214 of the stepping magnet. The stepping magnet 213 operates, interrupts its own circuit at contacts 214, and restores to cause its wipers 215 and 220 to advance one step. When the stepping magnet restores it recloses its own cir-

cuit at contacts 214 and initiates a second cycle of operations. The stepping magnet thus advances its wipers over the bank contacts until the wiper 220 is connected to the contacts of the particular auxiliary relay which was selected by the received code. At this time the advancement of the stepping switch ceases and a circuit is prepared to relay 216 through wiper 215 and its associated bank contacts to the bank contacts and wiper 217 of a second stepping switch controlled by stepping magnet 218. The stepping magnet 218 is controlled by a pulsing mechanism, which is not shown, so as to cause its wipers 217 and 219 to stand on the bank contacts corresponding to the digit which should be received. If the proper digit is received wiper 215 and wiper 217 will be standing on corresponding contacts and a circuit will be completed to relay 216 causing it to operate. The operation of relay 216 opens a common circuit for the printing magnets at the top of the figure to prevent the number from being recorded. However, if wiper 215 is not advanced to the same contact as wiper 217, relay 216 will not be operated and a circuit will be completed to the printing magnet, corresponding to the digit which should have been received, from the contacts of relay 216 through the particular printing magnet which is connected to the bank contact on which wiper 219 is standing. The timing mechanisms at the remote stations are preferably arranged so that the stations report in the same sequence as their assigned numbers. Under these conditions the stepping magnet 218 need only be advanced one step each time a signal is to be received. This could conveniently be accomplished by an additional set of cam springs which would be operated momentarily by cam 205 at the same time that cam springs 206 are operated. Only that portion of the recorder which corresponds to the units digit is shown, the other portions are identical except that the stepping magnet which corresponds to 216 would be operated once for every ten, hundred, or thousand operations of magnet 218. The contacts of relay 216 are also multiplied by lead 221 to the contacts of the relays which correspond to relay 216 for the tens, hundreds, and thousands digits. If the incoming signals arrive in the proper sequence stepping magnet 213 will only be operated once for each incoming signal. The circuit to relay 216 will thus be continuous except during the brief interval between the advancement of wiper 217 by magnet 218 and the advancement of wiper 215 by magnet 213. Relay 216 may be made slow-to-release by means of a copper slug to maintain it operated during this short open period. If any one of the digits is not received none of the selecting relays associated with that digit will be operated and consequently the wiper 215, or the corresponding wiper for the tens, hundreds, or thousands digit, will remain in the position corresponding to the previously received signal causing relay 216, or the corresponding relay for the other digits, to release and complete a circuit to the printing magnets corresponding to each of the digits in the signal which should have been received. If the next signal is received properly the wiper 215 will be advanced two steps causing relay 216 to be reoperated, preventing further operation of the printing magnets. Thus only the numbers corresponding to the stations which fail to report at the allotted time are recorded.

Having described and illustrated the invention, what is considered new and is desired to secure

by Letters Patent is pointed out in the subjoined claims.

What is claimed is:

1. In a remote control system having a control station and a plurality of remote stations, a pair of signaling channels common to all of said stations, means at said control station for transmitting a first signal over one of said signaling channels to initiate an operation at all of said remote stations, and means at each of said remote stations operated in response to said first signal for transmitting a return signal over the other of said signaling channels a predetermined length of time after the reception of said first signal, said predetermined length of time being different for each remote station.

2. A remote control system as claimed in claim 1 in which said return signals are characteristic of the remote station which transmits them.

3. In a remote control system including a control station and a controlled station, a radio transmitter and receiver at each of said stations, an apparatus unit at said controlled station, means at said controlled station associated with the receiver thereat for operating said apparatus unit and for normally causing the transmitter thereat to send a verification signal to the receiver at the control station in response to the operation of the transmitter at the control station, and means at said controlled station for disabling the transmitter thereat when said apparatus unit fails to operate properly.

4. In a remote control system wherein a switching device is controlled by means of a modulated high frequency carrier signal received from a control point, a radio receiver, a gaseous discharge device comprising a cathode, a starting electrode, and an anode, a frequency selective network connecting said starting electrode and cathode to the audio frequency output of said receiver so as to initiate a discharge in said gaseous discharge device when the modulated carrier signal is received, and a source of alternating current and a relay connected in series with the anode to cathode path of said gaseous discharge device, said relay operated responsive to the discharge of said tube to perform an operation, and means operated responsive thereto to transmit a characteristic signal to said control point after a predetermined time interval which is indicative of the operation performed.

5. In a signaling system including a receiving station and a plurality of sending stations, a signaling channel common to all of said stations, and means at each of said sending stations for transmitting a signal characteristic of that station to the receiving station over said signaling channel at predetermined time intervals, said means being arranged to allocate the use of said signaling channel to each of said sending stations in succession.

6. In a signaling system as claimed in claim 5, means at said receiving station for identifying the sending station in response to the reception of each of said signals.

7. In a signaling system as claimed in claim 5 including means at each of said sending stations for at times preventing the transmission of a signal therefrom, recording means at said receiving station adapted to identify a sending station in response to the absence of a signal from said sending station.

8. A remote control system comprising a control station and a plurality of remote stations, a

radio transmitter and receiver at each of said stations, means controlled by the receiver at each remote station for starting a timing mechanism thereat and for operating an associated apparatus unit in response to the reception of a prearranged signal from the transmitter at said control station, each of said timing mechanisms being arranged to momentarily enable the operation of its associated transmitter to normally send a verification signal to the control station after a predetermined time interval which is different for each remote station, and means for preventing the operation of the transmitter at a remote station when the operation of the associated apparatus unit is abnormal.

9. A remote control system as claimed in claim 8 including a recording device at the control station, and means associated with the receiver thereat for operating said recording device in accordance with the verification signals transmitted by said remote stations.

10. A remote control system as claimed in claim 8 including a recording device at the control station, and means controlled by the receiver thereat for operating said recording device so as to identify any one of said remote stations which fails to transmit said verification signal.

11. The method of operating a remote control system which consists of transmitting a signal from a control point to a plurality of remote points for controlling the operation of apparatus units thereat, periodically transmitting a signal from each of said remote points in succession to the control point only if the apparatus units at said remote points are operating normally, and continuously monitoring the signals received at the control point.

12. The method of operating a remote control system which consists of transmitting a signal from a control point to a plurality of remote points for controlling the operation of apparatus units thereat, periodically transmitting a signal from each of said remote points in succession to the control point only if the apparatus units at the remote point are operating normally, continuously monitoring the signals received at the control point, and noting the identity of those remote points which fail to return a signal.

13. In a remote control system having a control station and a plurality of remote stations, means at said control station for transmitting a first signal to all of said remote stations to initiate an operation thereat, and means at each of said remote stations operated in response to said first signal for transmitting a return signal to said control station a predetermined length of time after the reception of said first signal, said predetermined length of time being different for each of said remote stations.

14. In a remote control system, a control station and a plurality of remote stations, an apparatus unit at each of the remote stations, means controlled from the control station for simultaneously operating said apparatus units, means at each of the remote stations for normally sending an identifying signal to the control station after a predetermined interval of time, said predetermined interval of time being different for each remote station so as to cause said signals to arrive at the control station in a predetermined sequence, means at the control station for successively preparing circuits corresponding to each of the remote stations in the same sequence as the signals are normally received, and means for completing one of said circuits if the corre-

9

sponding signal is not received, whereby the failure is noted at the control station.

15. In a signaling system including a receiving station and a plurality of sending stations, means at each of said sending stations for transmitting a signal to the receiving station at predetermined time intervals, said means being arranged to cause the signals to be transmitted in a predetermined sequence, means at the receiving station for successively preparing circuits in the same sequence as the signals are normally received, and means for completing one of said circuits when a signal fails to appear at the proper time whereby the failure is noted at the receiving station.

16. In a signaling system including a receiving station and a plurality of sending stations, a signaling channel common to all of said stations, and means at each of said sending stations for periodically transmitting a signal to the receiving station over said signaling channel, said means being arranged to cause the signals to be transmitted in succession.

17. In a remote control system, a control station and a plurality of remote stations, radio transmitting and receiving equipment at each of said stations, means controlled by the receiver at each of said remote stations for initiating an operation thereat in response to the operation of the transmitter at the control station, means at each of the remote stations causing the trans-

10

mitters thereat to send a signal to the control station if said operation is completed, said last means being arranged to cause said signals to be sent in a predetermined sequence, means at said control station for successively preparing circuits in the same predetermined sequence, and means controlled by the receiver at the control station for completing one of said circuits if one of said signals is not received, whereby the identity of the remote station which failed to return a signal is noted.

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