# United States Patent

**Auer, Jr. et al.**

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## [54] REMOTE CONTROL APPARATUS


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[21] Appl. No.: **18,980**

[52] **U.S. Cl.** ..... **343/225**, 328/109, 328/110, 340/164, 340/171 R

[51] **Int. Cl.** ..... **H03k 5/20**

[58] **Field of Search** ..... 340/167, 171, 164; 343/225, 343/228; 325/305, 306, 33, 40, 391, 392; 328/140, 109, 110



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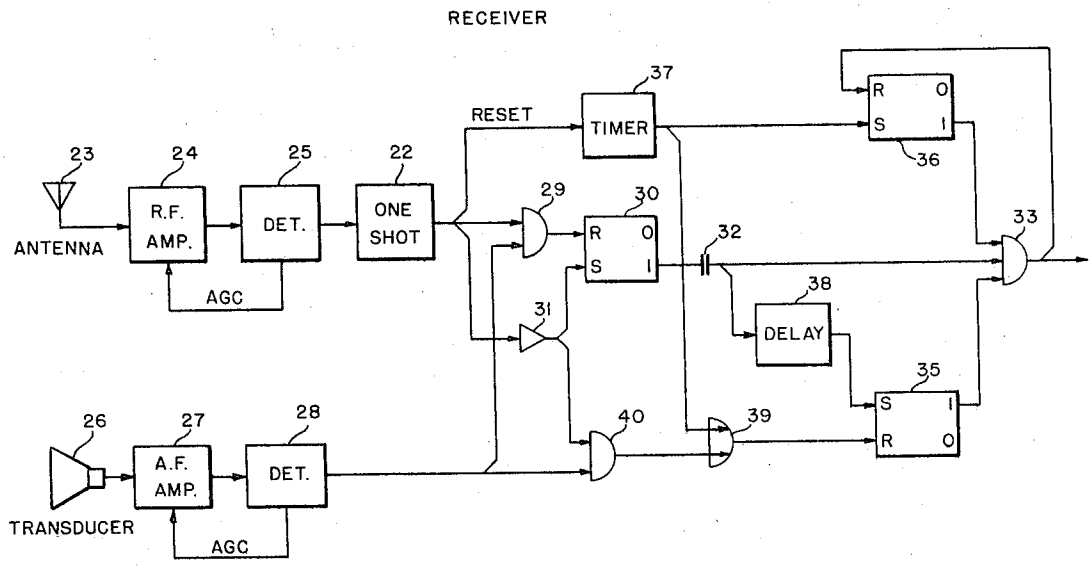
[57] **ABSTRACT**

There has been provided remote control apparatus for generating signals over a communications means which selectively controls the actuation of apparatus at remotely located devices from a control location in accordance with the distance of the control location to the devices.

The improvement includes dual range signal means for transmitting the signals over two ranges of energy having different propagation time characteristics and receiver means at each of these remotely located devices responsive to each associated range of energy for receiving the signal and generating associated outputs. Gating means responsive to the first associated output initiates the gating sequence signal having a duration relative to the propagation time of the second associated output. Output control means responsive to the gating sequence signal and the second associated output activates the apparatus when the second associated signal occurs within the duration of the gating sequence signal.

There has also been included a timing means coupled to the communication means at the remote location responsive to the control signals for generating a second gating signal of predetermined duration longer than the first gating signal for each control pulse. A counter responsive to the first gating means generates an output signal after a predetermined number of registered first gating signals, the output signal for activating the apparatus at the remotely located devices. Reset means responds to the control signals, the first gating means and the timing means for cancelling the counts stored in the counter when a control signal occurs during the first gate interval and without said second gate interval thereby only control signals of a selected range of frequency are capable of driving the counter to predetermined counts for generating the output signal.


**12 Claims, 7 Drawing Figures**



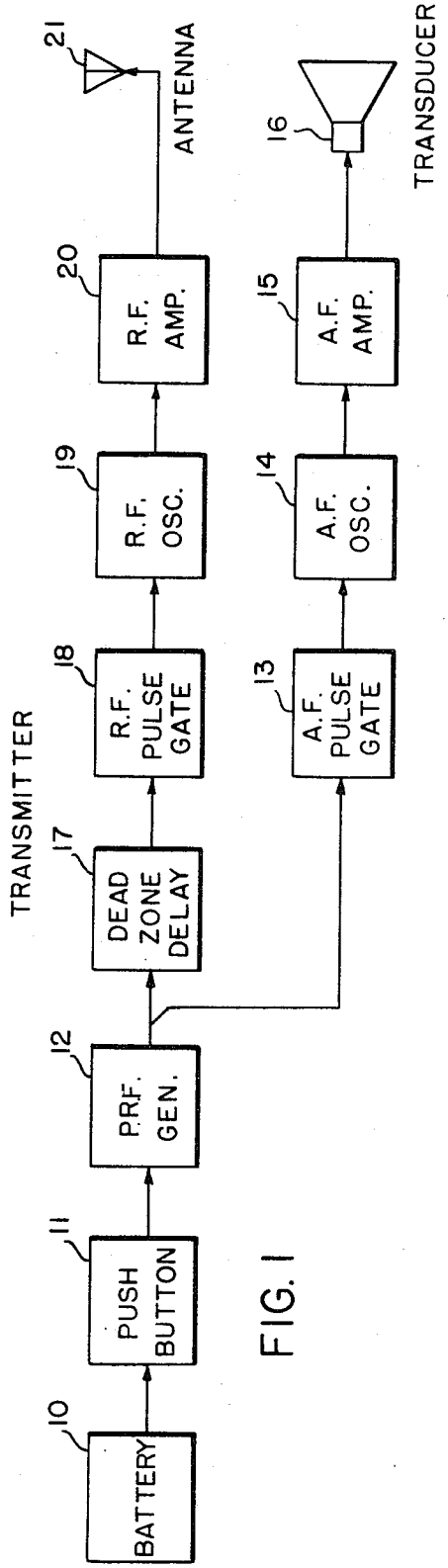

TRANSMITTER
BATTERY
10
PUSH BUTTON
11
PRF. GEN.
12
DEAD ZONE DELAY
17
R.F. PULSE GATE
18
R.F. OSC.
19
R.F. AMP.
20
ANTENNA
21
A.F. PULSE GATE
13
A.F. OSC.
14
A.F. AMP.
15
TRANSDUCER
16

FIG. 1

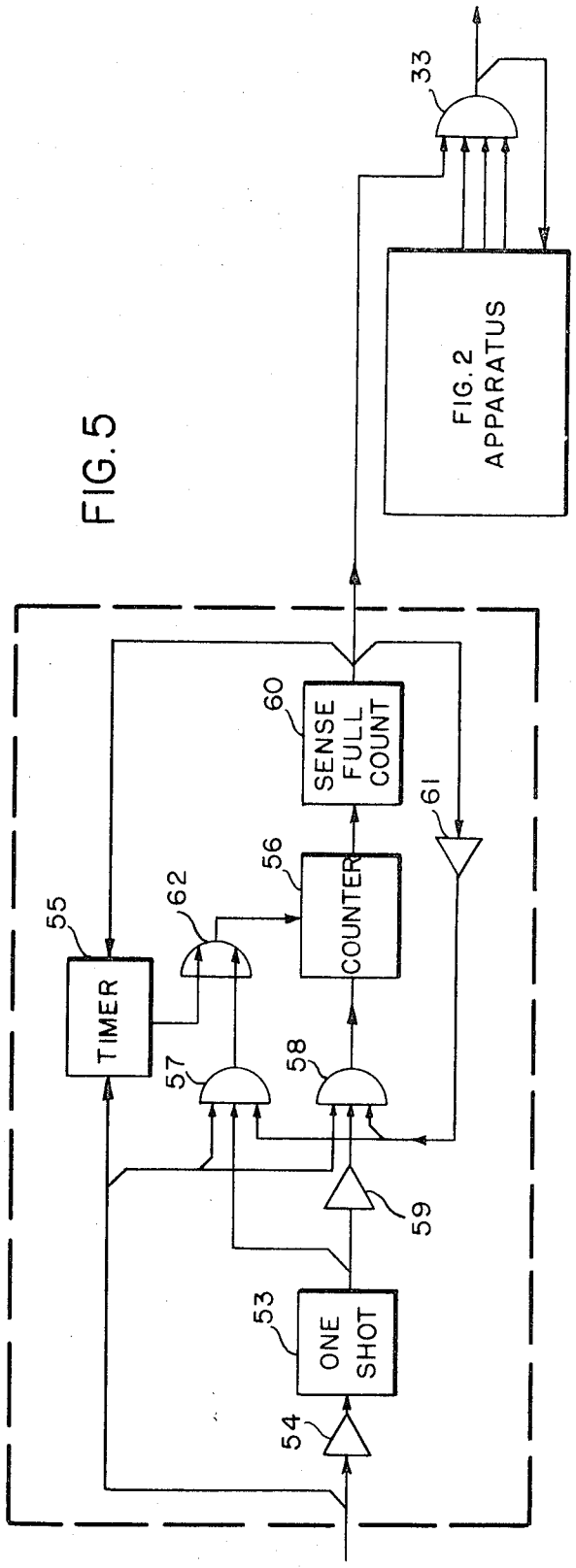

33
FIG. 2 APPARATUS
SENSE FULL COUNT
60
61
COUNTER
56
62
TIMER
55
57
58
59
ONE SHOT
53
54

FIG. 5

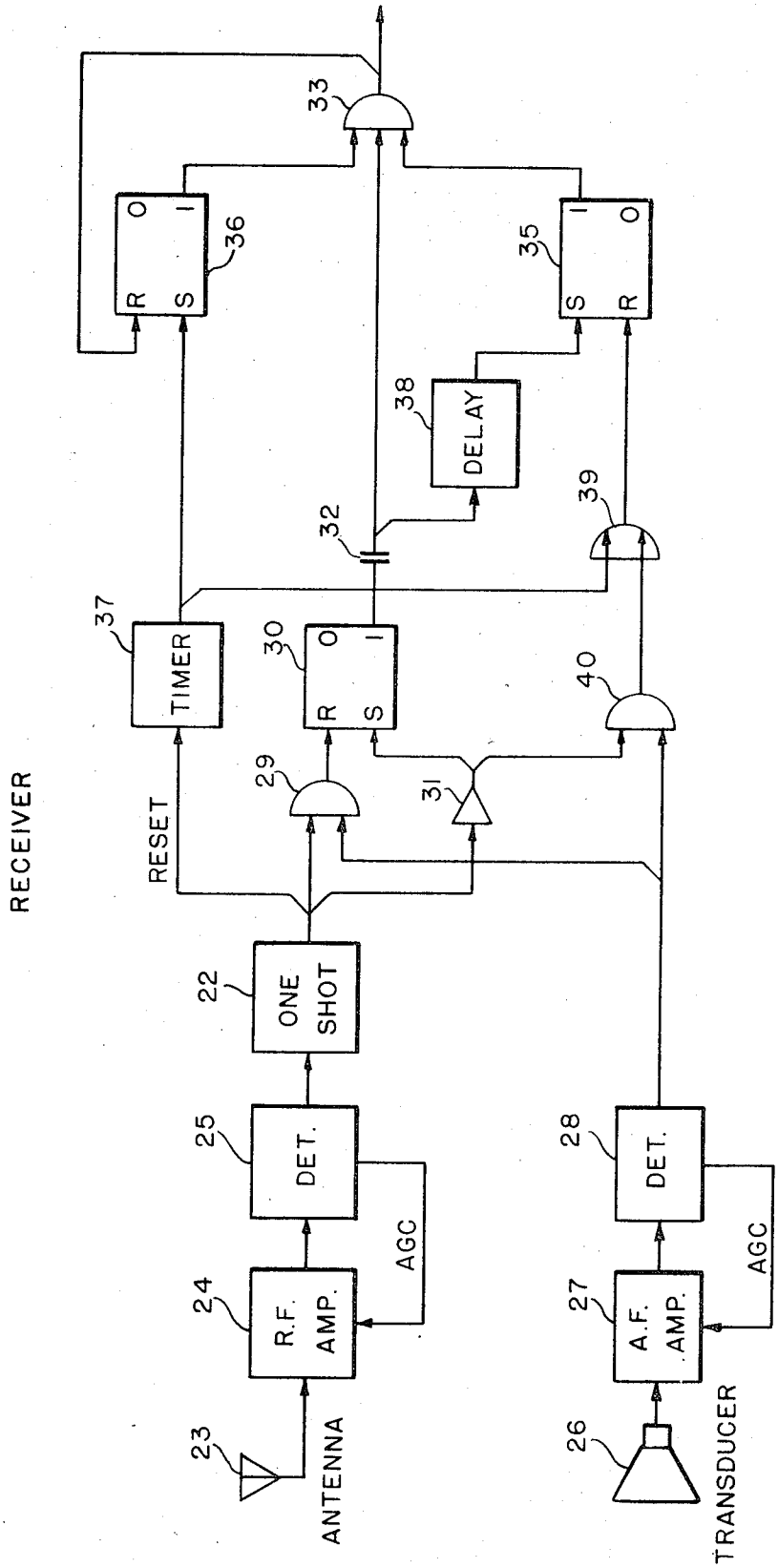

RECEIVER
RESET
ANTENNA
TRANSDUCER
AGC
AGC
TIMER
ONE SHOT
DELAY
DET.
DET.
R.F. AMP.
A.F. AMP.
23
24
25
26
27
28
29
30
31
32
33
35
36
37
38
39
40

FIG. 2

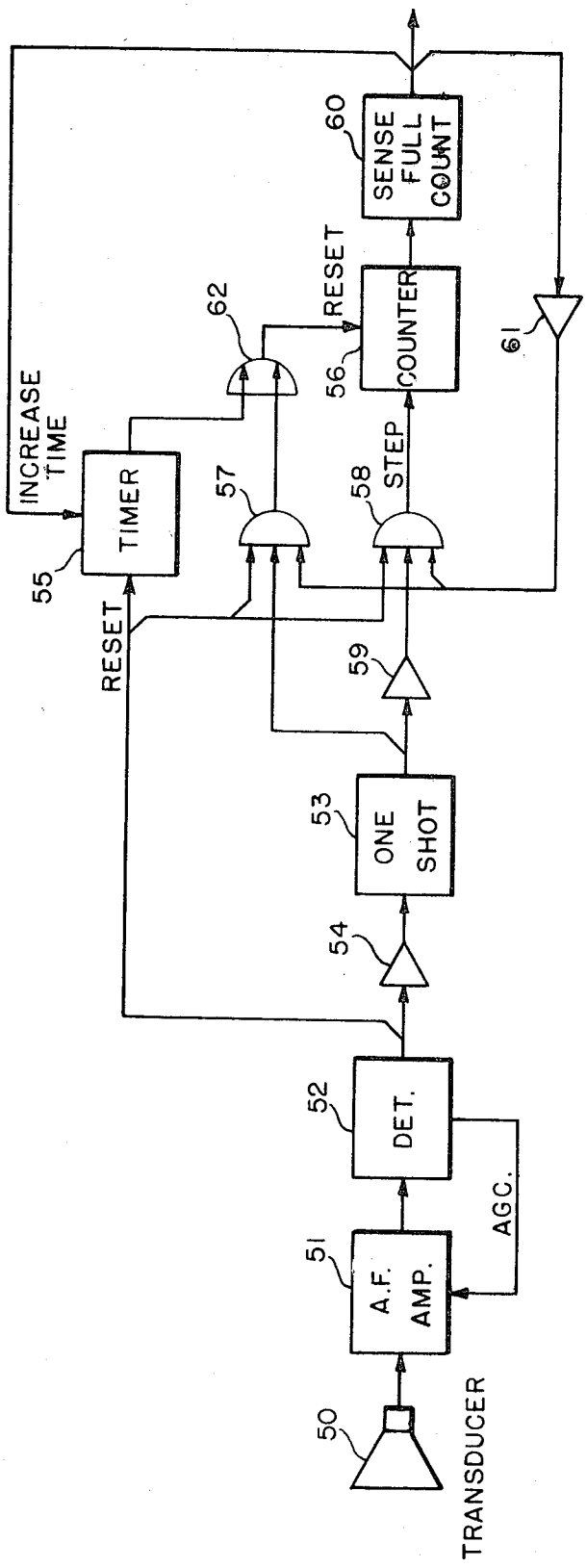

TRANSDUCER
50
A.F. AMP.
51
DET.
52
AGC.
ONE SHOT
53
54
RECEIVER
59
TIMER
55
RESET
INCREASE TIME
57
58
STEP
62
RESET
COUNTER
56
61
SENSE FULL COUNT
60

FIG. 3

FIG. 4B

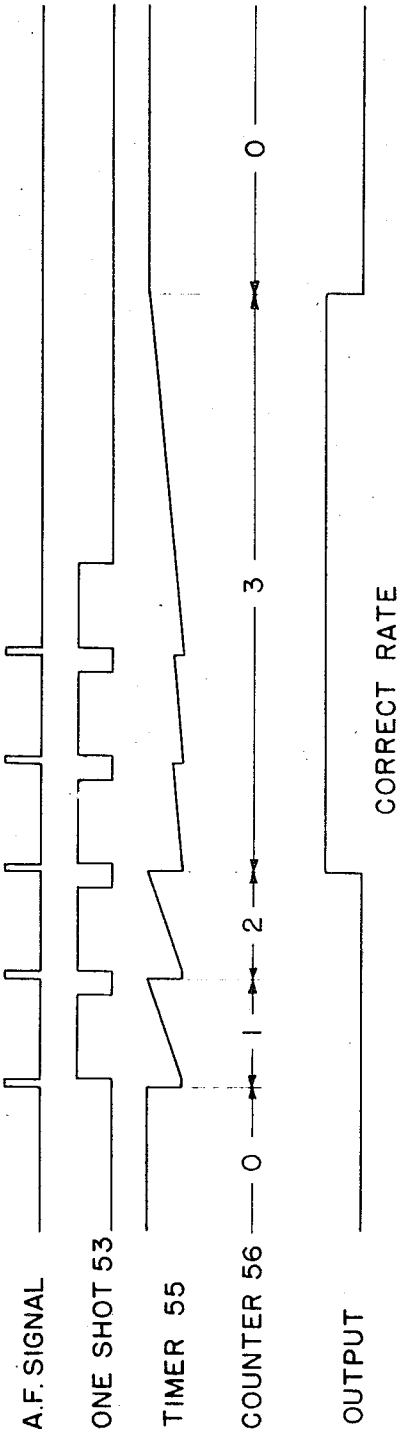
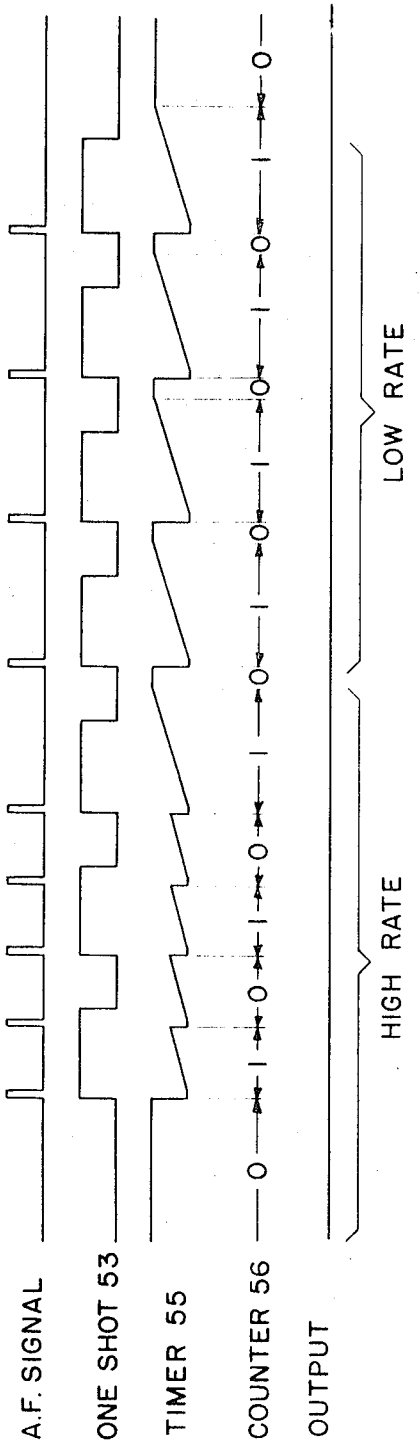

A.F. SIGNAL
ONE SHOT 53
TIMER 55
COUNTER 56
0
1
2
3
0
OUTPUT
CORRECT RATE

FIG. 4C


A.F. SIGNAL
ONE SHOT 53
TIMER 55
COUNTER 56
0
1
0
1
0
1
0
1
0
1
0
OUTPUT
HIGH RATE
LOW RATE

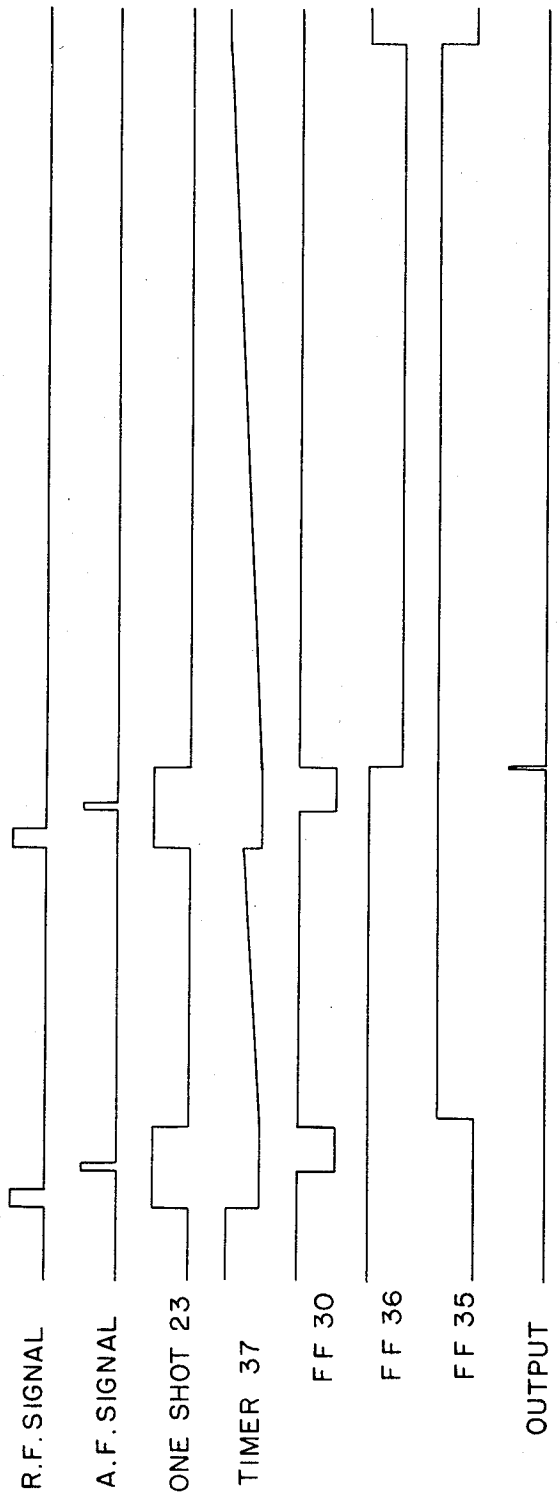

R.F. SIGNAL
A.F. SIGNAL
ONE SHOT 23
TIMER 37
F F 30
F F 36
F F 35
OUTPUT

FIG. 4A

# REMOTE CONTROL APPARATUS

## BACKGROUND OF THE INVENTION

This invention relates to remote-controlled devices and in particular to apparatus capable of selectively controlling one of a plurality of remote devices according to frequency discrimination and the distance of the control apparatus from the remote device.

In industrial yards where a substantial amount of freight is handled daily, there has been felt a need for reliable and inexpensive remote switching apparatus. In most cases it is not necessary to have a central control over a number of switches in an industrial yard because the particular operation may not be so complex as to warrant such an elaborate system. However, it has been found that if a crewman riding on the front of a vehicle could control the switch ahead of the train, then a great deal of time and effort could be saved in the handling of incoming and outgoing freight.

It is not desirable, however, to have a long-range or heavy-duty remote control device carried on the train. It is, on the other hand, desirable to have a hand- carried transmitter for communicating control signals to receiving apparatus at a switch for example, which is responsive to the particular characteristic of the control signal. Complex coding apparatus is also not warranted because malfunctions will not long go unobserved, and since the speed at which the vehicles in industrial yards travel is rather slow, command signals may be repeated in the event a particular function does not occur upon initial actuation.

It is therefore an object of the present invention to provide an arrangement which substantially obviates one or more of the limitations and disadvantages of the described prior arrangements.

Another object of the present invention is to provide a simplified control system for governing remotely located devices within a limited range.

It is another object of the present invention to provide for selective control of a number of remote control devices according to a selected frequency associated with each of the remotely located devices.

## SUMMARY OF THE INVENTION

There has been provided control apparatus for generating signals over communication means for selectively controlling actuation of remotely located devices from a control location in accordance with the distance of a control location to the devices and the improvement includes dual range signal means for transmitting signals over two ranges of energy having different propagation time characteristics. Receiver means at each of the remotely located devices responds to each associated range of energy for receiving the signals and generating associated outputs, and gating means responsive to the first of the associated outputs initiates a gating sequence signal having a duration relative to the propagation time of the second associated output. Output control means responsive to gating the sequence signal and a second associated output activates the apparatus when the second associated signal occurs within the duration of these gating sequence signals. There has also been provided a control apparatus including timing means coupled to the communication means at the remote location responsive to the control signals for generating a second gating signal of predetermined duration longer than the first gating signal for each control pulse occurring within the second gate interval. A counter responsive to the first gating signal means generates an output signal after a predetermined number of registered first gating signals, the output signal activates the apparatus at the remotely located devices. Reset means responsive to the control signals, first gating means and the timing means cancels the counts stored in the counter when the control signal occurs during the first gate interval and without the second gate interval thereby only control signals of a selected range of frequency are capable of driving the counter to the predetermined counts for generating the output signal.



For a better understanding of the present invention together with other and further objects thereof, reference is had to the following description, taken in connection with the accompanying drawings, while its scope will be pointed out in the appending claims.

FIG. 1 is a block diagram of the transmitter located at the control location.

FIG. 2 is a block diagram of the receiver at the remotely located device which is responsible to the two ranges of control signal energy.

FIG. 3 is a block diagram of a receiver located at the remotely controlled device responsive to selected control frequencies.

FIGS. 4A through 4C show diagrams of the various signal characteristics used in the explanation of the preferred embodiment of the present invention.

FIG. 5 is an adaptation of the devices of FIGS. 2 and 3 for range and frequency selectivity.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

The system contemplates the use of a portable transmitting device which may be carried by a man riding on the front of a railroad locomotive. The transmitter includes a power supply, preferably a battery **10** and a pushbutton **11** which when depressed supplies energy from the battery to a PRF generator **12** which supplies pulses at a preselected pulse repetition frequency. For each of such pulses both a sonic and radio transmission occur. By comparison of the propagation time of the radio and audio signal, a distance separating the transmitter and the receiver is manifested as a delay in the propagation of the sonic signal. The sonic transmission occurs usually following each PRF pulse as controlled by audiofrequency pulse gate **13** which is coupled to oscillator **14** for providing a carrier and amplifier **15** to transducer **16**.

The radio transmission on the other hand is delayed by an amount which establishes the minimum separation since the associated receiver will not accept a sonic pulse which arrives before the related radio pulse. By varying the duration of the delay, it is possible to select switches in various ranges. Delay **17** provides the pulse to pulse gate **18**, oscillator **19** and amplifier **20** to antenna **21** for transmission to the remote location.

The sonic pulses are rather short so as to conserve battery power and they are given a duration of several milliseconds so that they may be discriminated from transients at the receiver. Since little power is required for radio transmission, the duration of radio pulses is of little consequence, in fact, it might be desirable from a noise viewpoint to transmit a continuous radio signal while the pushbutton **11** is depressed and insert the intelligence by shifting the carrier frequency.

Since repeated pulses of sonic and radio energy occur as long as the button **11** is depressed, there exists a second active distance range at which the sonic pulse from one cycle relates to the radio pulse from the next cycle. Similarly, additional active cycles exist where a sonic pulse relates with the radio pulses, three, four or five cycles later. However, if low enough repetition frequency is selected, all but the first active cycle can be readily rejected on the basis of the attenuation of the sonic signal with distance.

A block diagram of the receiver is shown in FIG. 2. Automatic gain control AGC is used in both the radio and audio receivers respectively so that the system will operate in the presence of a strong noise. As shown in FIG. 4A, the leading edge of the RF pulse is received through antenna **23** amplified in radiofrequency amplifier **24** and transmitted through detector **25**. This signal is used to trigger one-shot multivibrator **22** which generates a gate pulse. Audiofrequency signals are received by transducer **26** amplified in audiofrequency amplifier **27** and transmitted through detector **28** which provides automatic gain control to amplifier **27**. If the audiofrequency signal arrives during the gate of the one-short **22**, it is accepted by AND-gate **29** and serves to reset a flip-flop **30**. When the one-shot pulse ends, the flip-flop **30** is set by the trailing edge of the one-shot **22** pulse through inverter **31**. The setting of

flip-flop 30 produces an output signal which is differentiated through capacitor 32 and applied to AND-gate 33. Flip-flop 35 is initially in a reset condition and flip-flop 36 controlled by timer 37 is initially in a set position and therefore only two of the three inputs to AND-gate 33 are satisfied and no output pulse occurs. After the delay governed by delay element 38, flip-flop 35 is set and AND-gate 33 is enabled to respond to the next sonic pulse.

The next time a radiofrequency pulse is received through antenna 23 and amplified for triggering one-shot 22, another gate is produced. If an audio signal is received by transducer 26 during this second successive gate interval, AND-gate 29 is satisfied resetting flip-flop 30 and when the gate ends, a pulse produced at the output of flip-flop 30 by the setting of that flip-flop satisfies the input to gate 33. When the output pulse occurs and AND-gate 33, flip-flop 36 is reset so that no more output pulses will occur until timer 37 times out. When timer 37 achieves its timeout cycle, the pulse produced sets flip-flop 36 which activates its output to AND-gate 33. In addition, the timing of timer 37 is coupled to the reset of flip-flop 35 through OR-gate 39 resetting flip-flop 35 and thus decoupling its output to AND-gate 33. This waveform sequence is illustrated in FIG. 4A. According to the description in FIG. 2, in order to produce an output, it takes two sonic pulses, each occurring within successive radiofrequency controlled one-shot gate pulses. That is, sonic pulses must occur within different cycles of the gate since only one output pulse can be generated per cycle as flip-flop 30 is set. Furthermore, no sonic pulses are permitted between the pulses of one-shot 22. Such signal would reset flip-flop 35 and cancel the effect of the preceding pulse. This occurs because a second audio signal received in between the gate pulses of one-shot 22 provide one input to AND-gate 40 the other being supplied by the off state of one-shot 22 through inverter 31. When one-shot 22 is off condition, the input to AND-gate 40 through inverter 31 is satisfied and the input from the audio receiver completes the inputs to the gate 40 and produces a pulse which is coupled through OR-gate 39 to reset flip-flop 35, thus inhibiting the output AND-gate 33. Once an output is produced, another cannot occur until the pushbutton 11 is released through a substantial interval.

Another variation of the present invention uses only the sonic signal although this could as readily use a radio signal or an infrared signal. Selectivity is achieved by providing more than one pulse repetition frequency and designing receivers which respond only to a specific pulse repetition frequency. The transmitter is the same as that shown in FIG. 1, except that the radiofrequency signal is not required and the PRF generator 12 is selectable.

The receiver block diagram shown in FIG. 3 includes the receiver transducer 50, amplifier 51 and detector 52 with automatic gain control feedback. When a received sonic pulse terminates, an input to one-shot 53 is satisfied through inverter 54, this input causing the one-shot to produce a gate within which the next sonic pulse must not occur. At the end of the sonic pulse, one-shot 53 is triggered and timer 55 previously held reset by the audio signal, begins running. For the next pulse to operate in conjunction with the first, it must arrive after the one-shot 53 has completed it cycle but before the timer 55 has completed its cycle. For an output to be produced, a series of pulses meeting these requirements must be received. Each such pulse advances a counter 56 by one count and when the counter 56 is full, an output is produced. If a pulse should occur before the cycle of one-shot 53 is complete, the counter 56 is reset. If a pulse does not occur before the timer 55 cycle is complete, the counter 56 is reset also. Therefore, a series of pulses with the correct spacing and with no intervening pulses is required; that is, a series of pulses having the correct frequency must be received.

An output from one-shot 53 is transmitted directly to AND-gate 57 and also to AND-gate 58 through inverter 59. Thus an ON condition of one-shot 53 satisfies an input to gate 57 while an OFF condition satisfies the input to gate 58. A second input to AND-gate 58 is provided from a sense full count detector 60. If the counter 56 is not at its full count, no output is produced and is sensed and transmitted through inverter 61 to satisfy the second input to AND-gate 58 and also a second input to AND-gate 57. A third input to the gate 58 is provided directly from detector 52 which also provides an input to gate 57. With the counter 56 at zero count, a received audio signal first triggers one-shot 53 and resets timer 55. A count is registered in counter 56 because the output of one-shot 53 is coupled to inverter 59 through AND-gate 58 satisfying the three inputs to gate 58. Since one-shot 53 is triggered on by the termination of the audio signal, the input from one-shot 53 to AND-gate 57 is not satisfied since the audio signal is off when the one-shot 53 is on. However, an audio signal occurring during the ON time of one-shot 53 will reset counter 56 because inputs to gate 57 are satisfied simultaneously and OR-gate 26 transmits the reset signal to the counter. On the other hand, if no audio signal occurs until the end of the pulse of one-shot 53, the inputs to AND-gate 53 are satisfied since the inverters 59 and 61 convert an OFF condition to a signal and the audio signal received satisfies the third input to gate 58 thus stepping counter 56.

According to the diagram in FIG. 4B showing the correct rate, the audiofrequency signals always occur during the OFF period of the one-shot 53 and at no other time. FIG. 4C shows what occurs when the audiofrequency signal occurs during the gate of the one-shot 53. Each time an audiofrequency occurs during that period, the counter is reset back to zero. On the other hand, if the audiofrequency signal does not occur within the timeout cycle of timer 55, a pulse is produced from output of timer 55 through OR-gate 62 resetting the counter 56, again cancelling the count stored therein. The low, high and correct rates are appropriately labeled in FIGS. 4A, 4B and 4C.

Once an output has been initiated, the counter is prevented from being affected by sonic pulses until a substantial time interval runs out. THis time interval does not begin to run, however, until the transmitter pushbutton 11 is again released.

An output to the timer 55 from the output of the count detector 60 provides a signal for increasing the timer timeout cycle once an output has been developed. This is done in order to reduce sensitivity of the receiver so that once an output is achieved, the counter 56 will not be reset if an intermediate pulse from the audiofrequency signal is missed. As shown in FIG. 4B, this tends to increase the duration of the output pulse so that a strong signal is transmitted to the apparatus responsive to the receiver.

A third embodiment of the present invention shown in FIG. 5 utilizes the distance selectivity of the device shown in FIG. 2 and the frequency sensitivity according to the drawing in FIG. 3. In order to end duplicate functions, it would be necessary to eliminate the transducer 50, audiofrequency amplifier 51 and detector 52 from the apparatus described in FIG. 3. By coupling the output of detector 28 of FIG. 2 to the inputs of timer 55 and inverter 54, and by providing an input to AND-gate 33 of FIG. 2 to accommodate the output of the apparatus shown in FIG. 3, the two systems functioning together will provide frequency and distance discrimination to the remote control apparatus. Under these conditions, four inputs must be satisfied to AND-gate 33 before an output pulse will be produced for activating the apparatus controlled by the devices herein discussed. An output pulse shown in FIG. 4A occurring within the output pulse shown in FIG. 4B would indicate that the proper frequency and distance requirements are satisfied.

There has therefore been shown a control apparatus for selectivity controlling actuation of apparatus at remotely located devices from a control location in accordance with the distance of said location to the devices and in response to frequency unique to that particular receiver.

While there have been described what are at present considered to be the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes

and modifications may be made therein without departing from the invention, and it is therefore aimed in the appended claims to cover all such changes and modifications that fall within the true spirit and scope of the invention.

What is claimed is:

1. Control apparatus for generating signals over communication means for selectively controlling actuation of apparatus at remotely located devices from a control location in accordance with the distance of said control location to said devices wherein the improvement comprises:

a. dual range signal means for transmitting the signals over a first and a second range of energy the former having a propagation time characteristic more rapid than the latter;

b. receiver means at each of the remotely located devices responsive to each associated range of energy for receiving said signals and generating associated outputs;

c. gating means responsive to the first of said associated outputs for initiating a gating sequence signal having a duration relative to the propagation time of said second associated signal; and

d. output control means responsive to the gating sequence signal and the second associated output for activating the apparatus when said second associated signal occurs within the duration of said gating sequence signal; and

e. delay means coupled to the more rapid transmission means for inhibiting the signal propagation for a selected interval relative to a predetermined distance of the control location and said devices.

2. The control apparatus of claim 1 wherein said dual range signal means respectively generating the signals over said first and second ranges of energy comprises:

a. pulse generator means for initiating the control pulses at a selected frequency and duration; and

b. sonic and radiant transmission means each responsive to the pulse generator means for projecting the control pulses over audio and radio ranges of energy propagation.

3. The control apparatus of claim 1 wherein said gating means comprises: a stable switching means having an ON state for projecting said gating signal activated in accordance with one of said receiver outputs, the duration of said gating signal indicative of an acceptable operative range of distance of the control location and said remote location from a minimum to a maximum.

4. The control apparatus of claim 1 wherein said output control means includes: primary bistable means controlling the output having a conductance state for generating said gate signal in response to said gating sequence signal and said second associated receiver signal.

5. The control apparatus of claim 4 wherein said output control means further includes:

a timer responsive to the gating sequence signal for producing a limit signal a predetermined time after said gating sequence signal; and

two secondary bistable means for enabling and disabling the output means; one of said secondary bistable means responsive to the output signal for inhibiting further outputs in one conductance state and responsive to enable said output means in response to said time limit signal; and

delay means responsive to the primary bistable means for delaying the first output of said bistable means;

the other of said secondary bistable means responsive to the OFF condition of said astable means and the limit signal for disabling the output means and responsive to the delay means for enabling the output for the second of said outputs of said primary bistable means; thereby two consecutive signals from the second receiver must be received within two consecutive gates of said gating means for each output to be produced.

6. A control apparatus for generating pulsed control signals over communication means for selectively controlling actuation of apparatus at remotely located devices wherein the improvement comprises:

a. gating means coupled to the communication means at the remote location responsive to the control pulses for generating a first gating signal of predetermined duration for each control pulse occurring without said gate interval;

b. timing means coupled to the communication means at the remote location responsive to the control pulses for generating a second gating signal of predetermined duration longer than said first gating signal for each control pulse;

c. a counter responsive to the first gating signal means for generating an output signal after a predetermined number of registered first gating signals; said output signal for activating the apparatus at the remotely located devices;

d. reset means responsive to the control signals, the first gating means and the timing means for cancelling the counts stored in said counter when a control signal occurs during said first gate interval and without said second gate interval, thereby only control signals of a selected range of frequency are capable of driving the counter to the predetermined counts for generating the output signal and

e. sensing means responsive to the counts stored in said counter for providing an inhibit to the counter after a predetermined number of counts and also providing said inhibit signal to the timer for increasing the duration of said second gating signal for maintaining the duration of said output signal.

7. The control apparatus of claim 6 wherein said gating means includes: a stable means having its conductance state responsive to the control pulses for producing said gating signal.

8. The control apparatus of claim 7 wherein said gating means further includes first and gate means responsive to said OFF condition of said astable means and the control pulses for permitting a step of said counter for each control pulse without said gating interval.

9. The control apparatus of claim 8 wherein said gating means further includes an input to said first AND-gate from said sensing means for permitting a step of said counter until said counter is at full capacity.

10. The control apparatus of claim 6 wherein said reset means comprises: a second AND-gate responsive to the control pulses and the OFF condition of said astable means for resetting said counter when control pulses occur within said gating pulses.

11. The control apparatus of claim 10 wherein said reset means further includes an input to said first AND-gate responsive to said sensing means for permitting a reset when said counter is at less than full count.

12. The control apparatus of claim 11 wherein said reset means further includes OR-gate means coupling said first AND-gate output and said timer output for permitting a reset of said counter when either of said timer and AND-gate outputs are satisfied respectively.

* * * * *