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(12) # EUROPEAN PATENT APPLICATION

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(54) **Remote control system.**

(57) A system for remotely controlling operation of a device has a transmitter unit (Figure 1) and a receiving unit (Figure 2). The transmitter unit has a circuit (2) which produces a control signal when the system is being operated, and transmitter circuit (6, 10, 11) for repeatedly transmitting the control signal. The receiver unit has a receiving circuit (20, 2, 22) which receives the transmitted signal, and operation control circuit (24-30) responsive to the received signal for initiating operation of the device and maintaining operation of the device provided the transmitted control signal continues to be received.

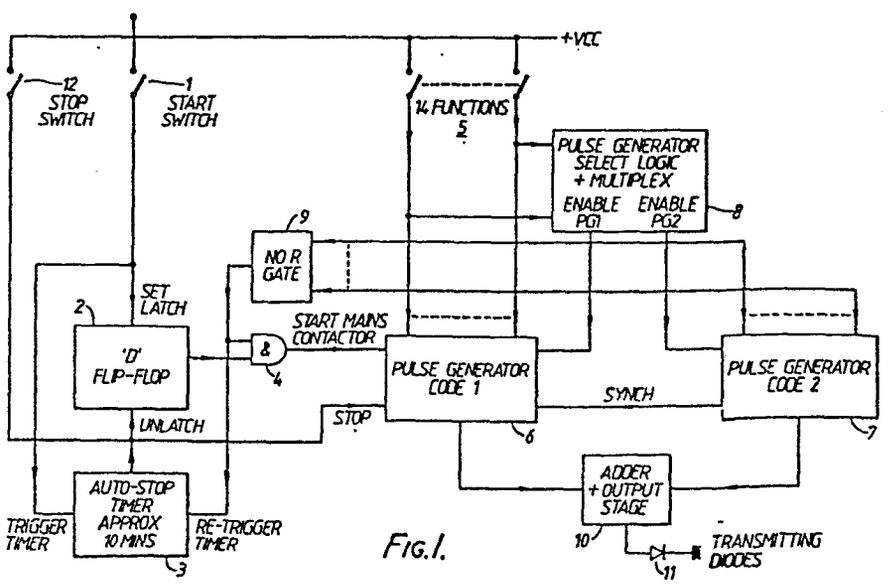

Fig. 1.

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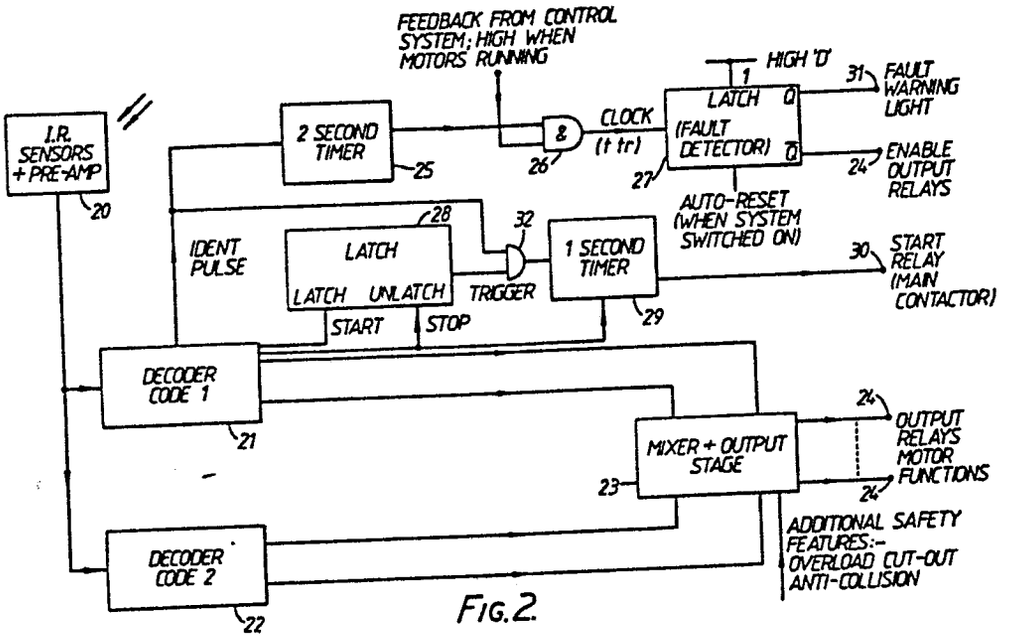
FEEDBACK FROM CONTROL SYSTEM; HIGH WHEN MOTORS RUNNING
HIGH 'D'
1
31
FAULT WARNING LIGHT
I.R. SENSORS + PRE-AMP
20
2 SECOND TIMER
25
&
26
CLOCK (t tr)
LATCH (FAULT DETECTOR)
Q
Q
27
24
ENABLE OUTPUT RELAYS
AUTO-RESET (WHEN SYSTEM SWITCHED ON)
IDENT PULSE
28
LATCH
LATCH UNLATCH
32
TRIGGER
1 SECOND TIMER
29
30
START RELAY (MAIN CONTACTOR)
START
STOP
DECODER CODE 1
21
24
OUTPUT RELAYS MOTOR FUNCTIONS
MIXER + OUTPUT STAGE
23
24
ADDITIONAL SAFETY FEATURES:- OVERLOAD CUT-OUT ANTI-COLLISION
DECODER CODE 2
22

FIG. 2.

REMOTE CONTROL SYSTEM.

The present invention relates to a remote control system, and in particular, although not exclusively to an infra-red remote control device for industrial machinery.

If an electrically controlled machine is to be operated by remote means it presents a possible danger once the main contactor is energised. With normal infra-red devices and remote control equipment the main contactor becomes energised by a manual operation e.g. push button, and stays energised until unlatched by a second manual operation.

According to the invention there is provided a system for remotely controlling operation of a device comprising: a transmitter unit including means for producing a control signal when the system is being operated, and transmitter means for repeatedly transmitting the control signal, and a receiver unit including means for receiving the transmitted signal, and means responsive to the received signal for initiating operation of the device and maintaining operation of the device provided the transmitted control signal continues to be received.

The control signal may be continuously transmitted, but preferably the transmitter means has means for intermitently and continually transmitting the control signal, and the receiver unit has timer means which provides an output to maintain the operation of the device provided the control signal is received within a time period of the timer means. Preferably the control signal is transmitted several times within the time period of the timer means, and provided that one of the control signals is received in the period of the timer means, the operation of the device will be maintained.

The remote control system can control a number of functions of the controlled device, by the transmitter unit including means for transmitting function codes corresponding to the desired control function, and the receiver unit includes decoding

means for decoding the transmitted function codes and control means controlling the required function in response to the output of the decoder means. A transmitted function code can serve as the control signal to main overall operation of the device. So the control signal can be constituted by a first signal transmitted while no function is selected, and a function code signal when a function is selected.

The system preferably has a number of code transmitter means the outputs of which are multiplexed, and the receiver has a corresponding number of decoders each responsive to the code signals from a particular one of the code transmitter means.

A preferred embodiment of the invention will now be described with reference to the accompanying drawings wherein:

Figure 1 is a block diagram of a transmitter unit; and

Figure 2 is a block diagram of a receiver unit.

Referring first to Figure 1, a transmitter unit has a start switch 1 connected to a "SET LATCH" input of a "D" type flip-flop 2. The start switch 1 is also connected to a "TRIGGER" input of an auto-stop timer 3 which has an output connected to an "UNLATCH" input of "D" type flip-flop 2. The "D" type flip-flop 2 has output connected to a first input of an AND gate 4.

Functions switches 5 on a key pad, are connected to a first pulse generator 6 and a second pulse generator 7, and also to a pulse generator select logic and multiplexer 8. The pulse generator select logic and multiplexer 8 has enable outputs PG1 and PG2 connected to the first pulse generator 6 and the second pulse generator 7, respectively. The second pulse generator 7 has a synchronisation output connected to a corresponding input of the first pulse generator 6.

The function switches 5 are also connected to inputs of a NOR gate 9, the output of which is connected to a second input of AND gate 4 and RE-TRIGGER input of auto-stop timer 3.

The pulse generators 6 and 7 have outputs connected to inputs of an adder/output stage 10. Output of adder/output stage 10 is connected to infra-red LEDs 11.

A stop switch 12 is connected to the UNLATCH input of "D" type flip-flop 2, and an input to pulse generator 6.

Referring now to Figure 2, a receiver unit has an I.R. sensor/preamp stage 20 with an output connected to a first decoder 21 and a second decoder 22. The decoders 21 and 22 have outputs connected to a mixer and output stage 23, which in turn has outputs connected to relays 24 for controlling motor functions.

The first decoder 21 has an IDENT pulse output connected to an input of a 2-second timer 25. An output of 2-second timer 25 is connected to a first input of an AND gate 26. An output from a feed back control system of the crane (HIGH when motors running) is connected to a second input of AND gate 26. An output of AND gate 26 is connected to an input of D-type latch 27, which has auto-reset input which operates at switch-on. A Q output of latch 27 is connected to a fault warning light 31 and a $\overline{Q}$ output is connected to output relays 24 as an enable.

A "START" output of decoder 21 is connected to a "LATCH" input of a latch 28, and a "STOP" output of decoder 21 is connected to an "UNLATCH" input of latch 28. An output of latch 28 is connected to one input of AND gate 32. The output of AND gate 32 is connected to a TRIGGER input of a 1-second timer 29. The timer 29 also has input connected to the "STOP" ouput of the decoder 21. An output of timer 29 is connected to "START" relay (main contactor) 30. The IDENT output of the first decoder 21 is connected to a second input of AND gate 32.

Operation of the combined transmitter/receiver system will now be described with reference to the operation of a crane, though it will be appreciated that other types of electromechanical devices can be operated by the system.

In general terms the system operates as follows: a user switches on the transmitter by means of the key operated start switch 1. The transmitter transmits an infra-red signal which is picked up by the receiver mounted on the crane. The receiver decodes the signal and starts the crane by engaging the main contactor 30. The user then operates one of the function selection

switches 5 and the transmitter sends the appropriate control signal which is decoded by the receiver and the selected part of the crane is operated.

The operation of the system will now be described in more detail.

When the start switch 1 is closed by operation of the key switch, the "D" type flip-flop 2 is triggered and the latched output of "D" type flip-flop 2 is applied to the first pulse code generator 6 through AND gate 4 as a START signal. The other input to AND gate 4 from NOR gate 9 is HIGH because the inputs to NOR gate 9 are low, no function being selected. The pulse generator produces a signal which is sent via the output stage 10 to I.R. LEDs 11 and the transmitted signal is received by I.R. sensor 20 of the receiver. The first decoder 21, receives the output of preamp 20 and supplies a START signal to latch 28. Timer 29 is triggered, which in turn operates the "START" relay or main contactor. The START signal is then sent repeatedly from the transmitter to maintain the contactor engaged.

The first decoder 21 responds to the output of preamp 20 and the provides a "START" output to latch latch 28. A high level is thus provided to one input of AND gate 32. The decoder 21 also produces an IDENT pulse each time a valid command signal is received (approx. every 130 ms.). This command signal may either be the START signal re-transmitted or a function signal. The IDENT signal is provided to AND gate 32 and thence to a TRIGGER input of 1 second timer 29. As long as the 1 second time 29 remains retriggered by the IDENT signal an output will be provided to engage START relay (main contactor) 30.

The time period between IDENT signals is of the order of one-eighth of the period of timer 29. This allows for the I.R. link to be momentarily broken without interrupting the main contactor. If the operator moves out of range, for example, for more than the one second period of timer 29, the main contactor will be denergised. However, when the operator moves back into range, the contactor will be re-energised.

If a single one of the function switches 5 is now operated, a corresponding function signal is generated by the first pulse generator 6. At the same time an input to NOR gate 9 goes low, setting the output low and thereby blocking the START signal from passing through AND gate 4. If the function button is released the levels of NOR gate 9 and AND gate 4 revert and the start signal is again transmitted. It will be appreciated that thus, once activated, the system continuously sends an output signal, either the start signal or a function signal.

The function signal received by the receiver is decoded in the first decoder 21 which provides an appropriate output to mixer and output stage 23 to operate one of the 14 function controlling relays 24, to carry out the selected operation.

The first and second pulse generators 6 and 7 each produces a distinct code which can only be recognised by the respective of the decoders 21,22 in the receiver. So, a transmitted signal originating from the first pulse generator (code 1) 6 can only be decoded by the first decoder 21, and similarly the output from pulse generator 7 can only be decoded by decoder 22. When two functions are selected, the pulse generators each respond to one of the input functions. The two functions are ordered in priority by select logic 8, and the function of higher priority is assigned to the first pulse generator 6 and the lower priority function is assigned to the second pulse generator 7, by the select logic enabling the appropriate pulse generator to respond to the appropriate function switch signal. The outputs of pulse generators 6,7 are multiplexed, and the adder stage 10 provides a composite signal in which the two coded signals remain separate. The output stage 10 produces large current pulse in transmitting diode 11 away.

When the multiplexed signal is received the decoders 21 and 22 respond to one or other of the coded signals. Thus, decoder 21 will respond to the code 1 part of the received signal and decoder 22 will respond to the code 2 part of the received signal. Each decoder 21, 22 will send an appropriate control output signal to mixer and output stage 23.

If the operator moves out of range while a function is selected, then the motor function is de-energised, followed 1 second later by the main contactor. When the operator again comes in range the function will have to be de-selected to allow the START signal to be sent again to reengage the main contactor.

The system also includes a time-out or auto-stop feature. Unless the auto-stop timer (3) receives a retrigger input within the allotted time period, e.g. 10 minutes, a "STOP" signal is sent to pulse generator 6 and an UNLATCH signal is sent to "D" type flip-flop 2. The retrigger input of auto-stop timer (3) is connected to receive the output of NOR gate 9, so that the timer will be retriggerd if one of function select switches 5 is operated providing an input to NOR gate 9.

The crane can be stopped at the end of operation by the stop switch 12. That switch provides a STOP signal to the pulse generator 6 which in turn sends the STOP signal to the receiver. The decoder 21 receives the STOP signal and passes the signal on to the latch 28 which is unlatched, and consequently the AND gate 32 is blocked. The timer 29 is not retriggered and the main contactor/START relay 30 will be opened. Further the STOP signal from decoder 21 is sent directly to timer 29 to overide the timer operation to give a rapid stop response.

The receiver includes error detection circuitry in which a signal is picked up by means of an opto-sensor in the motor operating contactor circuit, which signal is "HIGH" whilst any contactor is energised. This signal is supplied to one input of AND gate 26 which receives the output of timer 25. Ident signals are used to maintain timer 25 in a triggered condition. The fault detector includes D type latch (27) which is reset (Q=O) by a C/R network each time the system is switched on. The "D" input is set High and therefore the latch is waiting for a trigger edge at the clock input. In normal operation, a positive going edge is not presented to its clock input due to the fact that the feedback signal will always go low before $\overline{Q}$ from timer (25) goes high.

In a fault condition e.g. a relay contact welded shut,

there will be a High on the feedback line. If no signals are received, $\bar{Q}$ on timer (25) will also go high and thus trigger latch (27) by means of AND gate (26). The motor controls relays have a common supply rail and this is disabled (by means of a transistor switch) by the $\bar{Q}$ output of Latch (27). The system now remains inoperative and a warning beacon is lit (controlled by the Q output of (27)). Turning off and then on again resets the system (provided fault has been cleared).

CLAIMS:

1. A system for remotely controlling operation of a device comprising: a transmitter unit including means for producing a control signal when the system is being operated, and transmitter means for repeatedly transmitting the control signal, and a receiver unit including means for receiving the transmitted signal, and operation control means responsive to the received signal for initiating operation of the device and maintaining operation of the device provided the transmitted control signal continues to be received.

2. A system for remotely controlling operation of a device as claimed in claim 1, wherein the transmitter means has means for intermittently and continually transmitting the control signal, and in the receiver unit the operation control means has timer means for producing an output to maintain operation of the device provided the transmitted control signal is received within a timing period of the timer means.

3. A system for remotely controlling operation of a device as claimed in claim 2, wherein the transmitter means is adapted to transmit the intermittent control signal several times within the period of the timer means.

4. A system for remotely controlling operation of a device as claimed in claim 1, 2 or 3, wherein the transmitter unit includes means for producing function codes to be transmitted, which codes correspond to desired functions of the device to be controlled, and the receiver unit includes decoder means for decoding received function codes, and the operation control means has means for producing a function control signal for the device in response to the decoded function codes.

5. A system for remotely controlling operation of a device as

claimed in claim 4, wherein the control signal to maintain operation of the device can be constituted by a function code, so that operation of the device is maintained provided a function code is received or in the absence of a function code provided an operation maintenance signal transmitted by the transmitter unit is received.

6. A system for remotely controlling operation of a device as claimed in claim 4 or 5, wherein the transmitter unit includes means for generating two function codes, and forming a composite signal to be transmitted including both function codes, and the receiving unit has means for separating the transmitted signal to release the two function codes for decoding by the decoding means.

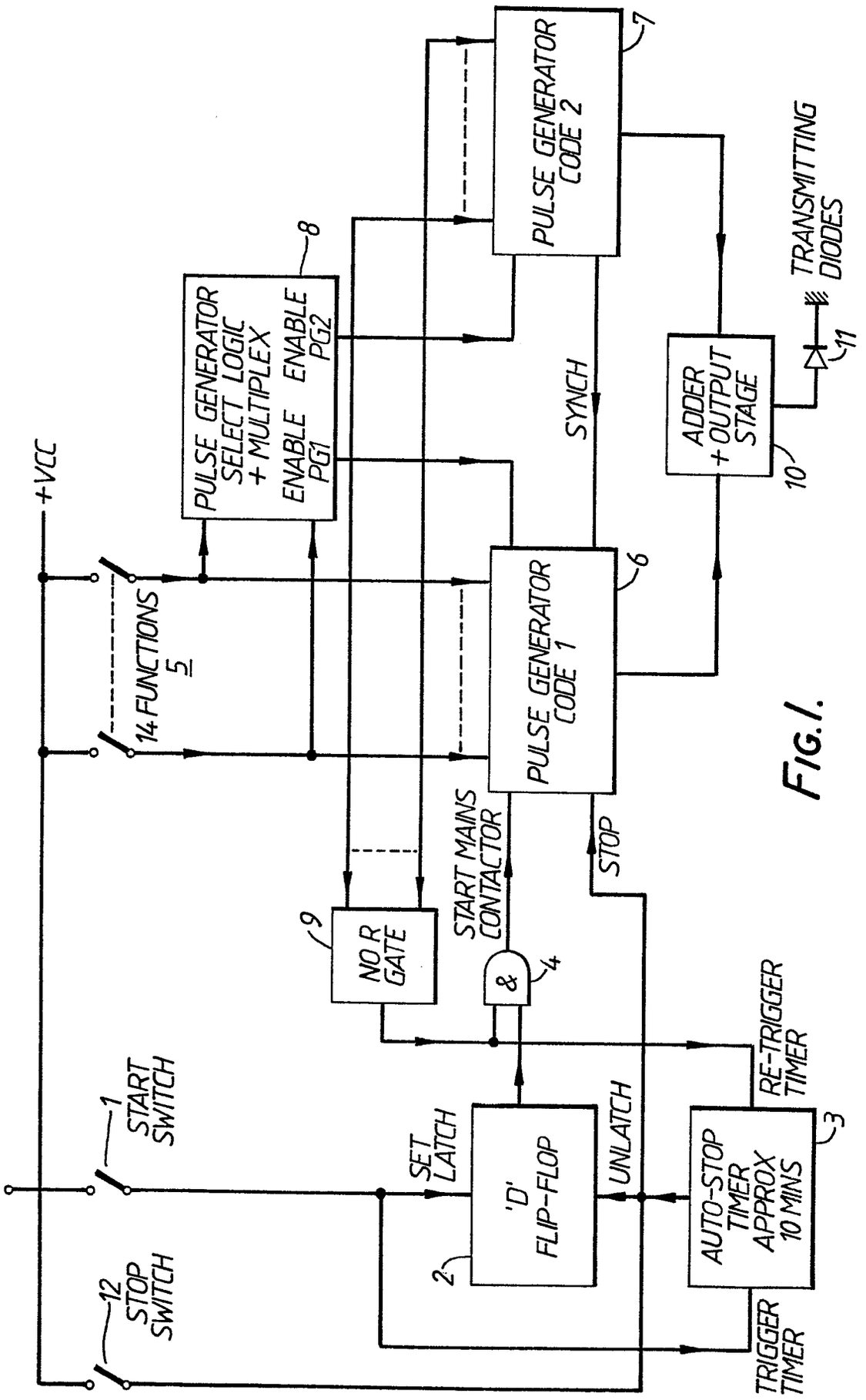
+VCC
14 FUNCTIONS
5
PULSE GENERATOR SELECT LOGIC + MULTIPLEX
ENABLE PG1
ENABLE PG2
8
PULSE GENERATOR CODE 2
7
PULSE GENERATOR CODE 1
6
SYNCH
ADDER + OUTPUT STAGE
10
TRANSMITTING DIODES
11
NO R GATE
9
START MAINS CONTACTOR
&
4
STOP
START SWITCH
1
STOP SWITCH
12
SET LATCH
'D' FLIP-FLOP
2
UNLATCH
AUTO-STOP TIMER APPROX 10 MINS
3
RE-TRIGGER TIMER
TRIGGER TIMER

FIG. 1.

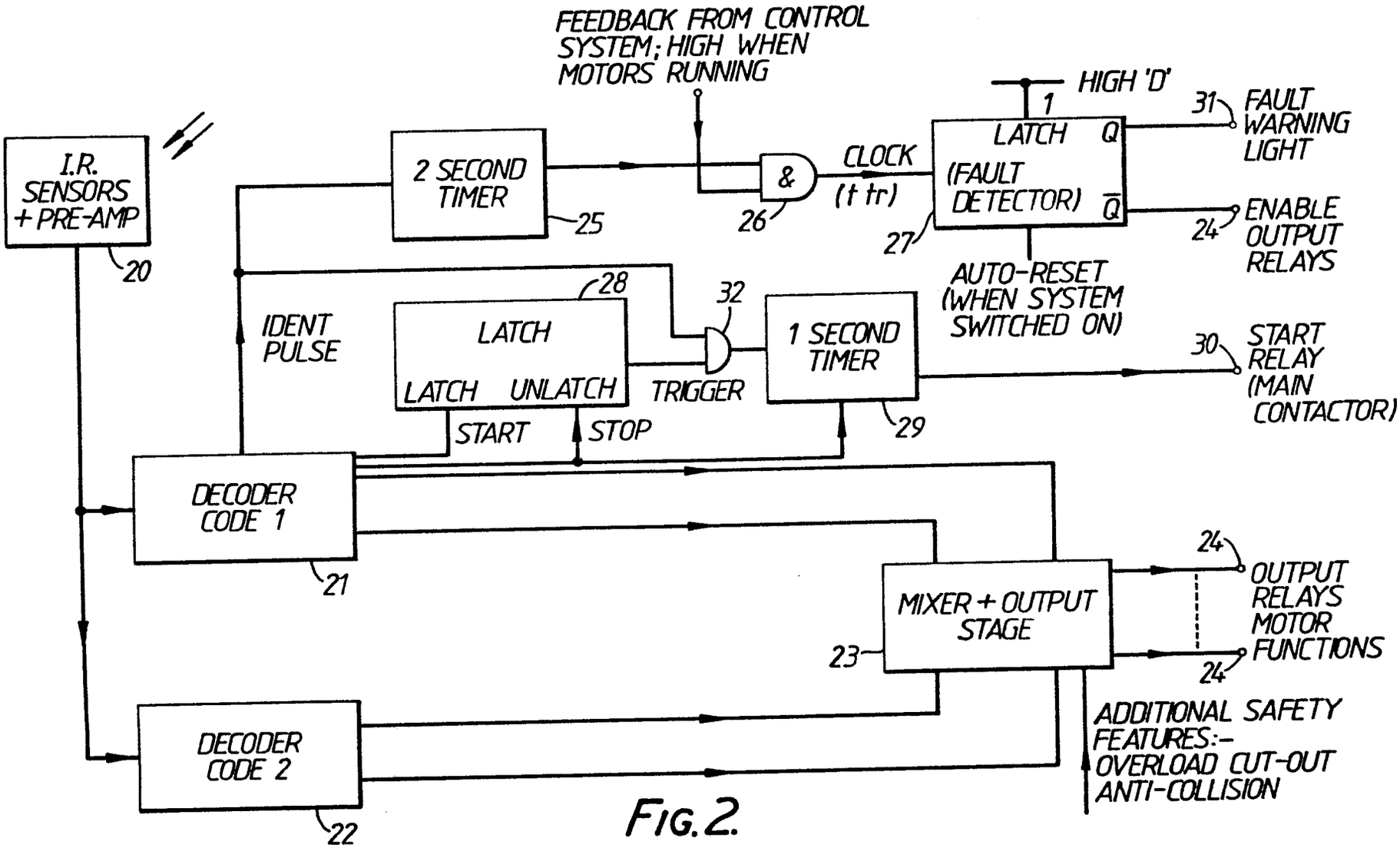

FIG. 2.

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