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Ergun et al.

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(45) **Date of Patent: *Jan. 9, 2007**

(54) **MOVABLE BARRIER OPERATOR HAVING SERIAL DATA COMMUNICATION**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

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Related U.S. Application Data

(63) Continuation of application No. 09/544,904, filed on Apr. 7, 2000, now Pat. No. 6,737,968.

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(51) **Int. Cl.**

G05B 5/00	(2006.01)
H02H 7/08	(2006.01)
H02P 1/00	(2006.01)
H02P 3/00	(2006.01)
H02P 7/00	(2006.01)

(52) **U.S. Cl.** **318/445**; 318/466; 318/15; 318/51; 318/62

(58) **Field of Classification Search** 318/466, 318/266, 286, 468, 480, 445, 16, 51, 62; 49/26, 27, 29, 25; 340/5.71, 5.7, 825.72, 340/545.1, 825.69

See application file for complete search history.

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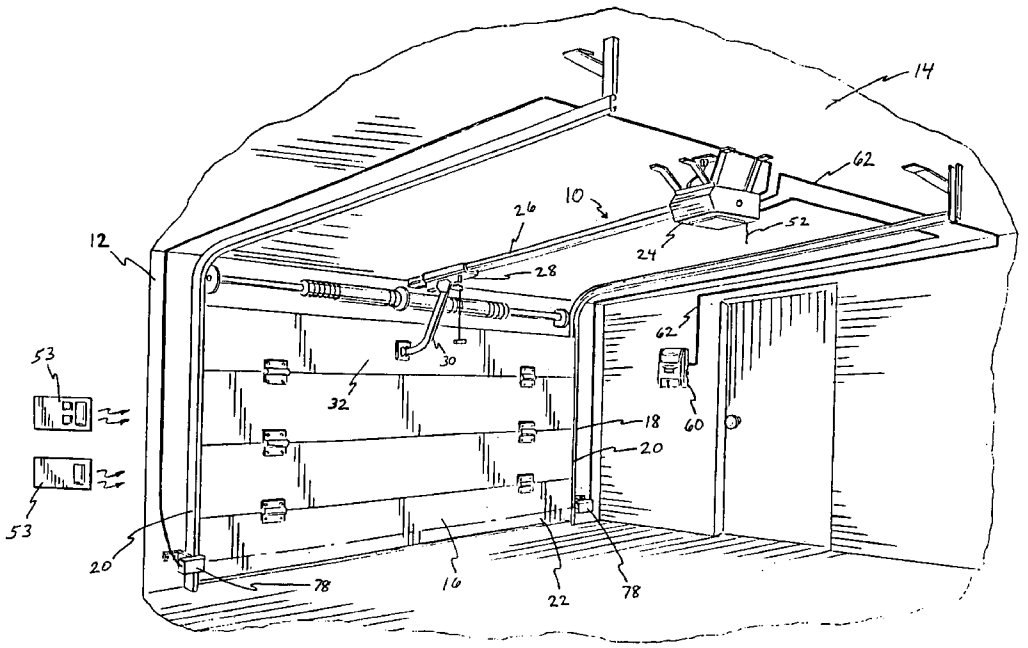
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(74) *Attorney, Agent, or Firm*—Fitch, Even, Tabin & Flannery

(57) **ABSTRACT**

A wall control unit for a movable barrier operator sends baseband signals over a wire connection to a head unit of a movable barrier operator to command the movable barrier to perform barrier operator functions. The wall control unit has a wall control unit port for connection to the wire connection. A first switch sends a barrier command signal to the head unit commanding the head unit to open or close a movable barrier. A second switch commands the head unit to provide energization to a light source. An infrared detector causes a command signal to be sent to the head unit to control the illumination state of the light source.

16 Claims, 16 Drawing Sheets



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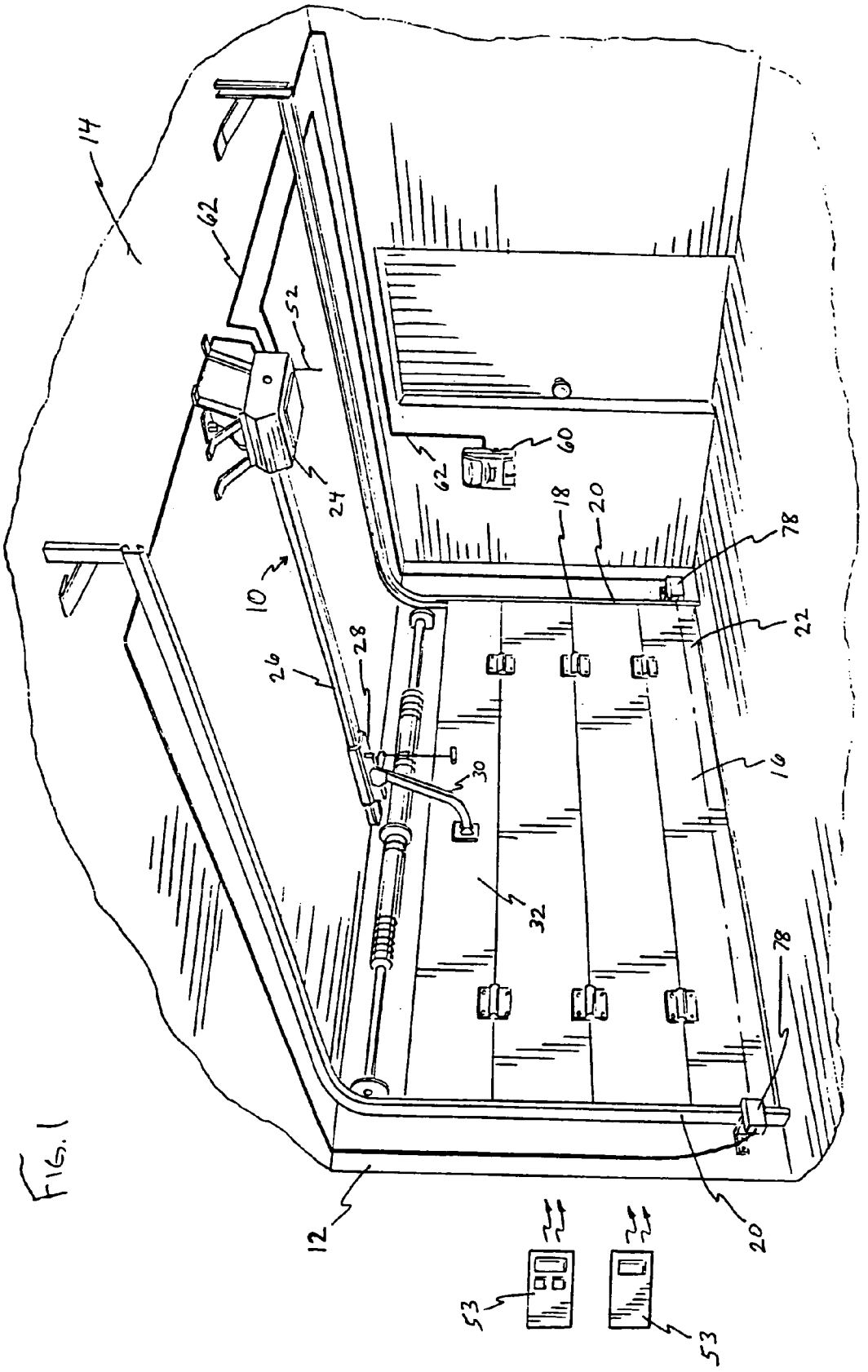


FIG. 1

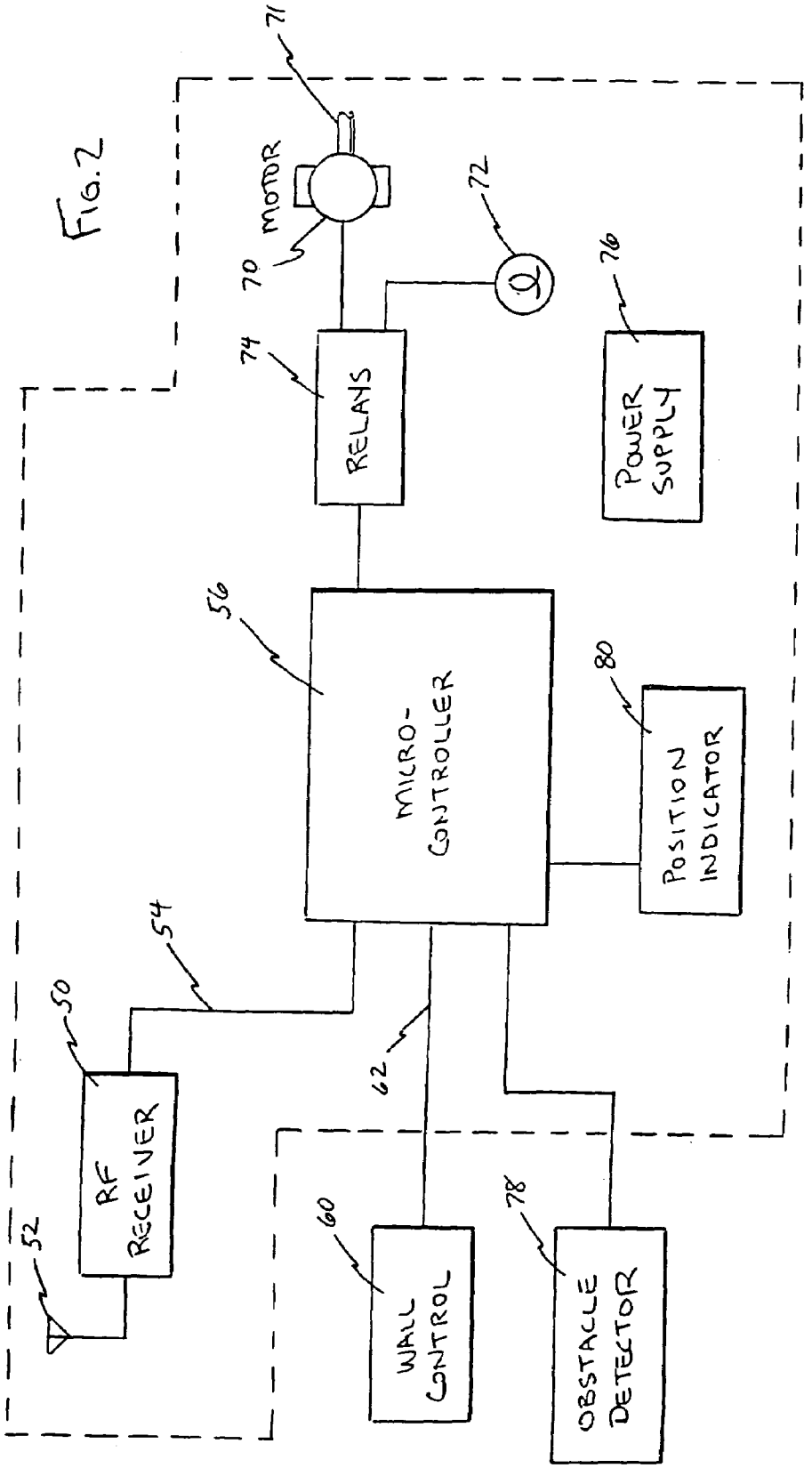

71
MOTOR
70
72
74
RELAYS
76
POWER SUPPLY
56
MICRO-CONTROLLER
80
POSITION INDICATOR
54
50
RF RECEIVER
52
62
60
WALL CONTROL
78
OBSTACLE DETECTOR

FIG. 2

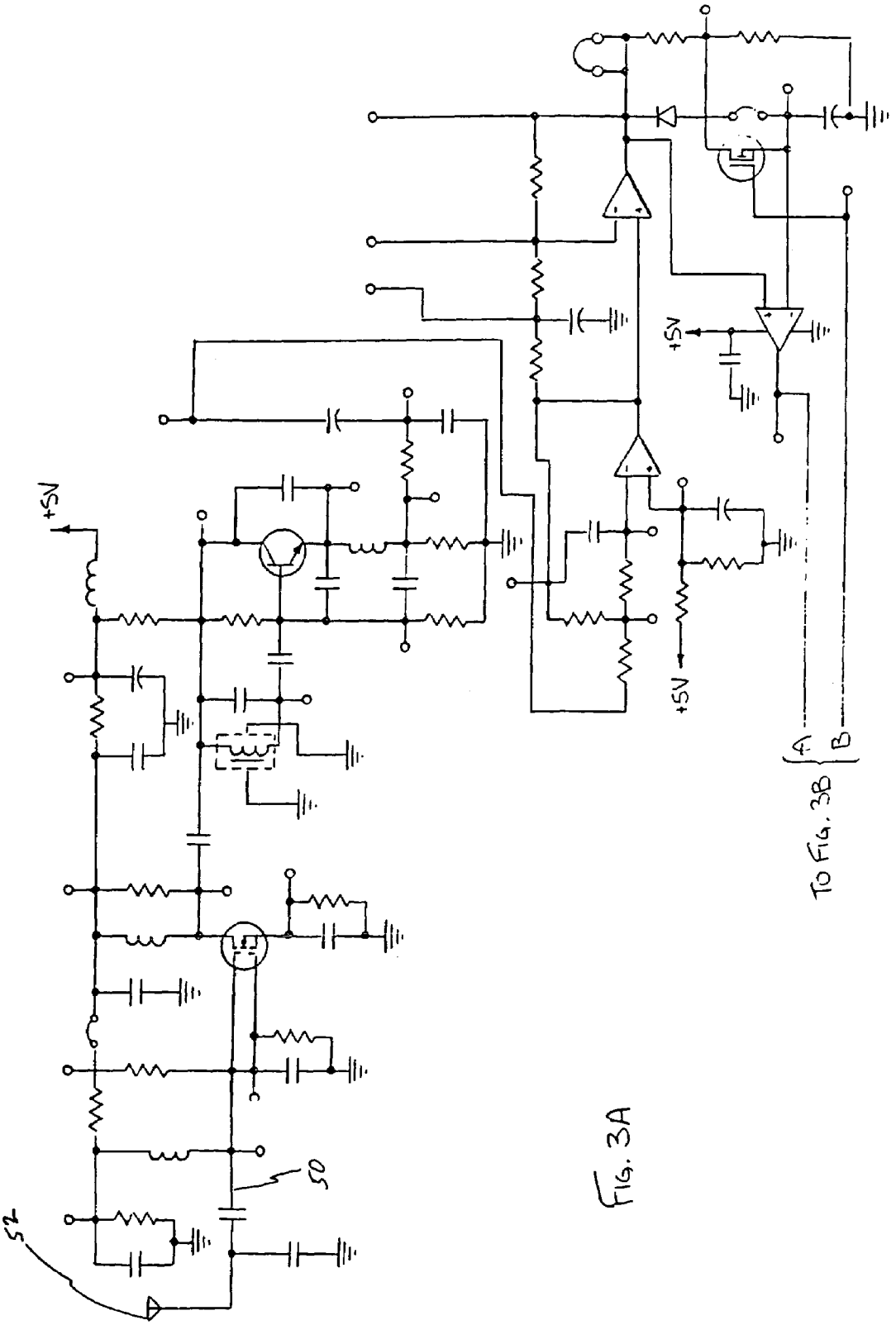


FIG. 3A

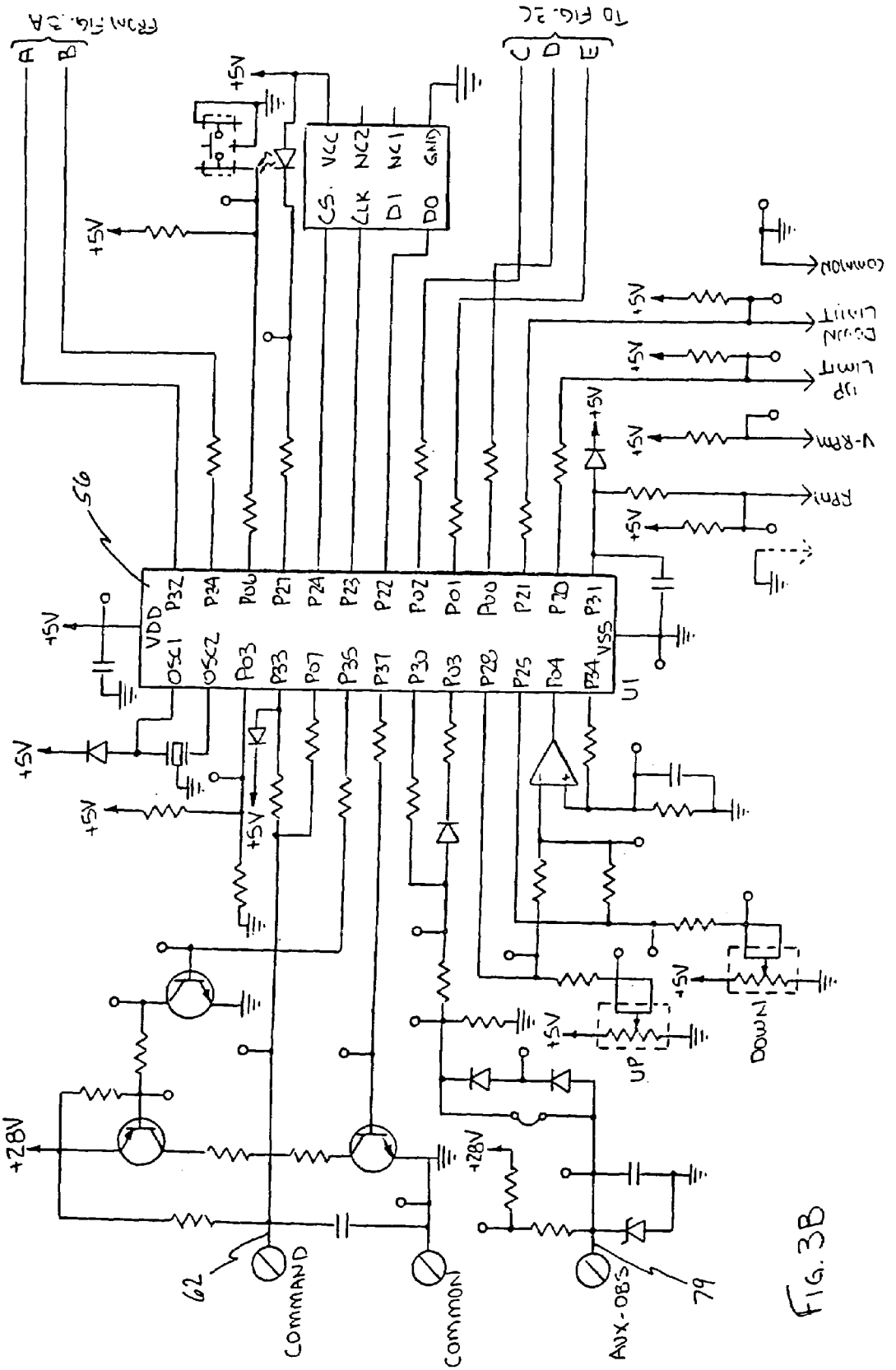

FROM FIG. 2A
TO FIG. 2C
A
B
C
D
E
+5V
VCC
NC2
NC1
GND
CS
CLK
DI
DO
COMMON
DOWN LIMIT
UP LIMIT
V-RPM
RPM
56
VDD
P32
P34
P00
P27
P24
P23
P22
P02
P01
P00
P21
P20
P31
OSC1
OSC2
P03
P33
P07
P35
P37
P30
P03
P28
P25
P04
P34
VSS
U1
+28V
62
COMMAND
COMMON
AUX-OBS
79
UP
DOWN

FIG. 3B

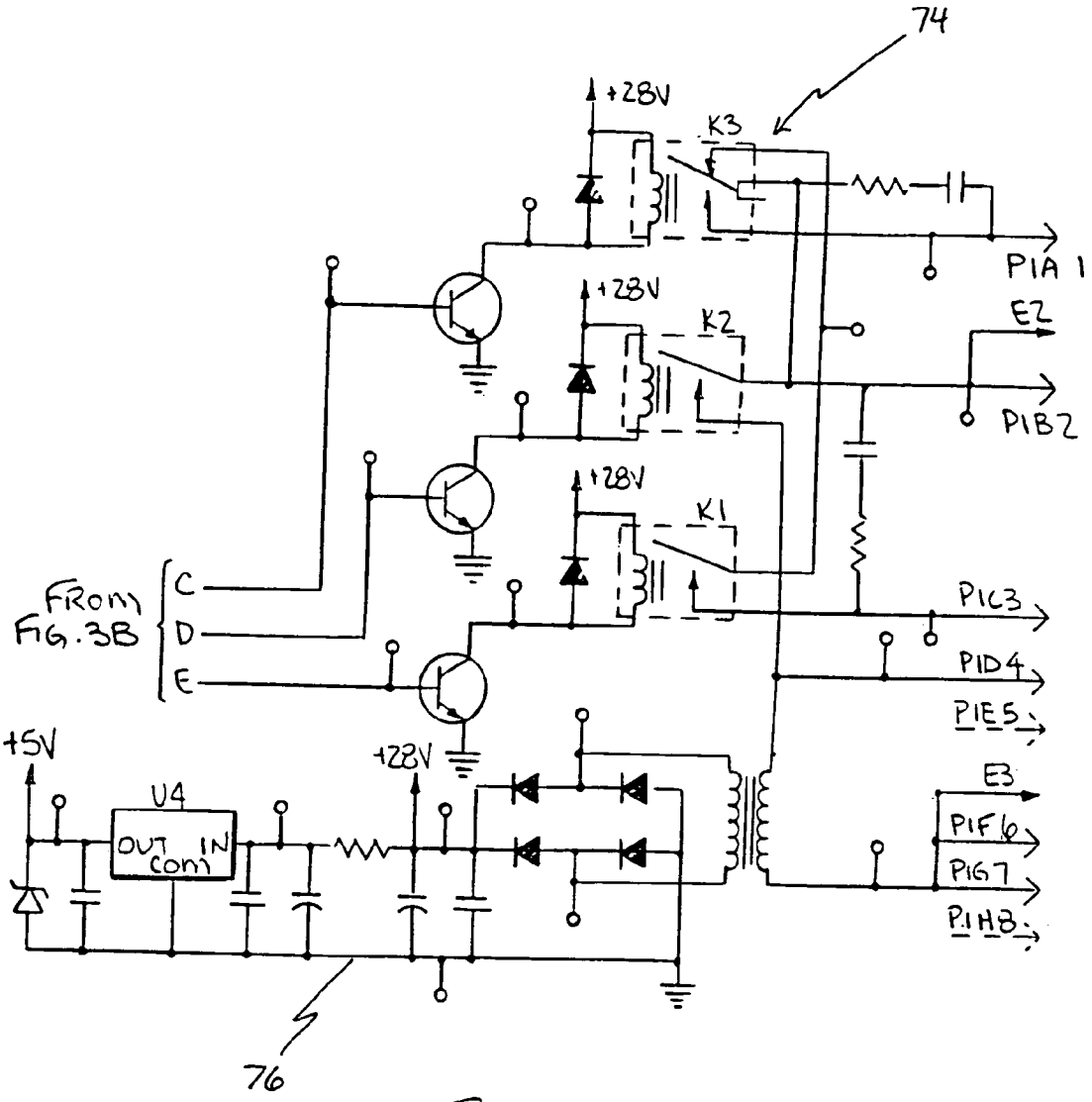

74
+28V
K3
P1A 1
+28V
K2
E2
P1B2
+28V
K1
P1C3
FROM FIG. 3B
C
D
E
P1D4
P1E5
+5V
+28V
U4
OUT
IN
COM
E3
P1F6
P1G7
P1H8
76

FIG. 3C

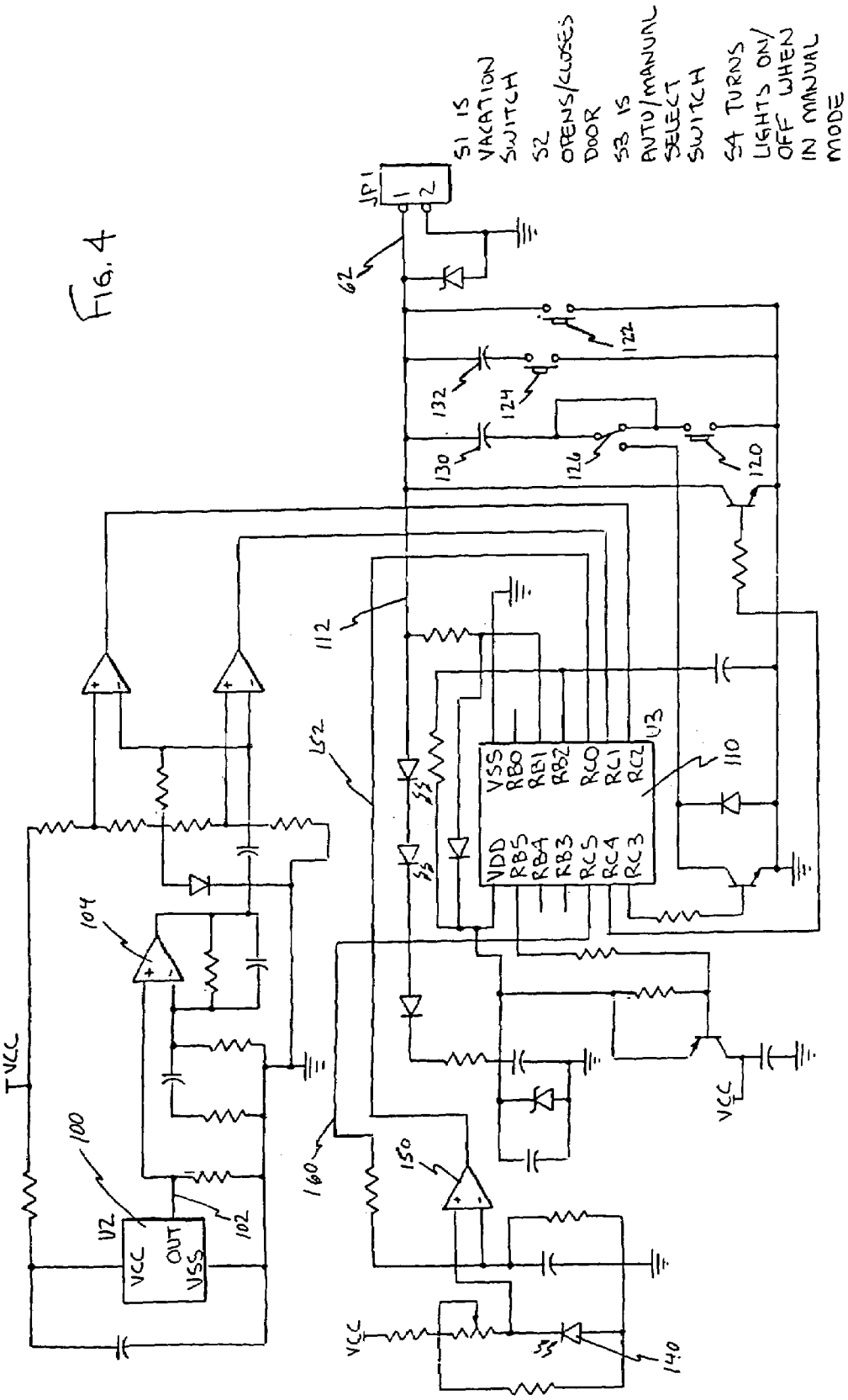

S1 IS VACATION SWITCH
S2 OPENS/CLOSES DOOR
S3 IS AUTO/MANUAL SELECT SWITCH
S4 TURNS LIGHTS ON/OFF WHEN IN MANUAL MODE
JP1
62
122
132
124
130
126
120
112
U3
VSS RB0 RB1 RB2 RC0 RC1 RC2
VDD RB5 RB4 RB3 RC5 RC4 RC3
110
52
54
LS2
104
VCC
100
102
U2
VCC OUT VSS
160
150
140
VCC

FIG. 4

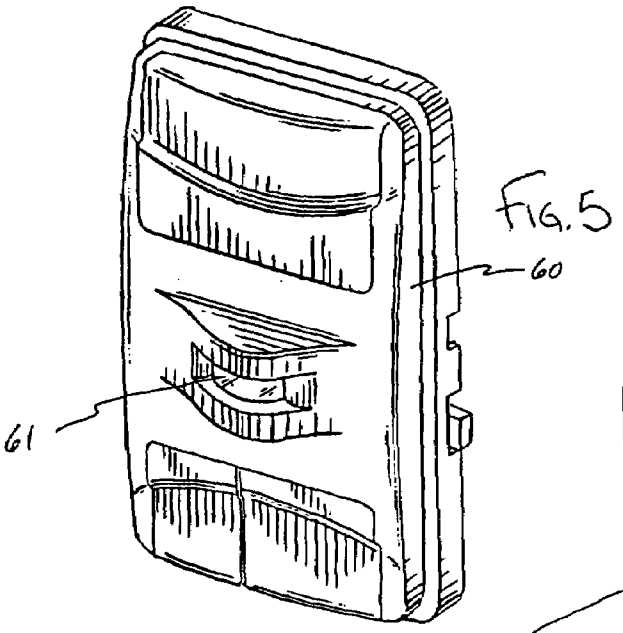


FIG. 5

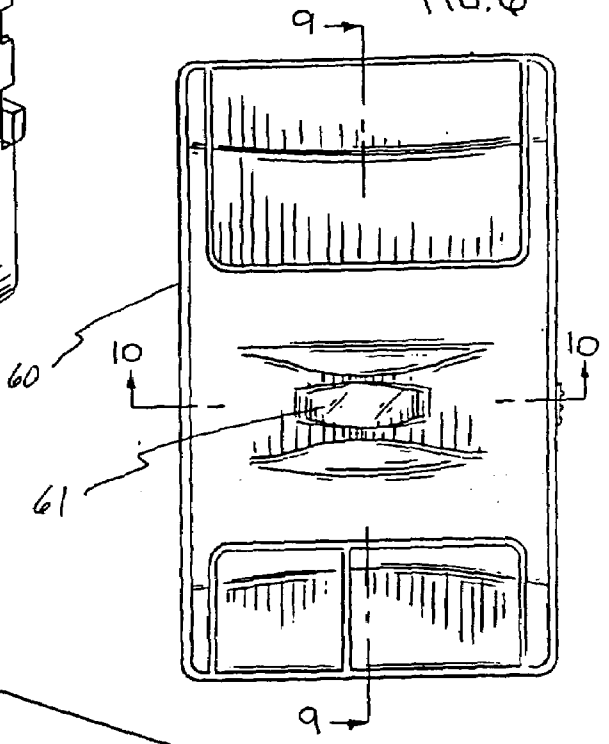


FIG. 6

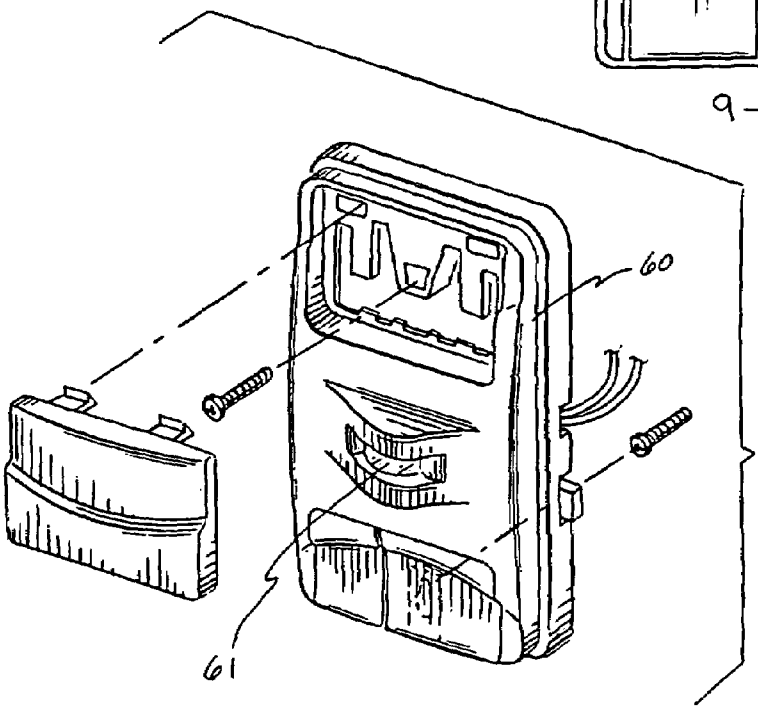


FIG. 11

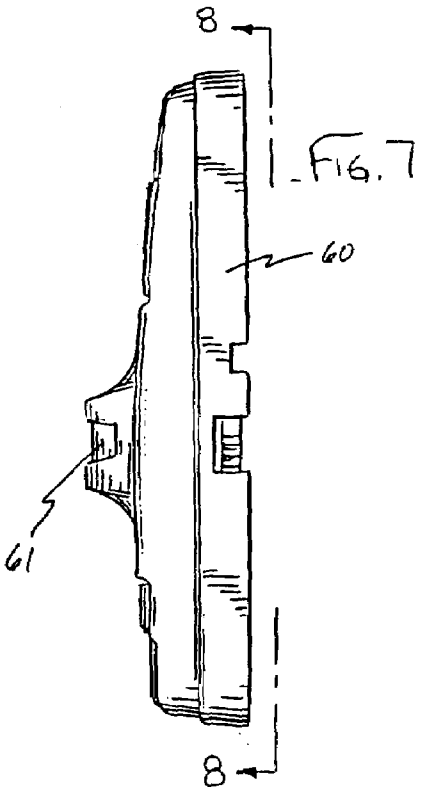


FIG. 7

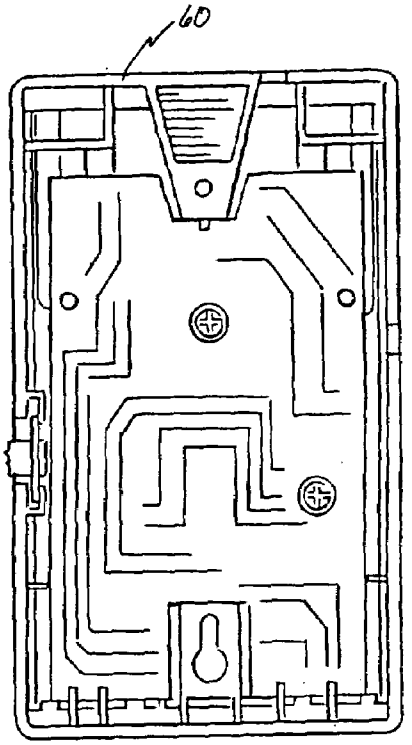


FIG. 8

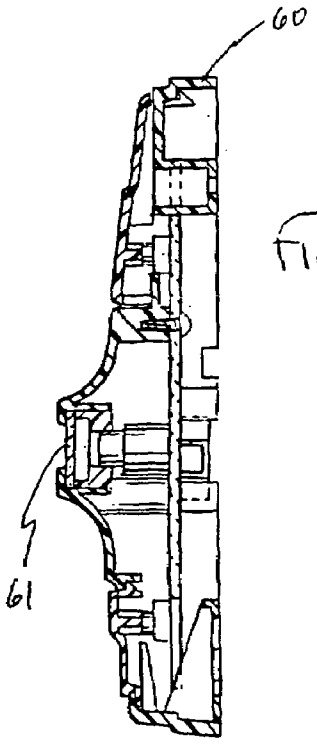


FIG. 9

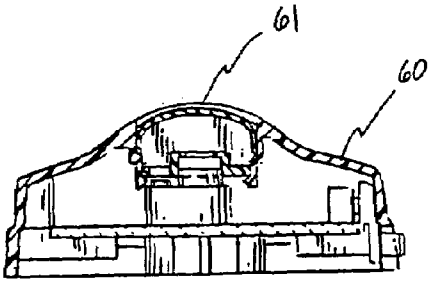


FIG. 10

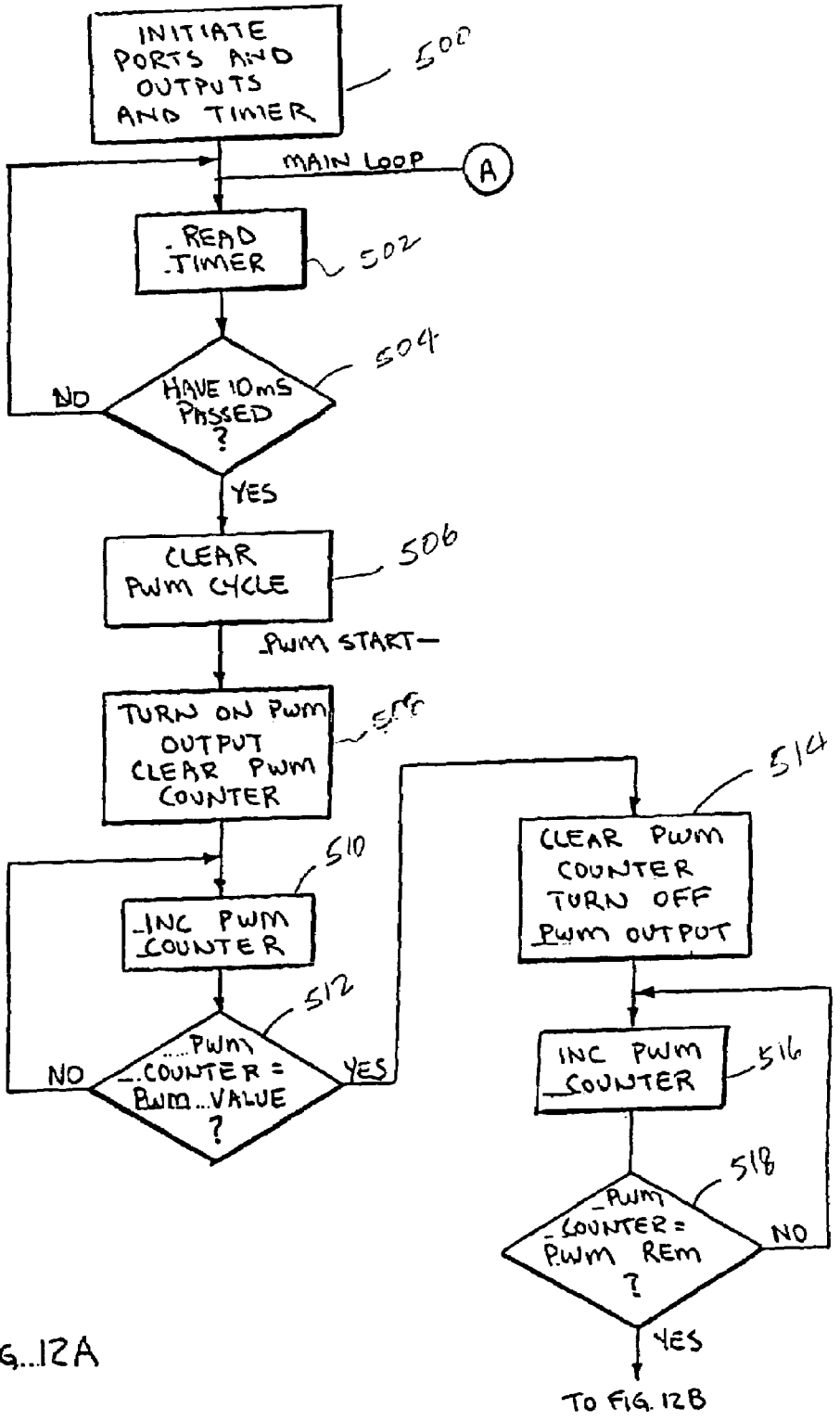

INITIATE PORTS AND OUTPUTS AND TIMER
500
MAIN LOOP
A
READ TIMER
502
HAVE 10mS PASSED ?
504
NO
YES
CLEAR PWM CYCLE
506
PWM START
TURN ON PWM OUTPUT CLEAR PWM COUNTER
508
INC PWM COUNTER
510
PWM COUNTER = PWM VALUE ?
512
NO
YES
CLEAR PWM COUNTER TURN OFF PWM OUTPUT
514
INC PWM COUNTER
516
PWM COUNTER = PWM REM ?
518
NO
YES
TO FIG. 12B

FIG. 12A

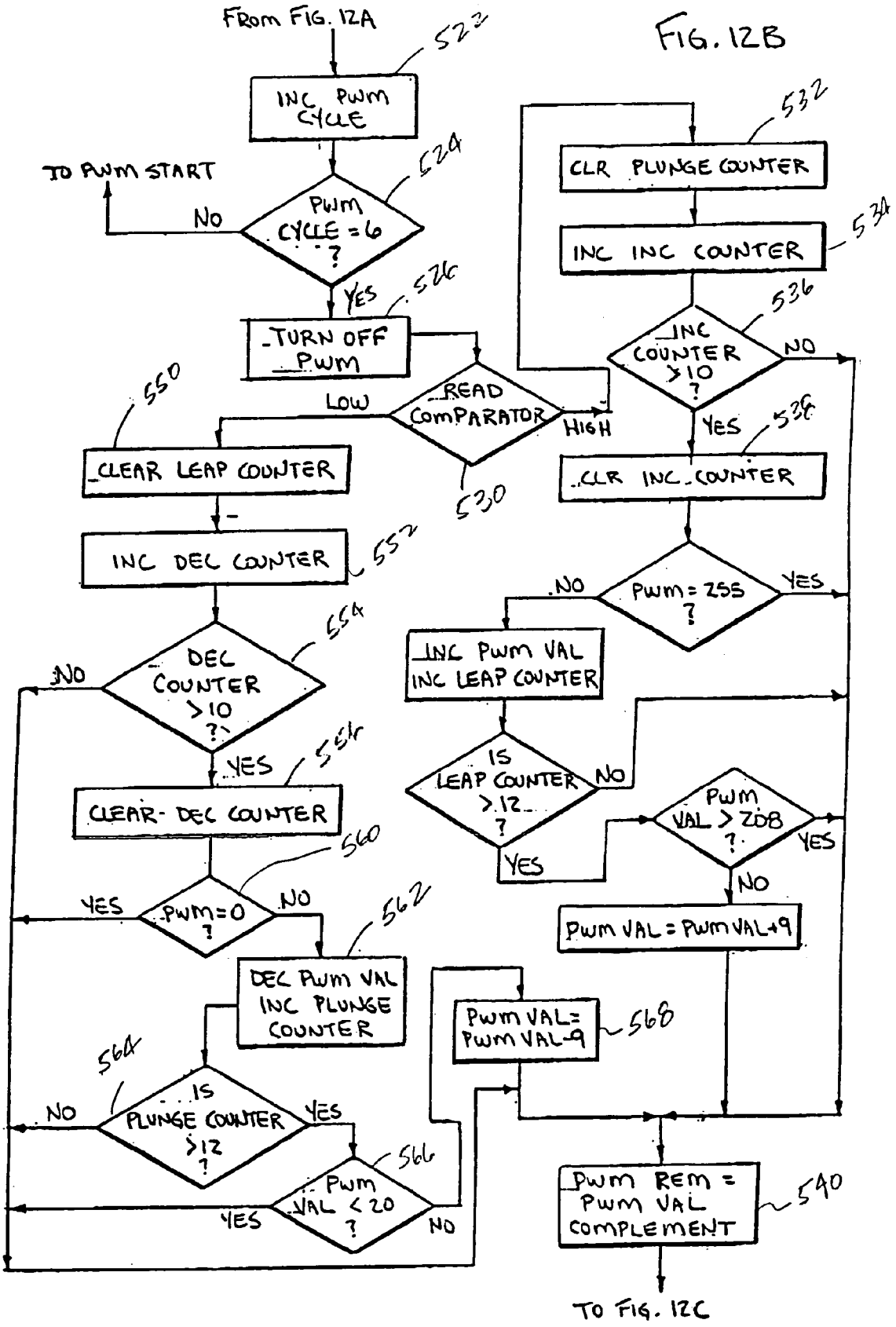
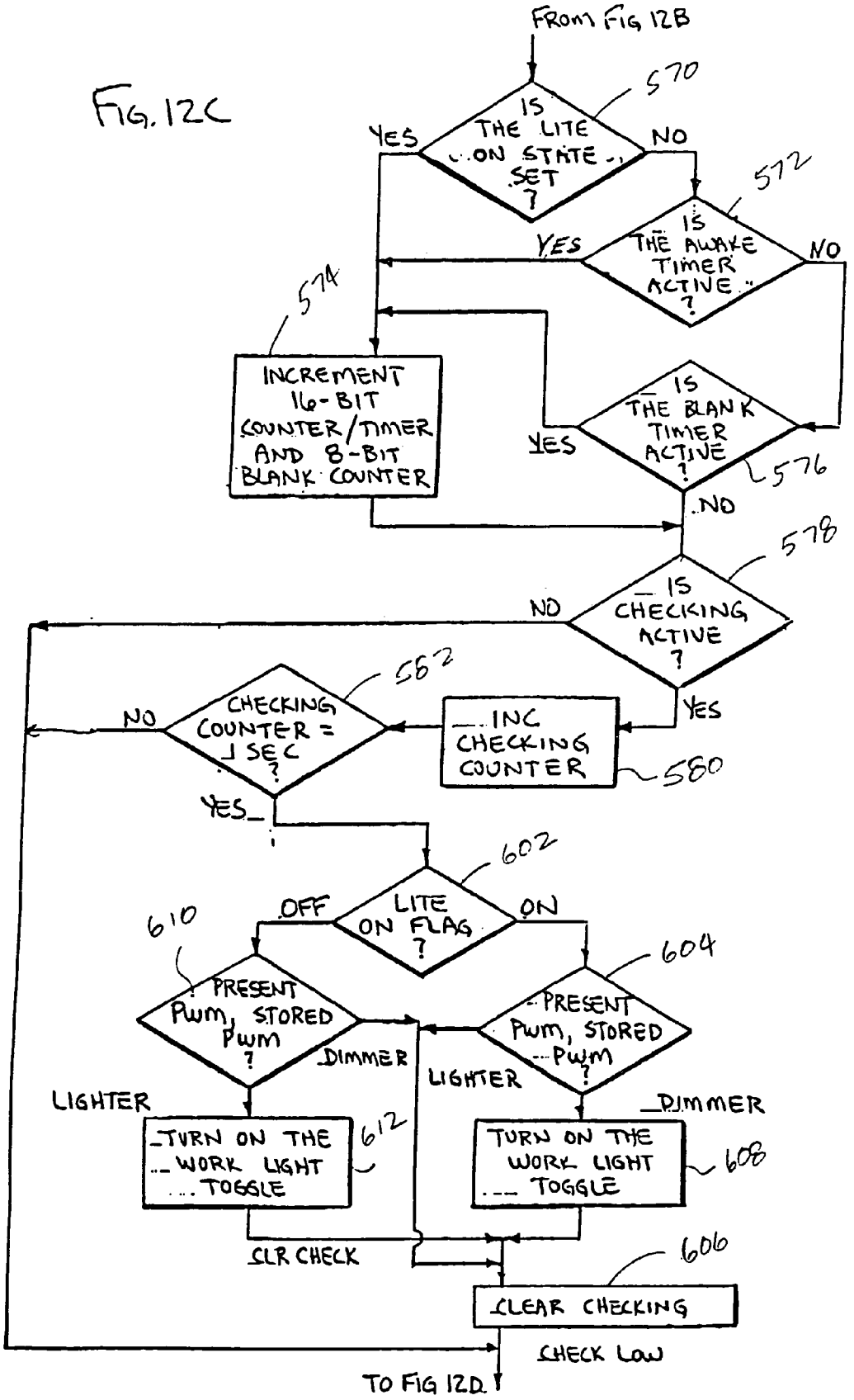

FROM FIG. 12A
522
INC PWM CYCLE
524
TO PWM START
No
PWM CYCLE = 6 ?
Yes
526
TURN OFF PWM
READ COMPARATOR
LOW
HIGH
530
550
CLEAR LEAP COUNTER
INC DEC COUNTER
552
554
DEC COUNTER >10 ?
NO
YES
556
CLEAR DEC COUNTER
560
PWM=0 ?
YES
NO
562
DEC PWM VAL INC PLUNGE COUNTER
564
IS PLUNGE COUNTER >12 ?
NO
YES
566
PWM VAL < 20 ?
YES
NO
FIG. 12B
532
CLR PLUNGE COUNTER
534
INC INC COUNTER
536
INC COUNTER >10 ?
NO
YES
538
CLR INC COUNTER
PWM = 255 ?
NO
YES
INC PWM VAL INC LEAP COUNTER
IS LEAP COUNTER >12 ?
NO
YES
PWM VAL > 208 ?
YES
NO
PWM VAL = PWM VAL+9
568
PWM VAL = PWM VAL-9
PWM REM = PWM VAL COMPLEMENT
540
TO FIG. 12C

FIG. 12C


FROM FIG 12B
570
IS THE LITE ON STATE SET ?
YES
NO
572
IS THE AWAKE TIMER ACTIVE ?
YES
NO
574
INCREMENT 16-BIT COUNTER/TIMER AND 8-BIT BLANK COUNTER
IS THE BLANK TIMER ACTIVE ?
YES
576
NO
578
IS CHECKING ACTIVE ?
NO
YES
562
CHECKING COUNTER = 1 SEC ?
NO
YES
INC CHECKING COUNTER
580
602
LITE ON FLAG ?
OFF
ON
610
PRESENT Pwm, STORED Pwm ?
DIMMER
LIGHTER
604
PRESENT Pwm, STORED Pwm ?
LIGHTER
DIMMER
TURN ON THE WORK LIGHT TOGGLE
612
TURN ON THE WORK LIGHT TOGGLE
608
CLR CHECK
606
CLEAR CHECKING
CHECK LOW
TO FIG 12D

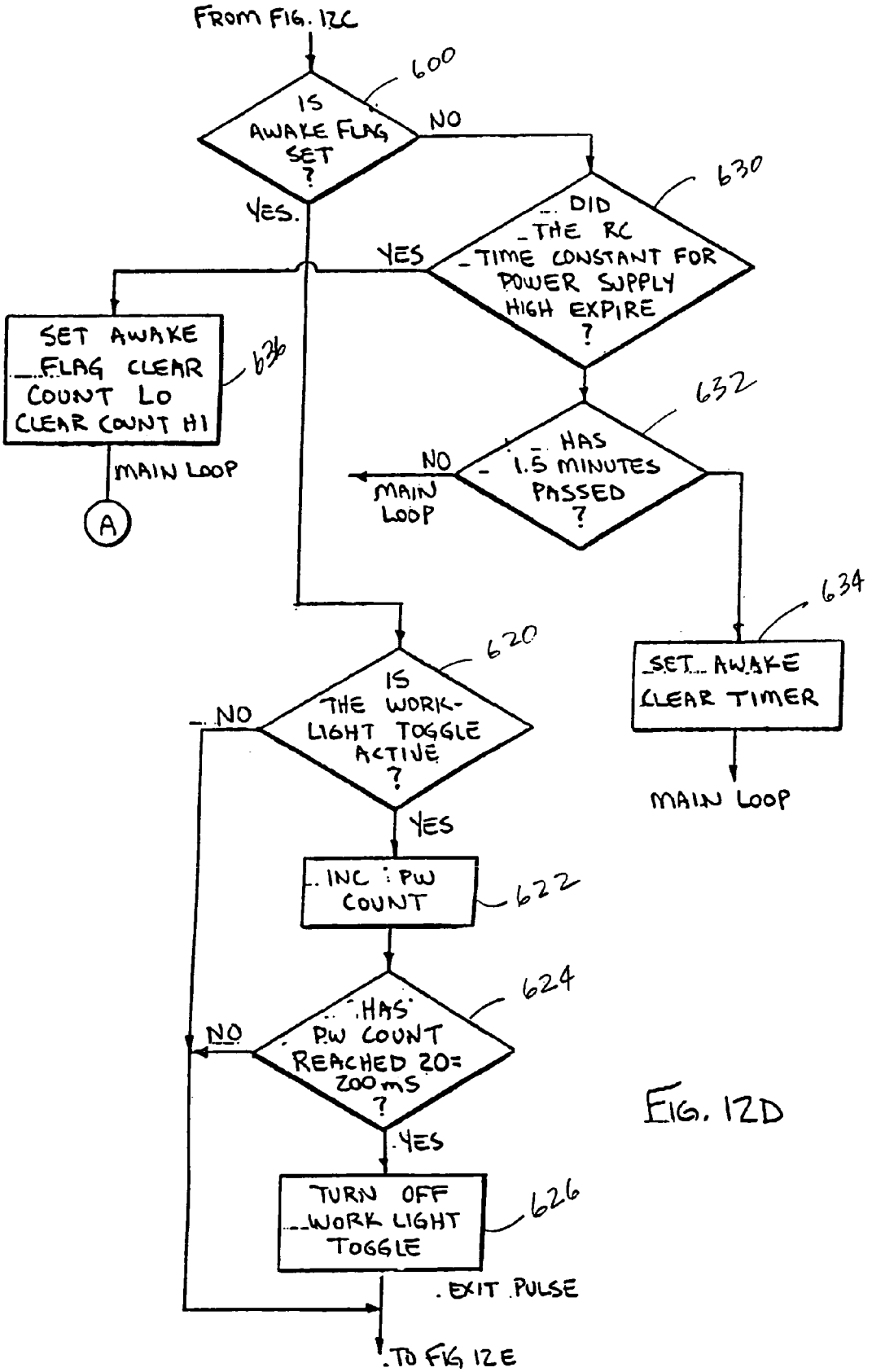

FROM FIG. 12C
600
IS AWAKE FLAG SET ?
NO
YES
630
DID THE RC TIME CONSTANT FOR POWER SUPPLY HIGH EXPIRE ?
YES
SET AWAKE FLAG CLEAR COUNT LO CLEAR COUNT HI
636
MAIN LOOP
A
632
HAS 1.5 MINUTES PASSED ?
NO
MAIN LOOP
634
SET AWAKE CLEAR TIMER
MAIN LOOP
620
IS THE WORK-LIGHT TOGGLE ACTIVE ?
NO
YES
INC PW COUNT
622
624
HAS PW COUNT REACHED 20= 200mS ?
NO
YES
TURN OFF WORK LIGHT TOGGLE
626
EXIT PULSE
TO FIG 12E

FIG. 12D

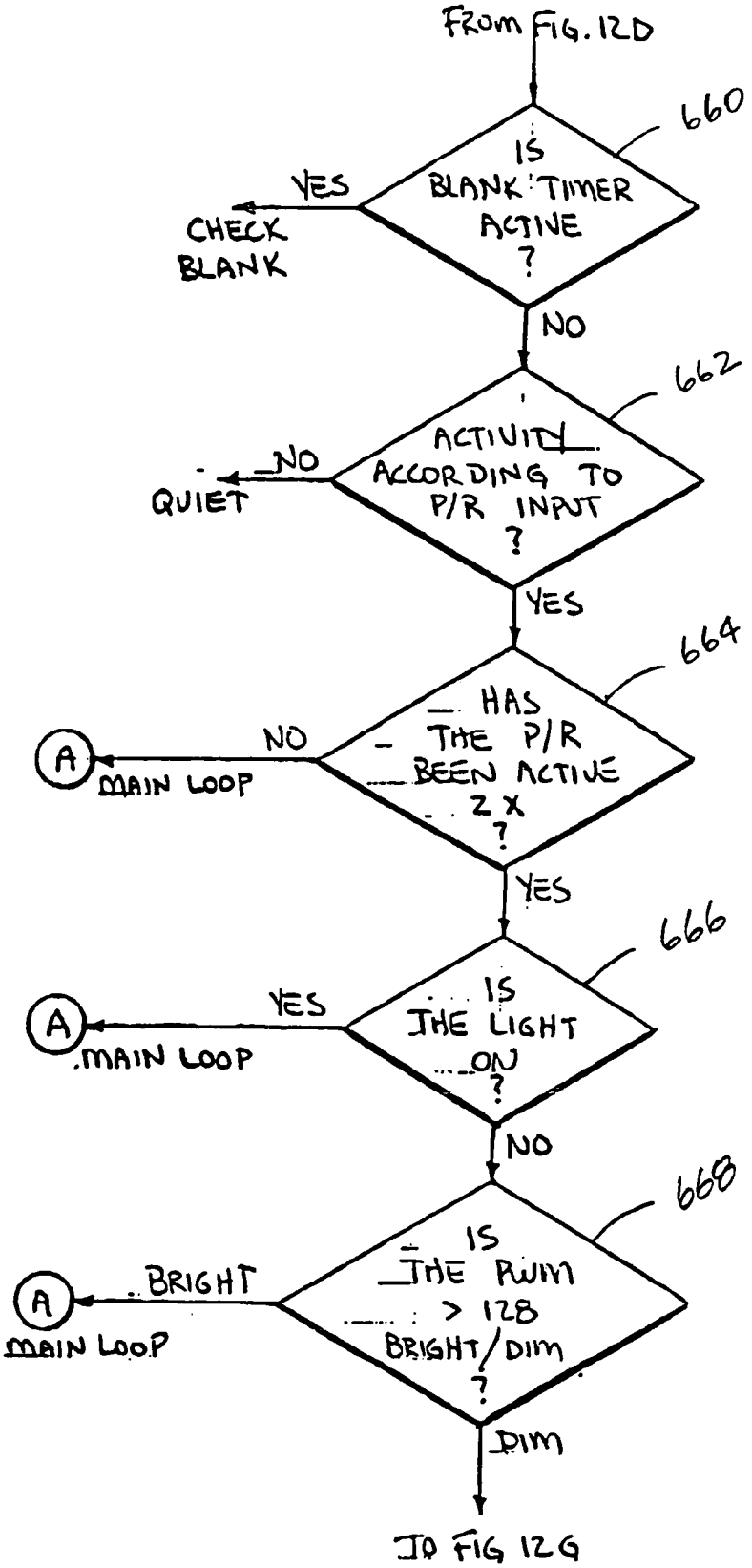

FROM FIG. 12D
660
IS BLANK TIMER ACTIVE ?
YES
CHECK BLANK
NO
662
ACTIVITY ACCORDING TO P/R INPUT ?
NO
QUIET
YES
664
HAS THE P/R BEEN ACTIVE 2 X ?
NO
A
MAIN LOOP
YES
666
IS THE LIGHT ON ?
YES
A
MAIN LOOP
NO
668
IS THE PWM > 128 BRIGHT/DIM ?
BRIGHT
A
MAIN LOOP
DIM
TO FIG 12G

FIG. 12E

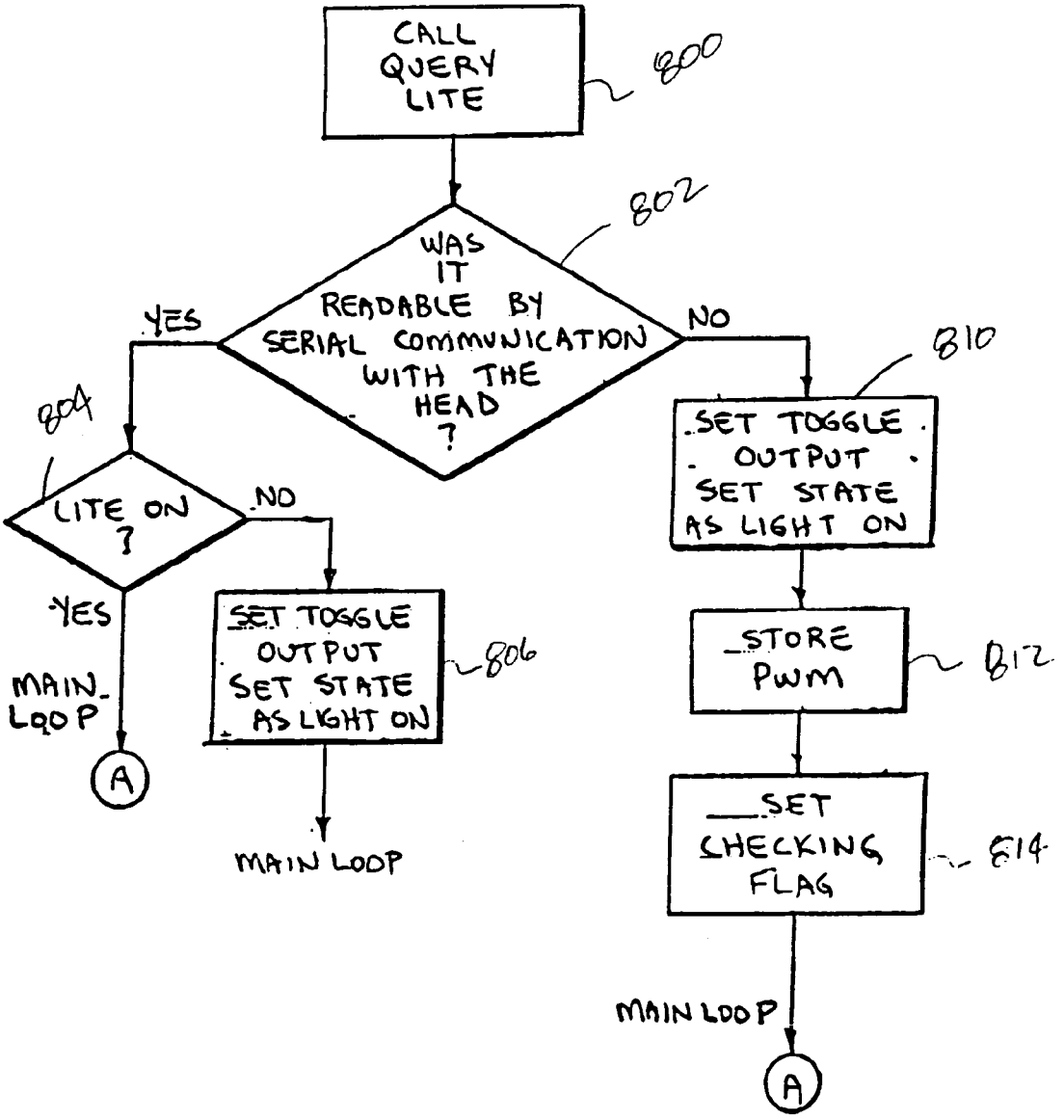
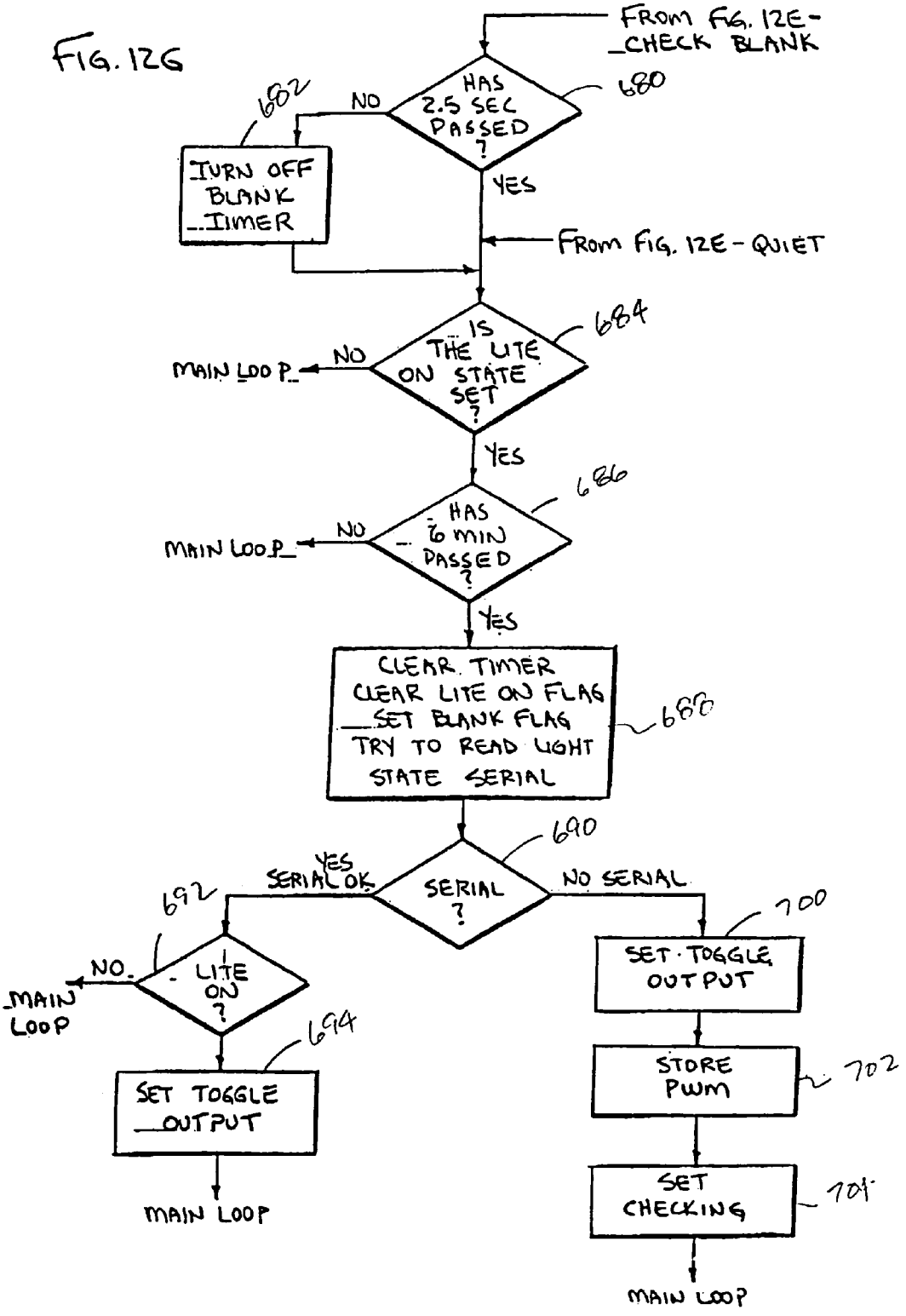

CALL QUERY LITE
800
WAS IT READABLE BY SERIAL COMMUNICATION WITH THE HEAD ?
802
YES
NO
804
LITE ON ?
NO
YES
MAIN LOOP
A
SET TOGGLE OUTPUT SET STATE AS LIGHT ON
806
MAIN LOOP
SET TOGGLE OUTPUT SET STATE AS LIGHT ON
810
STORE PWM
812
SET CHECKING FLAG
814
MAIN LOOP
A

FIG. 12F

FIG. 12G


FROM FIG. 12E-CHECK BLANK
680
HAS 2.5 SEC PASSED ?
NO
682
TURN OFF BLANK TIMER
YES
FROM FIG. 12E - QUIET
684
IS THE LITE ON STATE SET ?
NO
MAIN LOOP
YES
686
HAS 6 MIN PASSED ?
NO
MAIN LOOP
YES
CLEAR TIMER
CLEAR LITE ON FLAG
SET BLANK FLAG
TRY TO READ LIGHT STATE SERIAL
688
690
SERIAL ?
YES SERIAL OK
NO SERIAL
692
LITE ON ?
NO
MAIN LOOP
694
SET TOGGLE OUTPUT
MAIN LOOP
700
SET TOGGLE OUTPUT
STORE PWM
702
SET CHECKING
704
MAIN LOOP

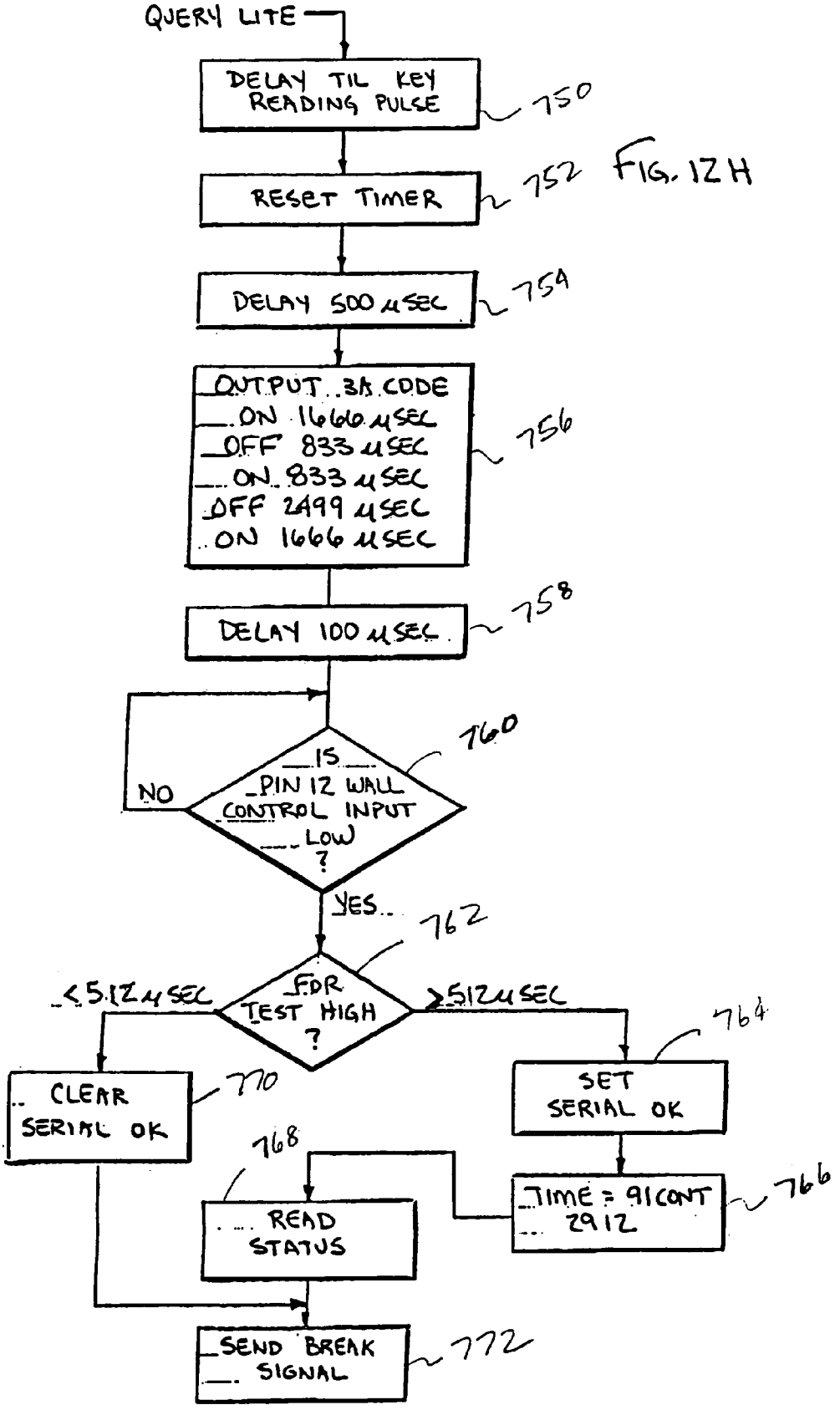

QUERY LITE
DELAY TIL KEY READING PULSE
750
RESET TIMER
752
DELAY 500 μSEC
754
OUTPUT 3A CODE
ON 1666 μSEC
OFF 833 μSEC
ON 833 μSEC
OFF 2499 μSEC
ON 1666 μSEC
756
DELAY 100 μSEC
758
IS PIN 12 WALL CONTROL INPUT LOW ?
760
NO
YES
FOR TEST HIGH ?
762
<512 μSEC
≥512 μSEC
CLEAR SERIAL OK
770
SET SERIAL OK
764
TIME = 91 CONT 2912
766
READ STATUS
768
SEND BREAK SIGNAL
772

FIG. 12H

MOVABLE BARRIER OPERATOR HAVING SERIAL DATA COMMUNICATION

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation of application Ser. No. 09/544,904 filed Apr. 7, 2000, now U.S. Pat. No. 6,737,968, which claims the benefit of provisional application 60/128,209 filed Apr. 7, 1999.

BACKGROUND OF THE INVENTION

The invention relates in general to movable barrier operators and in particular to movable barrier operators such as garage door operators or gate operators which include passive infrared detectors associated with them for detecting the presence of a person or other high temperature object for controlling a function of the movable barrier operator such as illumination.

It has been known to use pyroelectric infrared detectors or passive infrared (PIR) detectors for the detection of a person in a particular vicinity. For instance, it is well known that pyroelectric infrared detectors can be used in combination with illumination lamps, carriage lamps, spot lamps and the like to form a low cost home security system. The pyroelectric infrared detector typically has a plurality of segments. One or more of the segments may be actuated by infrared radiation focused thereon by a Fresnel lens positioned in front of the PIR detector. The pyroelectric detector provides an output signal when a change occurs in the potential level between one element and another element in the array. Such an infrared detected voltage change indicates that a warm object radiating infrared radiation, typically a person, is moving with respect to the detector. The detectors to provide output signals upon receiving infrared radiation in about the ten micron wavelength range. The micron infrared radiation is generated by a body having a temperature of about 90° F., around the temperature of a human body (98.6° F.).

It is also known that garage door operators or movable barrier operators can include a passive infrared detector associated with the head unit of the garage door operator. The passive infrared detector, however, needed some type of aiming or alignment mechanism associated with it so that it could be thermally responsive to at least part of the garage interior. The detectors were connected so that upon receiving infrared energy from a moving thermal source, they would cause a light associated with the garage door operator to be illuminated.

It was known in the past to use timers associated with such systems so that if there were no further thermal signal, the light would be shut off after a predetermined period. Such units were expensive as the passive infrared detector had to be built into the head unit of the garage door operator. Also, the prior PIR detectors were fragile. During mounting of the head unit to the ceiling of the garage a collision with the aiming device associated with the passive infrared detector might damage them. The ability to aim the detection reliably was deficient, sometimes leaving blank or dead spots in the infrared coverage.

Still other operators using pivoting head infrared detectors required that the detector be retrofitted into the middle of the output circuit of a conventional garage door operator. This would have to have been done by garage door operator service personnel as it would likely involve cutting traces on a printed circuit board or the like. Unauthorized alteration of the circuit board by a consumer might entail loss of warranty coverage of the garage door operator or even cause safety problems.

What is needed then is a passive infrared detector for controlling illumination from a garage door operator which could be quickly and easily retrofitted to existing garage door operators with a minimum of trouble and without voiding the warranty.

SUMMARY OF THE INVENTION

A passive infrared detector for a garage door operator includes a passive infrared detector section connected to a comparator for generating a signal when a moving thermal or infrared source signal is detected by the passive infrared detector. The signal is fed to a microcontroller. Both the infrared detector and the comparator and the microcontroller are contained in a wall control unit. The wall control unit has a plurality of switches which would normally be used to control the functioning of the garage door operator and are connected in conventional fashion thereto.

The PIR detector is included with the switches for opening the garage door, closing the garage door and causing a lamp to be illuminated. The microcontroller also is connected to an illumination detection circuit, which might typically comprise a cadmium sulphide (CdS) element which is responsive to visible light. The CdS element supplies an illumination signal to an ambient light comparator which in turn supplies an illuminator level signal to the microcontroller. The microcontroller also controls a setpoint signal fed to the comparator. The setpoint signal may be adjusted by the microcontroller according to the desired trip point for the ambient illumination level.

The microcontroller also communicates over the lines carrying the normal wall control switch signals with a microcontroller in a head unit of the garage door operator. The wall control microcontroller can interrogate the garage door operator head unit with a request for information. If the garage door operator head unit is a conventional unit, no reply will come back and the wall control microcontroller will assume that a conventional garage door operator head is being employed. In the event that a signal comes back in the form of a data frame which includes a flag that is related to whether the light has been commanded to turn on, the microcontroller can then respond and determine in regard to the status of the infrared detector and the ambient light whether the light should stay on or be turned off.

In the event that a conventional garage door operator head is used, the microcontroller can, in effect, create a feedback loop with the head unit by sending a light toggling signal to the microcontroller in the head unit commanding it to change the light state. If the light turns on, the increase in illumination is detected by the cadmium sulphide sensor and so signaled to the microcontroller head allowing the light to stay on. If, in the alternative, the light is turned off and the drop in light output is detected by the cadmium sulphide detector, the wall control microcontroller then retoggles the light, switching it back on to cause the light to stay on for a full time period allotted to it, usually two-and-one-half to four-and-one-half minutes.

It is a principal aspect of the present invention to provide a quickly and easily retrofitted passive infrared detector for controlling the illumination of a garage door operator through conventional signaling channels.

It is another aspect of the instant invention to provide a garage door operator having a passive infrared detector which passive infrared detector can-control a variety of garage door operators.

Other aspects and advantages of the present invention will become obvious to one of ordinary skill in the art upon a perusal of the following specification and claims in light of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a garage including a movable barrier operator, specifically a garage door operator, having associated with it a passive infrared detector in a wall control unit and embodying the present invention;

FIG. **2** is a block diagram showing the relationship between major electrical systems of a portion of the garage door operator shown in FIG. **1**;

FIGS. **3**A–C are schematic diagrams of a portion of the electrical system shown in FIG. **2**;

FIG. **4** is a schematic diagram of the wall control including the passive infrared detector;

FIG. **5** is a perspective view of the wall control;

FIG. **6** is a front elevational view of the wall control shown in FIG. **6**;

FIG. **7** is a side view of the wall control shown in FIG. **6**;

FIG. **8** is a rear elevational view of the wall control shown in FIG. **6**;

FIG. **9** is a side view, shown in cross section, of the wall control in FIG. **7**;

FIG. **10** is a plan view, shown in cross section, of the wall control;

FIG. **11** is a partially exploded perspective view of the wall control shown in FIG. **5**; and

FIGS. **12**A–H are flow charts showing details of a program flow controlling the operation of a microcontroller contained within the wall control as shown in FIGS. **3**A–C.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to drawings and especially to FIG. **1**, a movable barrier operator embodying the present invention is shown therein and generally identified by reference numeral **10**. The movable barrier operator, in this embodiment a garage door operator **10**, is positioned within a garage **12**. More specifically, it is mounted to a ceiling **14** of the garage **12** for operation, in this embodiment, of a multipanel garage door **16**. The multipanel garage door **16** includes a plurality of rollers **18** rotatably confined within a pair of tracks **20** positioned adjacent to and on opposite sides of an opening **22** for the garage door **16**.

The garage door operator **10** also includes a head unit **24** for providing motion to the garage door **16** via a rail assembly **26**. The rail assembly **26** includes a trolley **28** for releasable connection of the head unit **24** to the garage door **16** via an arm **30**. The arm **30** is connected to an upper portion **32** of the garage door **16** for opening and closing it. The trolley **28** is connected to an endless chain to be driven thereby. The chain is driven by a sprocket in the head unit **24**. The sprocket acts as a power takeoff for an electric motor located in the head unit **24**.

The head unit **24** includes a radio frequency receiver **50**, as may best be seen in FIG. **2**, having an antenna **52** associated with it for receiving coded radio frequency transmissions from one or more radio transmitters **53** which may include portable or keyfob transmitters or keypad transmitters. The radio receiver **50** is connected via a line **54** to a microcontroller **56** which interprets signals from the radio receiver **50** as code commands to control other portions of the garage door operator **10**.

A wall control unit **60** embodying the present invention, as will be seen in more detail hereafter, communicates over a line **62** with the head unit microcontroller **56** to effect control of a garage door operator motor **70** and a light **72** via relay logic **74** connected to the microcontroller **56**. The entire head unit **24** is powered from a power supply **76**. In addition, the garage door operator **10** includes an obstacle detector **78** which optically or via an infrared pulsed beam detects when the garage door opening **22** is blocked and signals the microcontroller **56** of the blockage. The microcontroller **56** then causes a reversal or opening of the door **16**. In addition, a position indicator **80** indicates to the head unit microcontroller **56**, through at least part of the travel of the door **16**, the door position so that the microcontroller **56** can control the close position and the open position of the door **16** accurately. FIGS. **3**A–C are schematic diagrams of a portion of the electrical system shown in FIG. **2**.

The wall control **60**, as may best be seen in FIG. **4**, includes a passive infrared sensor **100** having an output line **102** connected to a differential amplifier **104**. The differential amplifier **104** feeds a pair of comparators **106** and **108** coupled to a wall control microcontroller **110**, in this embodiment a Microchip PIC 16505. The sensor **100** changing signals from the comparators when the infrared illumination changes at the passive infrared sensor **100**. The microcontroller **110** provides an output at line **112** to the line **62**, which is connected to the microcontroller in the GDO head. Also associated with the wall control is a momentary contact light switch **120**, a door control switch **122**, a vacation switch **124**, and an auto-manual select switch **126**. The light switch **120** is connected through a capacitor **130** to other portions of the wall control **60**. The vacation switch **124** is connected through a capacitor **132** to the wall control **60**. The capacitor **132** has a different value than the capacitor **130**. The wall control **60** controls the microcontroller **56** through its switches by the effective pulse width or charging time required when a respective switch closes as governed by its associated capacitor or by the direct connection, as is set forth for the door control switch **122**.

In addition, an ambient light sensor **140** is provided connected in a voltage divider circuit having a variable resistance **134** which feeds a comparator **150** which supplies an ambient light level signal over a line **152** to the microcontroller **110**.

In addition, the microcontroller **110** supplies a setpoint signal on a line **160** back to the comparator **150** so that the microcontroller **110**, through the use of pulse width modulation, can control the setpoint of the light level comparator **150** to determine the point where the ambient light comparator **150** trips and thereby determine the ambient light illumination level. FIGS. **5**–**11** are various views of the wall control **60** discussed above. FIGS. **12**A–H are flow charts showing details of a program flow controlling the apparatus of microcontroller **56** contained within the wall control **60** as shown in FIGS. **3**A–C.

As may best be seen in FIG. **12** when the processor or microcontroller **110** powers up ports and outputs are set as well as the timer in a step **500** at which point a main loop is entered and the timer is read in a step **502**. A test is made to determine if 10 milliseconds have elapsed in step **504** if they have not, control is transferred back to step **502**. If they have, the pulse width modulation cycle is cleared in a step **506** in order to start the pulse width modulation to govern the

setpoint for the illumination. In step **508**, the pulse width modulation output is turned on and the pulse width modulation counter is cleared. In step **510**, the pulse width modulation counter is incremented and a test is made to determine whether the pulse width modulation counter is equal to the pulse width modulation value in a step **512**. If it is not, control is transferred to step **510**. If it is, control is transferred to a step **514** where the pulse width modulator has the counter cleared and is turned off and the pulse width modulation value is output. Followed by a step **516** where the pulse width modulation counter is incremented and a test is made to determine whether the value of the pulse width modulation counter is equal to pwm rem in a step **518**. If it is not, control is transferred back to step **516**.

If it is, as may best be seen in FIG. **12**B, the pulse width modulation cycle is incremented in a step **520**, and a test is made in step **522** to determine whether it is equal to six. If it is not, control is transferred back to step **508** to restart the pulse width modulation. If it is, the pulse width modulator is turned off in step **526** and a read comparison is made in a step **530**. If the read comparator is high, the plunge counter is decremented in a step **532**, and the increment counter is incremented in a step **534**. In a step **536**, the value of the incremented counter is tested to determine whether it is greater than **10**. If it is, the counter is cleared and a step **538**. If it is not, control is transferred to a step **540** where the pulse width remainder value is set equal to pulse width modulation value compliment.

In the event that the value of the read comparison step **530** yields a low value, a leap counter is cleared in a step **550** and a decrement counter is incremented in a step **552**. A test is made in a step **554** to determine whether the decrement counter value is greater than **10**. If it is not, control is passed to step **540**. If it is, the decrement counter is cleared in a step **556** and a test is made to determine whether the pulse width modulation value is zero in a step **560**. If it is zero, control is transferred to step **540**. If it is not, the pulse width modulation value is decremented, the plunge counter is incremented in a step **562**. In a step **564**, the plunge counter is tested to determine whether it is greater than **12**. If it is, the pulse width modulation value is tested for whether it is less than **20** in a step **566**. If it is not, the pulse width modulation value is set equal to the pulse width modulation value minus nine in a step **568** and control is transferred to the step **540**.

Upon exiting the step **540**, as may best be seen in FIG. **12**C, a test step **570** is entered to determine whether the light on state has been set by the head unit of the movable barrier operator. If it is not, a test is made in a step **522** to determine whether the awake timer is active. If the awake timer is active, control is transferred to a step **574** causing a 16-bit counter timer to be incremented and to blank any bit counter. If the timer is not active, control is transferred to determine whether the blank timer is active in a step **576**. If it is, control is transferred to step **574**. If it is not, control is transferred to a test step **578** to determine whether checking is active. If checking is active, the checking counter is incremented in the step **530** and a test is made to determine whether the value of the checking counter is equal to one second in a step **582**. If it is not, control is transferred to a test step **600**, as shown in FIG. **12**D. If it is, a test is made to determine whether the light-on flag is on or not in a step **602**. If it is on, a test is made in a step **604** to determine whether the present pulse width modulation value is equal to the stored modulation value. If it is indicated to be lighter, control is transferred to a step **606** to clear checking. If it is indicated to be dimmer, control is transferred to a step **608** causing the work light signal to e toggled by the wall control over the lines connected to the head unit. If the light-on value flag is indicated to be off, a test is made in a step **610** to determine whether the present pulse width modulation value is equal to the stored value. If it's indicated to be dimmer, control is transferred to the step **606**. If it's indicated to be lighter, step **612** turns on the work light toggle to flip the light state and transfers control to step **606**.

Once the light has been toggled, a test is made in step **600**, as shown in FIG. **12**D, to determine whether the awake flag has been set. If it has, a test is made in a step **620** to determine whether the work light toggle is active. If it is, the pulse width value is incremented in a step **622**, and a test is made to determine whether the pulse width count is equal to 20 (which is equivalent to 200 milliseconds) in a step **624**. If it is not, the work light is toggled off in a step **626**. In the event that the awake flag has not been set, a test is made in a step **630** to determine whether the RC time constant for the power supply has expired. In other words, has the power been kept high for more than 1.5 minutes as tested for in step **630**. If it has not, control is transferred back to the main loop in FIG. **12**A. If it is, the awake value is set and the timer is cleared in the step **634**, and control is transferred back to the main loop. In the event that the time constant has expired in step **630**, the awake flag is cleared and the counts are set high in the step **636** after which control is transferred back to the main loop. After the work light has been toggled and the step **626**, a step is made in a step **660**, as may best be seen in FIG. **12**E to determine if the blank timer is active. If it is, it is checked. If it is not, a test is made to determine whether there is indicated to be activity from the passive infrared input indicating a change in a step **662**. If not, a quiet state is entered. If the PIR has been indicated to be active, a second test is made to determine whether the PIR still indicates that it is changing to indicate that a false signal has not been received. If it is, a test is made to determine whether the work light is on within the garage. If the work light is on, control is transferred back to the main loop. If the work light is indicated not to be on, a test is made to determine whether the pulse width value is greater than **128**, in other words, whether the garage is indicated to be bright or dim. If it is indicated to be bright, indicating it's illuminated control is transferred back to the main loop. If it's indicated to be dim, control is transferred to the test step **680**, as may best be seen in FIG. **12**G to determine whether two-and-one-half seconds had elapsed. If they have not, the blank timer is turned off in the step **682**. If they have, a test is made in the step **684** to determine whether the light-on state has been set. If it has, a test is made in a step **686** to determine whether six minutes have passed. If they have, the timer is cleared, the light-on flag is cleared, the blank flag is set, and an attempt is made to read the light state from the head unit via serial communication in a step **688**. A test is made in a step **690** to determine whether the serial communication has been successful. If it has, a test is then made in a step **692** to determine whether the light-on flag has been returned from the head unit to the wall control. If it has, indicating the light has been set on, the toggle output is set in a step **694**. If it has not, control has been transferred to the main loop. If serial communication has failed, as tested for in step **690**, the toggle output is set in a step **700**, pulse width modulated value is stored in a step **702**, and checking is set in a step **704** prior to transfer back to the main loop.

In order to respond to the query function, which is used to interpret the word sent back by the head unit, as may best be seen in FIG. **12**H. In a step **750**, there is a delay until a key reading pulse in a step **752** and a timer is reset in a step

754. A 500 microsecond delay is waited for in a step 756. A series of delays are used to generate an on-off output code of varying pulse widths followed by a 100 microsecond delay in a step 758. A test is then made in a step 760 to determine whether the wall control input pin is low. If it is not, the test is remade. If it is, control is transferred to a step 762 to set a flag indicating serial communication is successful. A time value is set is a step 766 and status is read in a step 768. A test is made in step 770 to determine whether the serial is okay and in a test 772 a brake signal is tested for and sent.

In order to respond to the query light, as is shown in FIG. 12F, in a step 800 the query light is called. A test is made in a step 802 to determine whether it was readable by a serial communication with the head. If it was, a test is made in a step 804 to determine whether the light was on. If it was, control is transferred back to the main loop. If it was not, the toggle output is set to indicate that the state was light-on in step 806 to force the light to be on.

In the event that the serial communication was not readable, the toggle output state was set, it's light on in step 810, pulse width modulation value restored in the step 812, and the checking flag is set in the step 814. Attached is an Appendix consisting of pages A-1 to A-12 which comprises a listing of the software executing on the microcontroller 110.

While there has been illustrated and described a particular embodiment of the present invention, it will be appreciated that numerous changes and modifications will occur to those skilled in the art, and it is intended in the appended claims to cover all those changes and modifications which fall within the true spirit and scope of the present invention.

What is claimed is:

1. An improved garage door opener comprising a motor drive unit for opening and closing a garage door, said motor drive unit having a microcontroller and a wall console, said wall console having a microcontroller, said microcontroller of said motor drive unit being connected to the microcontroller of the wall console by means of a digital data bus.

2. The garage door opener according to claim 1 wherein said digital data bus is asynchronous.

3. The garage door opener according to claim 1 wherein at least one microcontroller controls the travel of said door and said one microcontroller makes calculations of the door's location during its travel.

4. The garage door opener according to claim 1 further comprising a keypad for operating the garage door opener and wherein said keypad is provided with a switch to turn on or off a light in the motor drive unit in the garage.

5. The garage door opener according to claim 1 comprising apparatus at the wall console for requesting the status of the drive unit via the data bus.

6. The garage door opener according to claim 5 comprising apparatus at the drive unit for responding to status requests from the wall console via the data bus.

7. The garage door opener according to claim 1 wherein power for the wall console is provided from the drive unit via power conductors of the data bus.

8. The garage door opener according to claim 7 wherein the power conductors convey both data and power.

9. An improved garage door opener comprising a motor drive unit for opening and closing a garage door, said motor drive unit having a controller and a wall console, said wall console having a controller, said controller of said motor drive unit being connected to the controller of the wall console by means of a digital data bus.

10. The garage door opener according to claim 9 wherein said digital data bus is asynchronous.

11. The garage door opener according to claim 9 wherein at least one controller controls the travel of said door and said one microcontroller makes calculations of the door's location during its travel.

12. The garage door opener according to claim 9 further comprising a keypad for operating the garage door opener and wherein said keypad is provided with a switch to turn on or off a light in the motor drive unit in the garage.

13. The garage door opener according to claim 9 comprising apparatus at the wall console for requesting the status of the drive unit via the data bus.

14. The garage door opener according to claim 13 comprising apparatus at the drive unit for responding to status requests from the wall console via the data bus.

15. The garage door opener according to claim 9 wherein power for the wall console is provided from the drive unit via power conductors of the data bus.

16. The garage door opener according to claim 15 wherein the power conductors convey both data and power.

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