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Booker, Jr. et al.

[11] **3,875,554**

[45] **Apr. 1, 1975**

[54] **ELEVATOR SYSTEM HAVING CURRENT LIMITED AND SHORT CIRCUIT PROTECTED POWER SUPPLY FOR HALL LAMPS**

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[73] Assignee: **Westinghouse Electric Corporation,** Pittsburgh, Pa.

[22] Filed: **May 8, 1973**

[21] Appl. No.: **358,430**

[52] **U.S. Cl.** **340/21,** 315/307

[51] **Int. Cl.** **B66b 3/02**

[58] **Field of Search** .... 340/19, 21, 166 EL; 187/28; 330/135, 141; 315/91, 307, 308; 321/16

[56] **References Cited**

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2,085,135	6/1937	Williams	340/21
3,719,858	3/1973	Gilbreath	315/308
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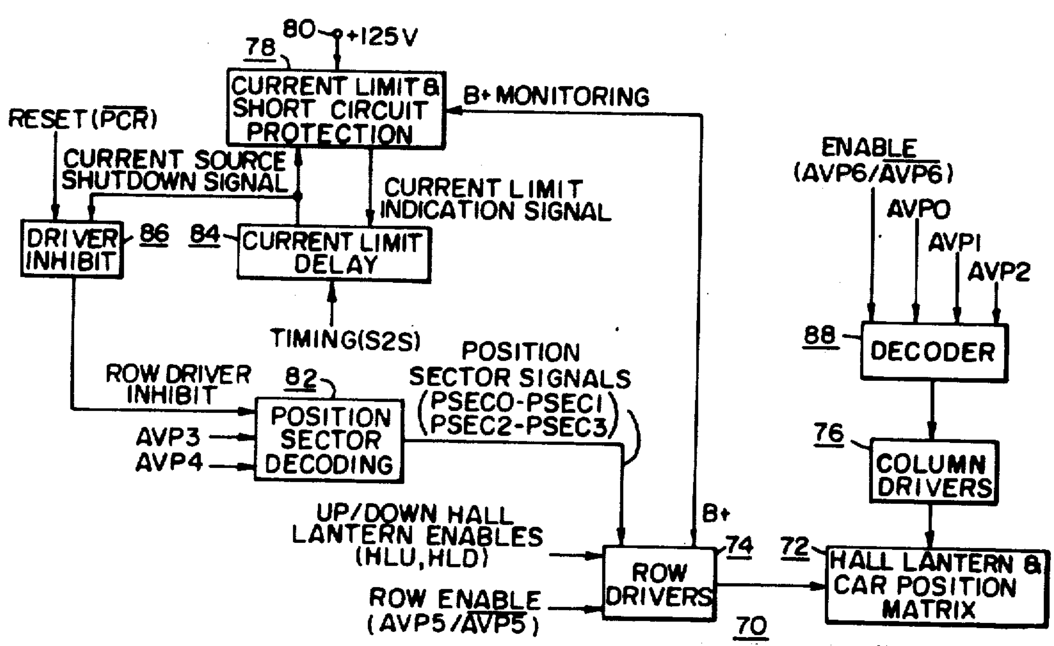
Primary Examiner—John W. Caldwell
Assistant Examiner—Marshall M. Curtis
Attorney, Agent, or Firm—D. R. Lackey

[57] **ABSTRACT**

An elevator system for a building having a plurality of floors, an elevator car mounted to serve the floors, and hall lamps disposed at the floors served by the car, which lamps are selectively operated in response to predetermined actions of the elevator car. Driver circuits are disposed between the hall lamps and a power supply. The power supply is limited as to the current it will supply, with the maximum current being less than the normal current inrush to a hall lamp. A shorted hall lamp or associated driver circuit turns off the power supply until such time that the shorted load circuit is not selected for connection to the power supply.

4 Claims, 6 Drawing Figures



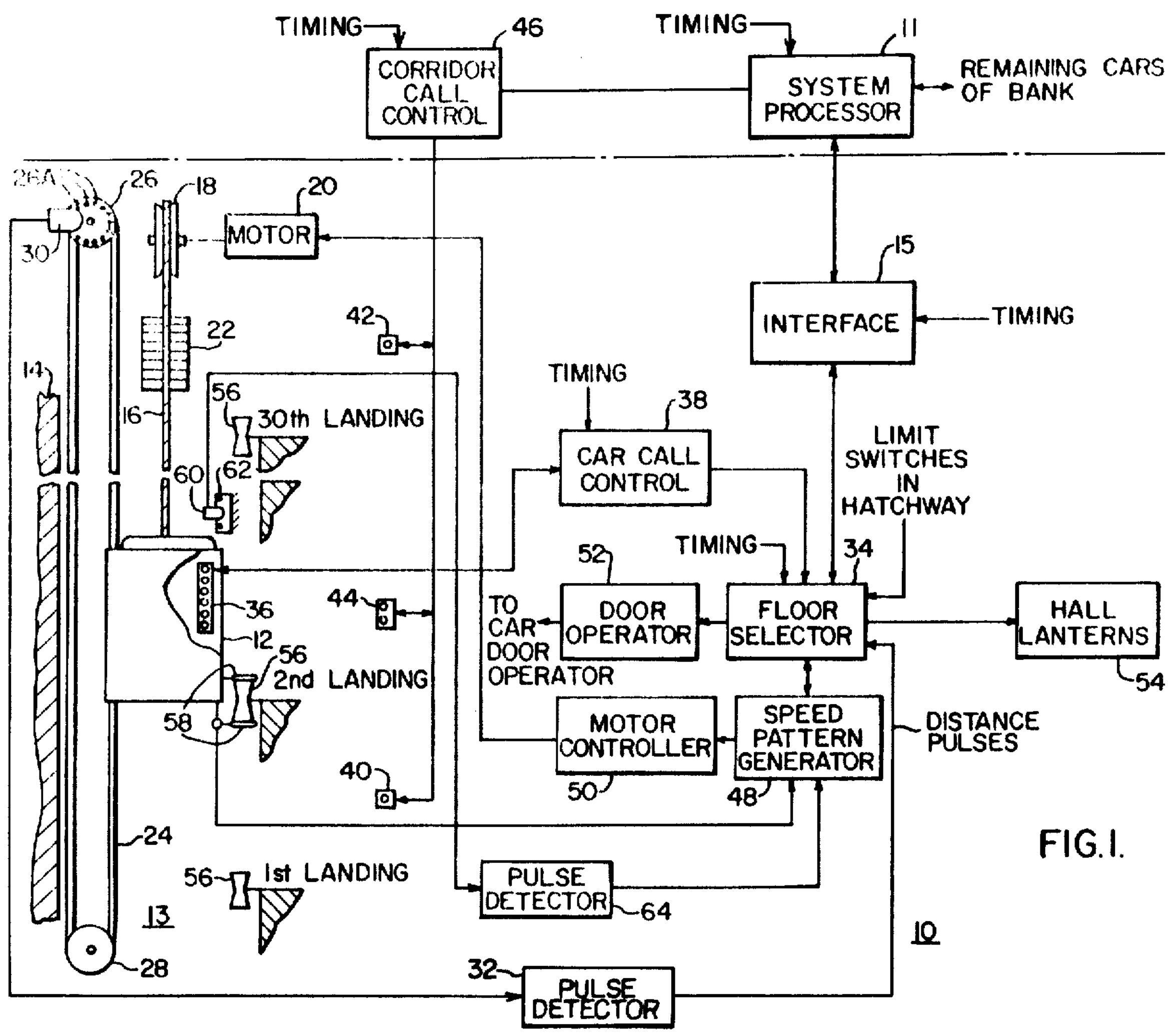

TIMING
46
CORRIDOR CALL CONTROL
TIMING
11
SYSTEM PROCESSOR
REMAINING CARS OF BANK
26A
26
18
20
MOTOR
30
15
INTERFACE
TIMING
42
22
14
TIMING
38
56
30th LANDING
16
60
62
CAR CALL CONTROL
LIMIT SWITCHES IN HATCHWAY
52
TIMING
34
36
44
TO CAR DOOR OPERATOR
DOOR OPERATOR
FLOOR SELECTOR
HALL LANTERNS
12
56
2nd LANDING
54
58
MOTOR CONTROLLER
SPEED PATTERN GENERATOR
DISTANCE PULSES
40
50
48
24
56
1st LANDING
PULSE DETECTOR
64
13
28
10
32
PULSE DETECTOR

FIG.1.

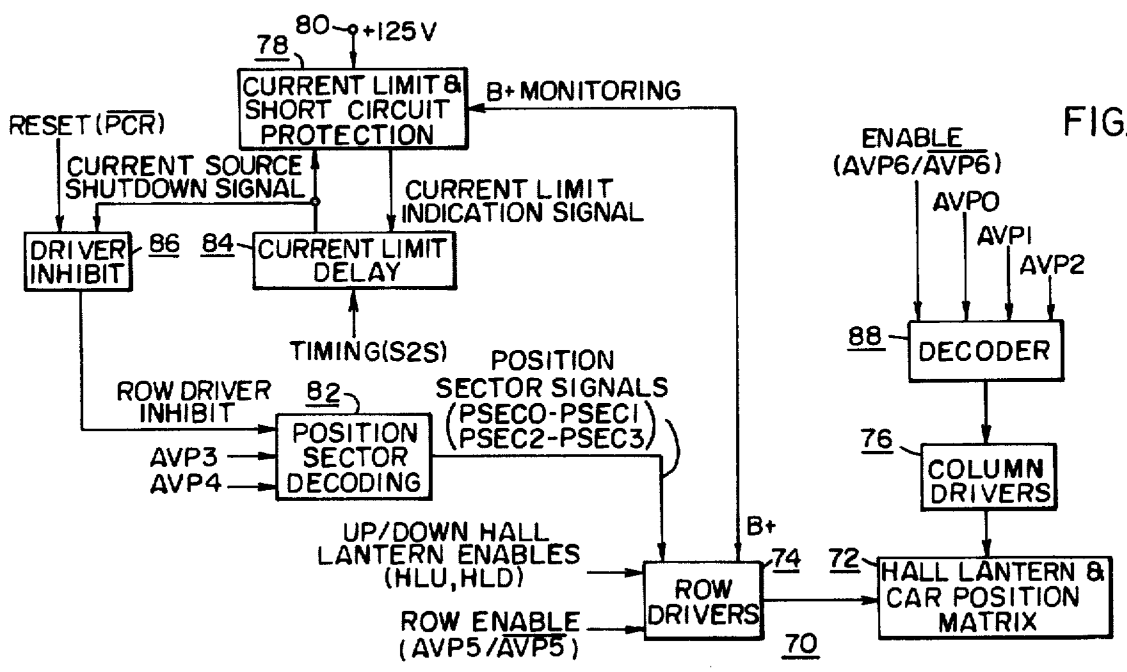

80
+125V
78
CURRENT LIMIT & SHORT CIRCUIT PROTECTION
B+ MONITORING
RESET (PCR)
CURRENT SOURCE SHUTDOWN SIGNAL
CURRENT LIMIT INDICATION SIGNAL
ENABLE (AVP6/AVP6)
AVPO
AVPI
AVP2
DRIVER INHIBIT
86
84
CURRENT LIMIT DELAY
TIMING (S2S)
88
DECODER
POSITION SECTOR SIGNALS (PSECO-PSECI PSEC2-PSEC3)
ROW DRIVER INHIBIT
82
POSITION SECTOR DECODING
AVP3
AVP4
76
COLUMN DRIVERS
B+
UP/DOWN HALL LANTERN ENABLES (HLU, HLD)
74
72
ROW DRIVERS
HALL LANTERN & CAR POSITION MATRIX
ROW ENABLE (AVP5/AVP5)
70

FIG.3

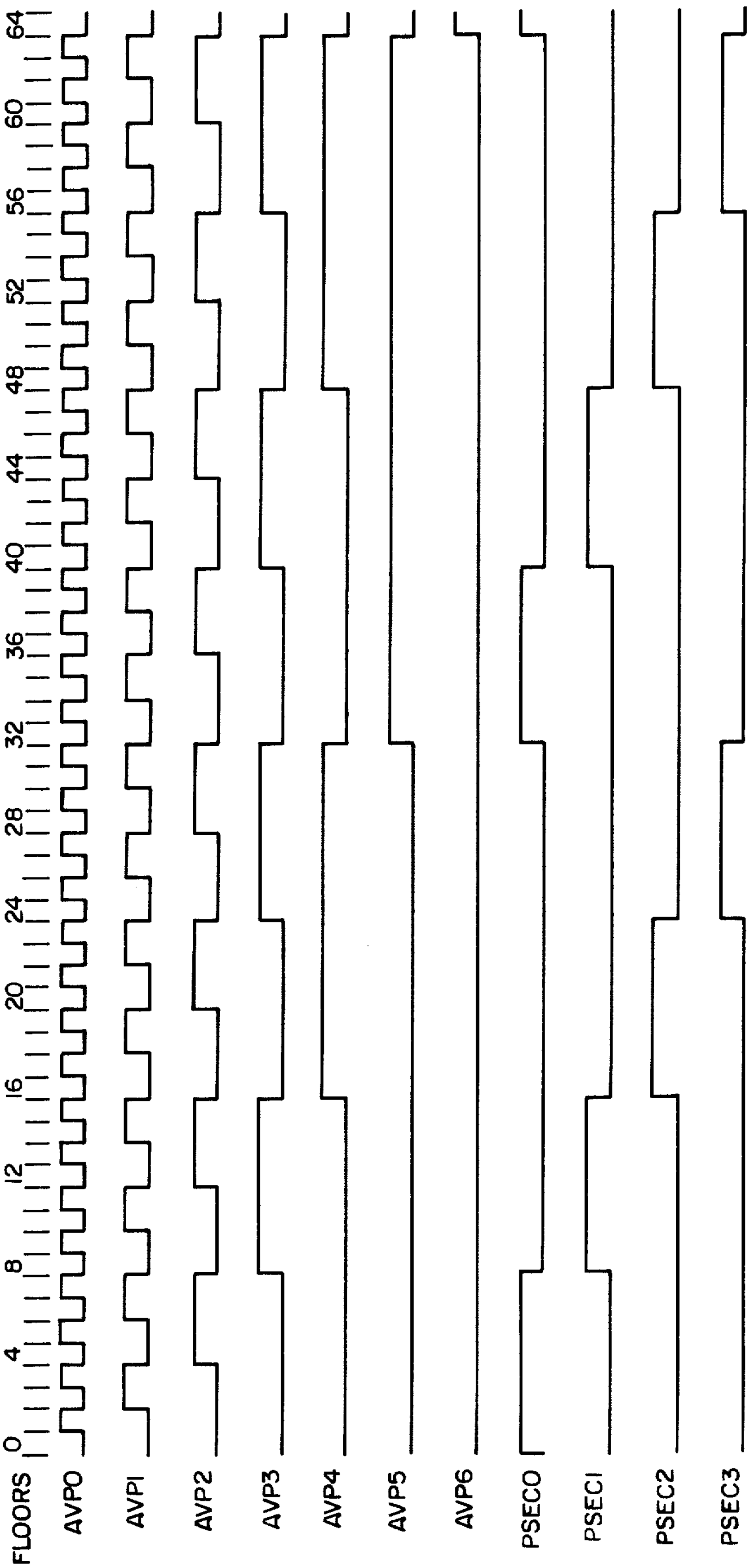

FLOORS
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
64
AVPO
AVPI
AVP2
AVP3
AVP4
AVP5
AVP6
PSECO
PSECI
PSEC2
PSEC3

FIG.2

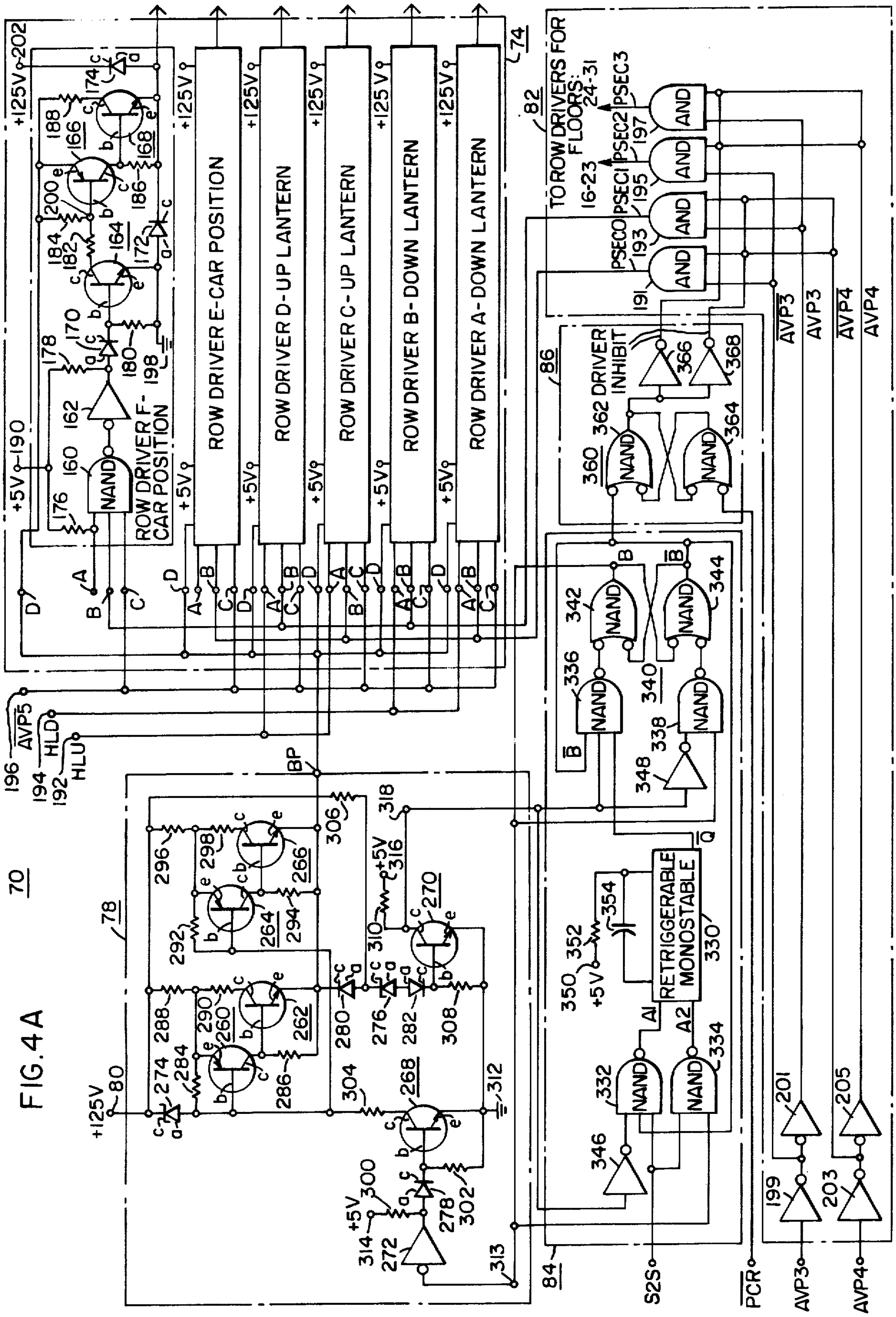

ROW DRIVER F-CAR POSITION
ROW DRIVER E-CAR POSITION
ROW DRIVER D-UP LANTERN
ROW DRIVER C-UP LANTERN
ROW DRIVER B-DOWN LANTERN
ROW DRIVER A-DOWN LANTERN
TO ROW DRIVERS FOR FLOORS: 16-23 24-31
DRIVER INHIBIT
RETRIGGERABLE MONOSTABLE
NAND
AND
+125V
+5V
BP
S2S
PCR
AVP3
AVP4
AVP5
HLD
HLU
PSEC0
PSEC1
PSEC2
PSEC3

FIG. 4A

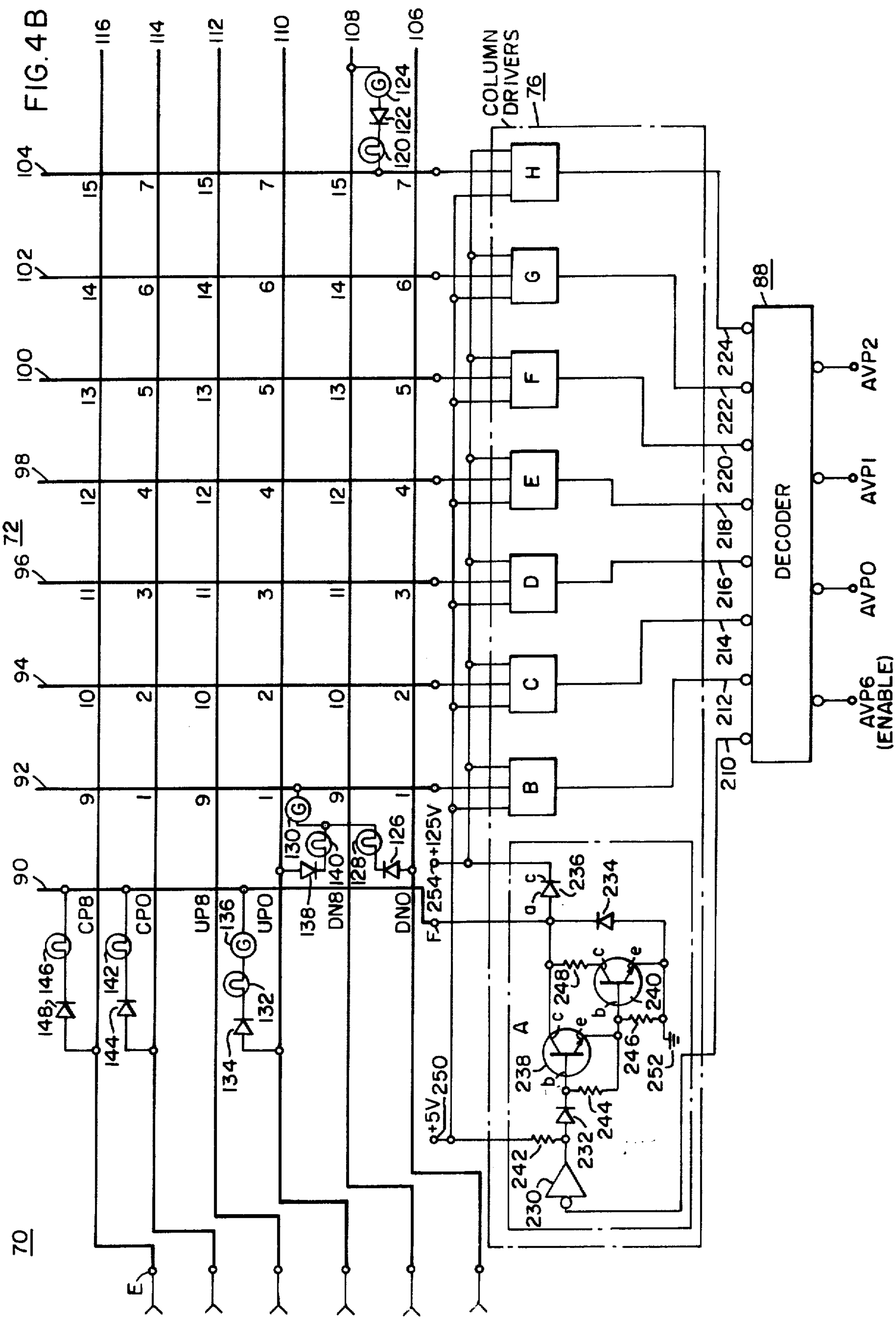
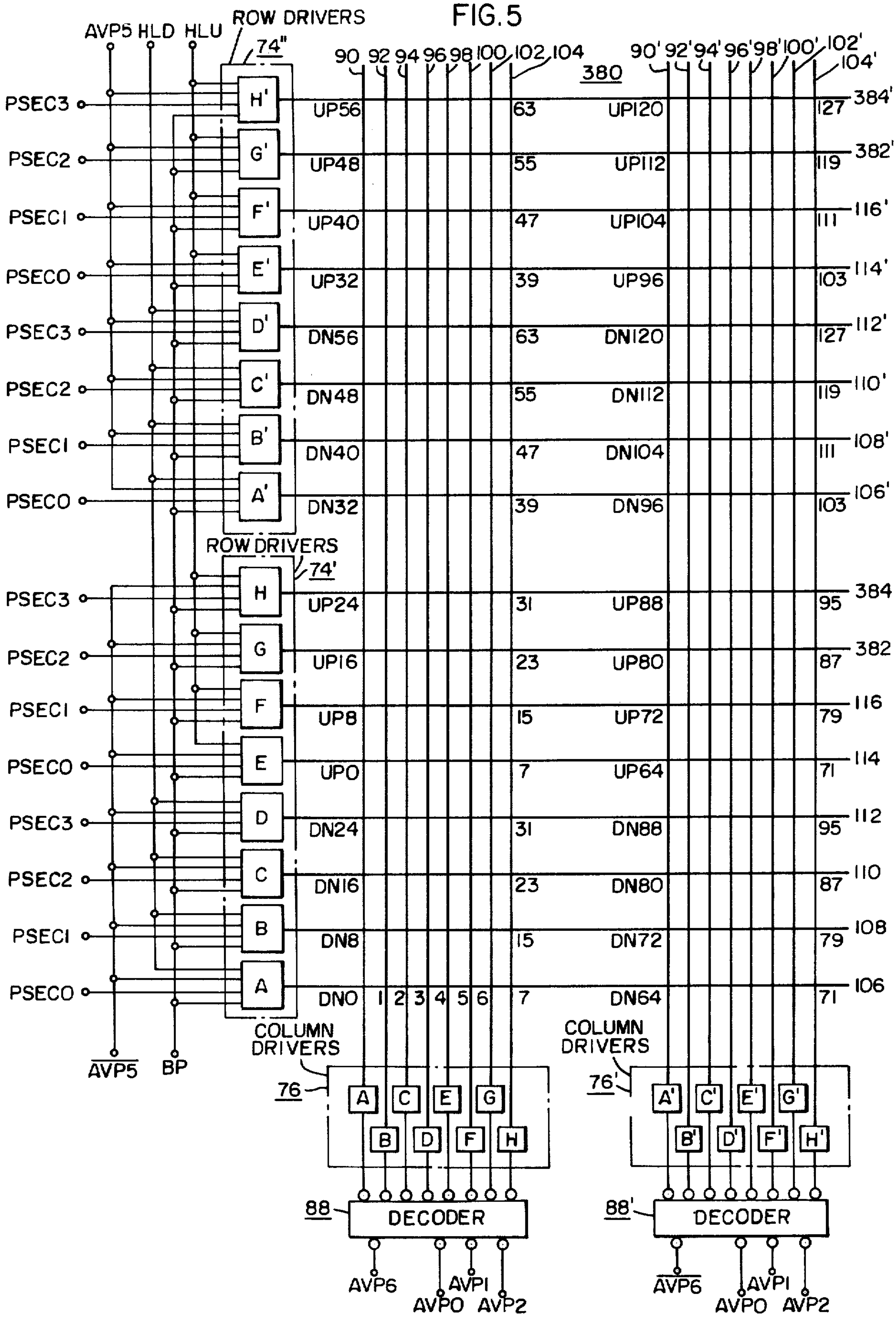


FIG. 4B
COLUMN DRIVERS
76
72
70
88
DECODER
AVP2
AVP1
AVP0
AVP6
(ENABLE)
B
C
D
E
F
G
H
A
CP8
CP0
UP8
UP0
DN8
DN0
+125V
+5V
E
F
90
92
94
96
98
100
102
104
106
108
110
112
114
116
210
212
214
216
218
220
222
224
250
252
254

FIG.5


ROW DRIVERS 74"
AVP5 HLD HLU
PSEC3 PSEC2 PSEC1 PSEC0
H' G' F' E' D' C' B' A'
90 92 94 96 98 100 102 104
380
90' 92' 94' 96' 98' 100' 102' 104'
UP56 63 UP120 127 384'
UP48 55 UP112 119 382'
UP40 47 UP104 111 116'
UP32 39 UP96 103 114'
DN56 63 DN120 127 112'
DN48 55 DN112 119 110'
DN40 47 DN104 111 108'
DN32 39 DN96 103 106'
ROW DRIVERS 74'
H G F E D C B A
UP24 31 UP88 95 384
UP16 23 UP80 87 382
UP8 15 UP72 79 116
UP0 7 UP64 71 114
DN24 31 DN88 95 112
DN16 23 DN80 87 110
DN8 15 DN72 79 108
DN0 1 2 3 4 5 6 7 DN64 71 106
AVP5 BP
COLUMN DRIVERS 76
COLUMN DRIVERS 76'
A C E G B D F H
A' C' E' G' B' D' F' H'
88 DECODER
88' DECODER
AVP6 AVP0 AVP1 AVP2
AVP6 AVP0 AVP1 AVP2

ELEVATOR SYSTEM HAVING CURRENT LIMITED AND SHORT CIRCUIT PROTECTED POWER SUPPLY FOR HALL LAMPS

CROSS-REFERENCE TO RELATED APPLICATIONS

Certain of the apparatus disclosed but not claimed in the present application may be claimed in one of the following concurrently filed co-pending applications:

Application Ser. No. 358,428, filed May 8, 1973, in the name of C. A. Booker, Jr., which application is assigned to the same assignee as the present application.

Application Ser. No. 358,429, filed May 8, 1973, in the name of A. F. Mandel, which application is assigned to the same assignee as the present application.

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The invention relates in general to elevator systems, and more specifically to new and improved hall lantern apparatus for elevator systems.

2. Description of the Prior Art:

Elevator systems having one or more elevator cars mounted in a building to serve the floors therein, conventionally include, for each car, up and down hall lanterns disposed at each floor for which the associated elevator car provides up and down service. The lowest and highest floors served by a specific car would only require up and down hall lanterns at these floors, respectively.

The lamps used in the hall lanterns conventionally draw a high inrush current which quickly settles to a much lower value as the lamp filament heats and reaches its normal operating temperature. The driver circuits, including the lamp, may fail in a low resistance or shorted mode, resulting in a very large current flowing to the low resistance or shorted load. The current inrush and short circuit conditions are handled without undue economic penalty when utilizing electromagnetic relays in the lamp driver circuits. It would be desirable, at least in certain applications, to use semiconductor or solid state switching devices in the lamp driver circuits. The current inrush and short circuit conditions associated with the hall lantern circuits, however, may cause failure of the solid state components, and attempts to reduce these failures by selecting devices with current ratings which will enable them to withstand the inrush and short circuit currents results in a severe economic penalty.

SUMMARY OF THE INVENTION

Briefly, the present invention is a new and improved elevator system including one or more elevator cars mounted to serve the floors of an associated building or structure. Each elevator car has hall lanterns associated with the floors it serves. The new and improved hall lantern apparatus disclosed herein enables solid state or semiconductor switching devices to be used for the lamp driver circuits in the hall lantern apparatus, which devices are assured a long operating life without a concomitant economic penalty.

The hall lantern apparatus for a specific elevator car includes a power supply, a plurality of hall lamps, and a plurality of driver circuits for selectively connecting the hall lamps to the power supply in response to predetermined actions of the elevator car, i.e., such as initiating the deceleration of an elevator car to stop at a landing for which it will provide up or down service.

The power supply includes means for limiting the maximum current that it will provide to the lamp circuits at any one time, with the maximum current being less than the normal inrush current to a cold lamp. Limiting the inrush current permits the use of smaller and less costly solid state switching devices in the lamp driver circuits. For example, transistors may be selected to operate in a saturated mode when conducting. The solid state switching devices in the lamp driver circuits are also protected in the event of a shorted load, since the maximum current they will be subjected to, and therefore the maximum dissipation, is limited.

Only the solid state switching devices in the current limit portion of the power supply need be selected with high dissipation capabilities, to withstand the high voltage drop across them during current inrush to a cold lamp. Even here, however, it is not practical to provide solid state switching devices large enough to withstand the dissipation which would result from a shorted load. The present invention solves this problem by distinguishing between normal current inrush to a cold lamp and a low resistance or shorted load. A shorted load shuts down the power supply. In the preferred embodiment of the invention, a current limit signal is provided by the power supply when it is supplying the predetermined maximum current to the driver and lamp circuitry. A protective circuit monitors this signal, starting a timing circuit when the current limit signal is initiated. The timing circuit is set to time out if the current limit signal persists for a time longer than the normal time for the current inrush to a lamp to settle below the predetermined maximum value. If the timing circuit times out, it indicates an abnormal condition, and the protective circuit provides a shutdown signal which shuts down the power supply.

However, since only one of a large plurality of lamp circuits is presumably shorted, the present invention enables the unshorted hall lantern circuits to be utilized. A driver inhibit circuit is provided which, in response to the shutdown signal provided by the protective means, inhibits all of the hall lamp driver circuits, with the inhibit signal persisting even after the current limit signal ceases. When the shorted load is disconnected from the power supply, the current limit signal is terminated and the power supply is returned to operation, but without a connected load. When the action of the car is such that the shorted load is no longer selected, the driver inhibit circuit is reset to remove the inhibit signals from the drivers. The hall lantern circuits are thus returned to normal operation.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be better understood and further advantages and uses thereof more readily apparent, when considered in view of the following detailed description of exemplary embodiments, taken with the accompanying drawings, in which:

FIG. 1 is a block diagram of an elevator system which may utilize the teachings of the invention;

FIG. 2 is a graph which illustrates certain signals which may be used in the hall lantern apparatus constructed according to the teachings of the invention;

FIG. 3 is a block diagram of a new and improved hall lantern arrangement constructed according to the teachings of the invention;

FIGS. 4A and 4B are schematic diagrams which may be assembled to provide a specific embodiment of the invention shown in block form in FIG. 3; and

FIG. 5 is a partially schematic and partially block diagram of hall lantern circuits which may also utilize the teachings of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. 1

Referring now to the drawings, and FIG. 1 in particular, there is shown an elevator system **10** which may utilize the teachings of the invention. Elevator system **10** includes an elevator car **12**, the movement of which may be controlled by a system processor **11**. Since each car of a bank of cars, and the controls therefor, would be similar in construction and operation, only the controls for a single car **12** are illustrated and described.

More specifically, car **12** is mounted in a hatchway **13** for movement relative to a structure **14** having a plurality of landings, such as **30**, with only the first, second and thirtieth landings being shown in order to simplify the drawing. The car **12** is supported by a rope **16** which is reeved over a traction sheave **18** mounted on the shaft of a drive motor **20**, such as a direct current motor as used in the Ward-Leonard drive system, or in a solid state drive system. A counterweight **22** is connected to the other end of the rope **16**. A governor rope **24** which is connected to the top and bottom of the car is reeved over a governor sheave **26** located above the highest point of travel of the car in the hatchway **13**, and over a pulley **28** located at the bottom of the hatchway. A pick-up **30** is disposed to detect movement of the car **12** through the effect of circumferentially spaced openings **26A** in the governor sheave **26**. The openings in the governor sheave are spaced to provide a pulse for each standard increment of travel of the car, such as a pulse for each 0.5 inch of car travel. Pick-up **30**, which may be of any suitable type, such as optical or magnetic, provides pulses in response to the movement of the openings **26A** in the governor sheave. Pick-up **30** is connected to a pulse detector **32** which provides distance pulses for a floor selector **34**. Distance pulses may be developed in any other suitable manner, such as by a pick-up disposed on the car which cooperates with regularly spaced indicia in the hatchway.

Car calls, as registered by push button array **36** mounted in the car **12**, are recorded and serialized in car call control **38**, and the resulting serialized car call information is directed to the floor selector **34**.

Corridor calls, as registered by push buttoms mounted in the corridors, such as the up push button **40** located at the first landing, the down push button **42** located at the thirtieth landing, and the up and down push buttons **44** located at the second and other intermediate landings, are recorded and serialized in corridor call control **46**. The resulting serialized corridor call information is directed to the system processor **11**. The system processor **11** directs the corridor calls to the cars through an interface circuit, shown generally at **15**, to effect efficient service for the various floors of the building and effective use of the cars.

The floor selector **34** processes the distance pulses from pulse detector **32** to develop information concerning the position of the car **12** in the hatchway **13**, and also directs these processed distance pulses to a speed pattern generator **48** which generates a speed reference signal for a motor controller **50**, which in turn provides the drive voltage for motor **20**.

The floor selector **34** keeps track of the car **12** and the calls for service for the car, it provides the request to accelerate signal to the speed pattern generator **48**, and provides the deceleration signal for the speed pattern generator **48** at the precise time required for the car to decelerate according to a predetermined deceleration pattern and stop at a predetermined floor for which a call for service has been registered. The floor selector **34** provides signals for controlling the door operator **52**, and it controls the resetting of the car call and corridor call controls when a car or corridor call has been serviced. The floor selector **34** also provides the signals for controlling the hall lanterns **54**, with the present invention relating to new and improved hall lantern circuits for this block function **54**.

Landing, and leveling of the car at the landing, is accomplished by a hatch transducer system which utilizes inductor plates **56** disposed at each landing, and a transformer **58** disposed on the car **12**.

The motor controller **50** includes a speed regulator responsive to the reference pattern provided by the speed pattern generator **48**. The speed control may be derived from a comparison of the actual speed of the motor and that called for by the reference pattern by using a drag magnet regulator, such as disclosed in U.S. Pat. Nos. 2,874,806 and 3,207,265, which are assigned to the same assignee as the present application. The precision landing system using inductor plates and transformer **58** is described in detail in U.S. Pat. No. 3,207,265.

An overspeed condition near either the upper or lower terminal is detected by the combination of a pick-up **60** and slow-down blades, such as a slow-down blade **62**. The pick-up **60** is preferably mounted on the car **12**, and a slow-down blade is mounted near each terminal. The slowdown blade has spaced openings, such as a toothed edge, with the teeth being spaced to generate pulses in the pick-up **60** when there is relative motion between them. These pulses are processed in pulse detector **64** and directed to the speed pattern generator **48** where they are used to detect overspeeds.

A new and improved floor selector **32** for operating a single elevator car, without regard to operation of the car in a bank of cars, has been disclosed in application Ser. No. 254,007, filed May **17, 1972,** now U.S. Pat. No. 3,750,850 which is assigned to the same assignee as the present application. Modification of the floor selector **32** to adapt it to bank operation and control by system processor **11** is disclosed in application Ser. No. 340,618 filed Mar. 12, 1973, now U.S. Pat. No. 3,804,209, which is assigned to the same assignee as the present application. In order to avoid duplication and to limit the complexity of the present application, these applications are hereby incorporated by reference, and will hereinafter be referred to as the first and second incorporated applications, respectively.

FIG. 2

The specific signals obtained from the floor selector **32** which are used by the hall lantern circuits **54** are **AVP0-AVP6**, which gives the floor number of the advanced car position in binary, $\overline{\text{PCR}}$, which goes low (true) each time the advanced car position changes floors, and clock signal S2S. Signal **AVP0-AVP6** is developed in a counter in FIG. **6** of the first incorporated application, PCR is developed by the synchronizing circuit shown in FIG. 10 of the first incorporated application, and clock S2S is illustrated in FIG. 12A of the second incorporated application. FIG. 2 illustrates signal AVP0-AVP6 for each of the floors 0 through 64, as well as position sector signals PSEC0-PSEC3. Signals PSEC0-PSEC3 are derived from bits AVP3 and AVP4 of signal AVP0-AVP6, as will be hereinafter described.

FIG. 3

FIG. 3 is a block diagram of a new and improved hall lantern circuit arrangement 70 which may be used for the block function 54 shown in FIG. 1 which is entitled "hall lanterns." In prior art hall lantern circuits, an electromechanical relay is provided to drive each hall lantern. The first and second incorporated applications utilize solid state components in the floor selector, car station, car controller, system processor, and related circuits. Thus, it would be desirable to use solid state drive circuits for the lamps associated with the up and down hall lanterns placed at the various floors of the building served by an elevator car. Each elevator car of a bank of elevator cars would have its own group of hall lanterns associated with the hoistway in which the car operates and with the specific floors served by the car. The bottom floor served by a car would only have an up hall lantern, the top floor served by a car would only have a down hall lantern, while the intermediate floors would have both up and down hall lanterns. An audible signal, such as a gong, is usually provided at each landing for each car serving the landing, which signal is initiated when its associated hall lantern, up or down, is energized, to draw prospective passengers' attention to the location of the arriving car and its service direction.

The incandescent type of lamp conventionally used in the hall lantern circuits, draws a heavy initial current when energized which is many times its normal operating current. This large inrush current is due to the cold filament of the lamp, which has a lower resistance than the resistance of a filament which has reached its normal elevated operating temperature. The cost of semiconductor switching devices increases with the current rating of the device, and thus the cost of solid state or semiconductor switching devices required to carry the heavy inrush current of a lamp would be substantially greater than the cost of solid state devices selected on the basis of carrying only the normal operating current of a lamp.

Another problem in applying solid state drivers to lamp circuits is the possibility of lamp failure in a shorted mode, which would cause short circuit currents capable of quickly destroying solid state switching devices, even if they were selected on the basis of handling the high inrush current of a lamp.

Providing a solid state driver for each hall lantern is also quite costly in a tall building having a bank of elevator cars, since each driver would require several semiconductor switching devices, such as transistors, along with the necessary biasing resistors, rectifier diodes, and logic elements for turning the lamps on and off in synchronism with the elevator car and its stops.

In addition to the hall lanterns, each car includes a plurality of relatively small lamps associated with a car position indicator. The car position indicator lights a lamp associated with the floor of the advanced car position of the elevator car. When a car is stationary, the advanced car position is the floor at which the car is standing. When a car is moving, the advanced car position is that floor at which the car could make a normal stop according to a predetermined deceleration schedule. The car position indicator is conventionally operated from contacts disposed on the electromechanical floor selector. It would be desirable to provide solid state driver circuits for these lamps which are driven by signals from a solid state floor selector. However, the short circuit problem of the hall lantern circuits just described would also be applicable here, as would be the economic problem of requiring a large number of driver circuits for a car which serves a large plurality of floors.

The hall lantern arrangement 70 solves the current inrush problem, enabling each solid state driver circuit to utilize solid state switching devices selected such that they will be subjected to a limited value of inrush current. Current limited power supply means is provided which enables each solid state switching device to operate in a saturated mode when conducting normal lamp current. The current limited power supply protects each drive circuit from excessive currents, both inrush and short circuit. Thus, smaller, less costly solid state switching devices may be employed in the driver circuits.

Arrangement 70 also includes short circuit detection means which quickly removes a shorted load from the current limited power supply, preventing destruction of the switching devices in the power supply.

Arrangement 70 shown in FIG. 3 substantially reduces the number of solid state drive circuits required to drive a given number of hall lanterns, by utilizing a matrix arrangement which includes a plurality of solid state row and column drivers. The binary advanced car position signal AVP0 through AVP6 is utilized to selectively energize a predetermined row and a predetermined column, energizing a lamp-diode circuit connected between the energized row and column. Thus, for example, an 8 by 8 matrix utilizing only 16 drivers will selectively energize 64 lamps, a saving of 48 solid state drivers, as well as a concomitant reduction in the number of external connections to the hall lantern circuit boards.

A matrix arrangement is used for the car position lamps associated with the car position indicator, as well as any other car position lamps, such as those which might be utilized above the car door at the main floor of the building, and those utilized in a traffic director station. The matrix for the car position indicator may be separate from the matrix used for the hall lanterns. However, in certain applications it will be advantageous to combine them, as the same column drivers and conductors may be used for both functions. With a matrix having 8 columns, for example, 8 car position lamps may be selectively energized for each car position row driver added to the matrix of the hall lanterns.

More specifically, the block diagram of FIG. 3 illustrates a new and improved hall lantern and car position arrangement 70, which includes a new and improved hall lantern and car position matrix 72 having a predetermined number of rows, each driven by a solid state row driver circuit, collectively shown generally at 74, and a predetermined number of columns, each driven by a solid state column driver circuit collectively shown generally at 76.

A new and improved power supply 78 provides a current limited drive voltage for the row drivers 74. As illustrated in FIG. 3, the power supply **78** is connected to a source of unidirectional potential, indicated generally by terminal **80.** The proper row driver is selected by a combination of signals which include position sector signals PSECO, PSEC1, PSEC2 and PSEC3, the sixth bit AVP5 or AVP5 of signal AVP0-AVP6, and the up and down hall lantern enable signals HLU and HLD, respectively. The position sector signals PSEC0-PSEC3 are provided by decoder **82,** which decodes the fourth and fifth bits AVP3 and AVP4 of signal AVP0-AVP6.

Short circuit protection for the current limited power supply **78** is provided by a protective or current limit delay circuit **84.** When the predetermined current limit is exceeded, power supply **78** provides a current limit indication signal which starts a timing circuit in the current limit delay circuit **84.** The timing circuit is clocked by timing signals S2S, and it delays shutdown of the current limited power supply **78** for a time sufficient for a lamp filament to reach operating temperature and its current to settle to its normal operating current. If the current limit indication persists beyond the time required for the lamp current to settle to its normal value, the current limit delay provides a current source shutdown signal. The shutdown signal is applied to the power supply **78** to remove the drive from the power supply and reduce dissipation in the solid state circuits to zero. The shutdown signal is also applied to a driver inhibit circuit **86** which in turn provides a row driver inhibit signal. The row driver inhibit signal removes all loading from the power supply **78,** which removes the current limit indication signal and allows the power supply **78** to return to normal operation. When the elevator car moves to another floor, signal $\overline{PCR}$ resets the driver inhibit circuit **86** and removes the row driver inhibit signal from the decoder **82.** Thus, a short circuit associated with a lamp circuit only disables the power supply **78** for the specific lamp circuit involved, automatically returning the power supply **78** and row drivers **74** to normal operation when the elevator car moves to a floor having a non-shorted hall lantern circuit.

The column drivers **76** are driven by a decoder **88** which drives the proper column driver in response to a column enable signal, which is the seventh bit AVP6 or $\overline{AVP6}$ of signal AVP0-AVP6, and the three least significant bits AVP0, AVP1 and AVP2 of signal AVP0-AVP6.

FIGS. 4A and 4B

FIGS. **4A** and **4B** may be assembled to provide a schematic diagram of a new and improved hall lantern and car position indicator arrangements which may be used to provide the functions of the block arrangement **70** illustrated in FIG. **3.** Like reference numerals in FIGS. **3, 4A** and **4B** indicate like functions.

The hall lantern and car position matrix **72** shown in FIG. **4B** has been selected, for purposes of example, to illustrate **16** floors, but any number, up to **128** floors may be accomodated by extending the matrix, as will be hereinafter described.

Matrix **72** includes first and second sets of conductors, with the first set being referred to as row conductors and the second set as column conductors. However, it is to be understood that the functions of the row and column conductors could be interchanged. Matrix **72** includes **8** columns, represented by conductors **90,** 92, 94, 96, 98, 100, 102 and **104,** and **6** rows, represented by conductors **106, 108, 110, 112, 114** and **116.** All of the rows may be associated with drivers for up or down hall lanterns, if desired, but the hall lantern matrix provides an economical arrangement for obtaining an indication of the advanced car position for use, by a car position indicator. A car position indicator is provided in each car. Additionally a matrix similar to matrix **72,** except directed entirely to the function of providing car position, may be used to provide a car position indicator for any other location, such as above the car door at the main floor, and/or at a traffic director station. Thus, matrix **72** combines the hall lantern function with the car position function to illustrate how the car position function may be easily added to the hall lantern function, and to illustrate how either may be used alone in a matrix.

Rows **106** and **108** are associated with the down hall lanterns, disposed at all floors for a specific car, except for the lowest floor served by the car, rows **110** and **112** are associated with up hall lanterns, disposed at all floors for a specific car, except the uppermost floor served by the car, and rows **114** and **116** are associated with car position lamps, which are disposed, for example, within the cab of the elevator car.

Row **106** and the seven columns **92, 94, 96, 98, 100,** 102 and **104** are associated with down hall lanterns for floors **1** through **7,** and row **106** and the eight columns **90, 92, 94, 96, 98, 100, 102** and **104** are associated with down hall lanterns for floors **8** through **15.** The uppermost floor served by the associated elevator car is floor **15,** and thus floor **15** has a single hall lantern, i.e., a hall lantern for signaling the arrival of the advanced car position of the elevator car at the floor for down service. The down hall lantern for floor **15** requires a lamp **120,** a diode **122,** and a gong **124** or other suitable audible indicator, which devices are serially connected between row **108** and column **104.** The diode **122** is poled to conduct current through the lamp **120** and gong **124** from the row to the column, with the diode being necessary to prevent "back paths" and thus false operation of other hall lamps and gongs. Lampdiode-gong arrangements for down hall lanterns, similar to the arrangement for the 15th floor, may be connected from each of the two rows **106** and **108** to each column, except from row **106** to column **90,** since there will be no down hall lantern for the lowest floor served by the car. However, the floors which have both an up hall lantern and a down hall lantern preferably utilize a common gong or audible signal. Thus, the down hall lantern for the first floor may utilize a diode **126,** a lamp **128,** and a gong **130,** serially connected from row **106** to column **92,** and the up hall lantern for the first floor may utilize the same gong, as will be hereinafter explained. The remaining down hall lanterns, along with the diodes and gongs are not illustrated in FIG. **4B,** since it will now be apparent how they would be connected in the matrix **72.**

Rows **110** and the eight columns **90, 92, 94, 96, 98,** 100, 102 and **104** are associated with up hall lanterns for floors **0** through **7,** and row **112** and the seven columns **90, 92, 94, 96, 98, 100** and **102** are associated with up hall lanterns for floors **8** through **14.** The bottom floor served by the elevator car is floor zero, and thus floor zero has a single hall lantern, i.e., a hall lantern for signaling the arrival of the advanced car position of the elevator car at floor zero for up service. The up hall lantern for floor zero requires a lamp **132**, a diode **134**, and a gong **136**, which are serially connected from row **110** to column **90**. The up hall lantern for the first floor may utilize the gong **130** of the first floor, which has already been described relative to the down hall lantern for the first floor, by serially connecting a diode **138** and a lamp **140** from row **110** to the side of gong **130** which is not directly connected to column **92**.

Car position lamps for the advanced car position indicator mounted in the car, or elsewhere, may be easily provided by utilizing the two rows **114** and **116** to indicate car position. No additional column conductors and column drivers are necessary. For example, a lamp **142** and a diode **144** may be serially connected from row **114** to column **90**, to indicate an advanced car position at floor zero, and a lamp **146** and a diode **148** may be serially connected from row **116** to column **90** indicate an advanced car position at the eighth floor. A similar diode-lamp combination would be connected from each of the rows **114** and **116** to each of the remaining columns to complete the car position indicator.

A selected lamp is energized by connecting the associated row to a source of unidirectional potential, and the associated column to ground, establishing a current path from the row, through the associated diode and lamp, and also the gong if the lamp is associated with a hall lantern.

The rows and columns are selected by energizing a row driver and a column driver, which will then energize one of the up or down hall lanterns, depending upon whether the up or down hall lanterns are enabled, and a car position lamp. The car position lamps are enabled for both the up and down hall lanterns.

Row drivers A through F are associated with rows **106, 108, 110, 112, 114** and **116**, respectively, and column drivers A through H are associated with columns **90, 92, 94, 96, 98, 100, 102** and **104**, respectively. Since the row drivers are similar in construction, only row driver F is shown in detail, and since the column drivers are similar in construction, only column driver A is shown in detail.

More specifically, row driver F includes a three input NAND gate **160**, an inverter or NOT gate **162**, first, second and third solid state switching devices **164, 166**, and **168**, respectively, such as transistors, rectifier diodes **170**, **172** and **174**, and resistors **176, 178, 180**, 182, 184, 186 and **188**. NAND gate **160** has three input terminals A, B and C, with input terminal A being permanently enabled for car position row driver F by connecting it to a source of unidirectional potential, represented by terminal **190**, via resistor **176**. This input terminal A for the up and down lantern row drivers is connected to receive the up and down hall lantern enable signals HLU and HLD, respectively, which are received at input terminals **192** and **194** from the call selector of the floor selector of the associated elevator car, as disclosed in the first and second incorporated applications. Signal HLU or HLD is provided when the car is going to stop at a predetermined floor and is enabled for up or down calls, respectively. Once initiated, the signal persists until the car stops at the floor, opens its door, and the door open time expires.

Input terminal B of row driver F is connected to position sector signal PSEC1 which, as illustrated in FIG. **2**, enables row driver F for floors **8** through **15**. Row drivers B and D, which are also associated with floors **8–15** have the B inputs of their associated NAND gates connected to row enable signal PSEC1. Row enable signal PSEC0, which, as illustrated in FIG. **2**, enables floors **0** through **7**, is connected to the B input terminal of row drivers A, C and E. Position sector signals PSEC2 and PSEC3 are not used in this embodiment, since they enable floors having a higher number than the number of floors of the building used in the example of the present embodiment. For example, if a building had 32 floors numbered 0 through 31, signal PSEC2 would enable floors **16–23** and signal PSEC3 would enable floors **24–31**.

The position sector decoding function **82** provides the position sector signals PSEC0, PSEC1, PSEC2 and PSEC3 by decoding the fourth and fifth bits AVP3 and AVP4 of the advanced car position signal AVP0-AVP6, such as by using four AND gates **191, 193, 195** and **197**, and four inverter or NOT gates **199, 201, 203** and **205**. The fourth bit AVP3 is connected to inputs of AND gates **193** and **197** via inverters **199** and **201**, and the junction of inverters **199** and **201**, which is bit $\overline{\text{AVP3}}$, is connected to inputs of AND gates **191** and **195**. The fifth bit AVP4 is connected to inputs of AND gates **195** and **197** via inverters **203** and **205** and the junction of these inverters, which is bit $\overline{\text{AVP4}}$, is connected to inputs of AND gates **191** and **193**. Thus, when $\overline{\text{AVP3}}$ and $\overline{\text{AVP4}}$ are both high, which occurs when the advanced car position is at a floor in the group of floors **0** through **7**, signal PSEC0 will high or true. Signal PSEC1 will be true when AVP3 and $\overline{\text{AVP4}}$ and both high, which occurs when the advanced car position is at a floor in the group of floors **8** through **15**. Signal PSEC2 will be true when $\overline{\text{AVP3}}$ and AVP4 are both true, which occurs for floors **16–23**. Signal PSEC3 will be true when AVP3 and AVP4 are both high, which occurs for floors **24-31**. The sector signals then repeat for floors higher than **32** floors, in the same order as hereinbefore described.

The output of NAND gate **160** is connected to the input of inverter **162**, and the output of inverter **162** is connected to input terminal **190** via resistor **178**, and to switching device **164** via diode **170**. Switching device **164** may be an NPN transistor, with the diode **170** connected to its base electrode b and poled to conduct current into the base and switch transistor **164** to its saturated state when the output of inverter **162** is high. The base of transistor **164** is also connected to ground **198** via resistor **180**. The collector electrode c of transistor **164** is connected to an input terminal D via a voltage divider which includes resistors **182** and **184**. Input terminal D of row driver F, as well as this same input terminal of the remaining row drivers is connected to the current limited and short circuit protected power supply **78**, which will be hereinafter described, which power supply limits the amount of current which can be drawn by the switching devices of the row drivers. Thus, the solid state switching devices of the row drivers are selected to withstand the maximum current which will be provided by the power supply **78**, and need not be selected to take the normal high inrush current of a cold lamp. The solid state switching devices of the row drivers may thus be selected with a lower current rating than they would if the power supply was not current limited, since they can operate in a saturated mode when conducting. The solid state switching devices are also protected in the event of a shorted load because dissipation is limited. As will be hereinafter explained, the current limited power supply **78** is shut down if the maximum current provided by the power supply persists for a predetermined period of time beyond the time required for a lamp filament to reach its normal operating temperature and the current drawn by the lamp to settle to the normal value, in order to protect the solid state switching devices of the power supply **78**. The emitter electrode e of transistor **164** is connected to ground **198**, and to the anode electrode a of diode **172**.

Solid state switching device **166**, which may be a PNP transistor, has its base electrode *b* connected to the junction **200** between resistors **182** and **184**. Its emitter electrode *e* is connected to input terminal D, and its collector electrode *c* is connected to the cathode electrode *c* of diode **172** and to output terminal E, via resistor **186**. Thus, when transistor **164** turns on, it provides base drive for transistor **166**, switching it to its saturated condition. The collector electrode *c* of transistor **166** is also connected to switching device **168**, which may be an NPN transistor, wherein the base electrode *b* of transistor **168** is connected to the collector electrode *c* of transistor **166**. The collector electrode c of transistor **168** is connected to input terminal D via resistor **188**, and its emitter electrode e is connected to output terminal E. Output terminal E is also connected to a source of unidirectional potential, indicated by terminal **202**, via diode **174**, which has its anode electrode a connected to output terminal E. This clamps the output voltage at output terminal E to a maximum level set by the voltage connected to the terminal **202**. When transistor **166** conducts, it provides base drive for transistor **168**, causing it to saturate and connect input terminal D to output terminal E. Output terminal E is connected to row conductor 116 of matrix **72**.

In the operation of row driver F, when any input to NAND gate **160** is low, the output of NAND gate **160** is high, which is inverted to logic zero by inverter **162**, causing transistor **164** to be in its non-conductive state. When transistor **164** is non-conductive, transistors **166** and **168** are also non-conductive, and row **116** of matrix **72** is not energized. If all inputs to NAND gate **160** are high, the output of NAND gate **160** is driven low, and inverter **162** then provides a logic one output turning on transistors **164**, **166** and **168**, and connecting row conductor **116** of matrix **72** to the output of the current limited power supply **78**.

When one of the row drivers is turned on to energize a row of the matrix, one of the column drivers will also be turned on to connect a predetermined column to ground and thus energize the lamp connected from the energized row to the grounded column. A specific row driver is enabled by decoder **88** which decodes the three LSB of the advanced car position signal, i.e., **AVP0**, **AVP1** and **AVP2**. A low **AVP6** bit enables the decoder, which thus enables decoder **88** for floors **0–63**. Bit $\overline{\textbf{AVP6}}$ is used for floors **64–127**, as will be observed when describing another embodiment of the invention. Decoder **88**, which for example may be Texas Instrument's **3** to **8** line decoder **SN 74155**, has a different low output for the **8** possible combinations of the three LSB of the advanced car position signal **AVP-0–AVP6**. When the advanced car position is at floor zero or floor **8**, output conductor **210** of decoder **88** which is connected to column driver A will be low, while the other output lines of decoder **88** will be high. Thus, the lamps associated with floor zero or floor **8** will be energized, depending upon which row is energized. In like manner, when the advanced car position is at floors **1** or **9**, conductor **212** connected to column driver B is driven low; when the advanced car position is at floors **2** or **10** conductor **214** connected to column driver C is driven low; when the advanced car position is at floors **3** or **11** conductor **216** connected to column driver D is driven low; when the advanced car position is at floors **4** or **12** conductor **218** connected to column driver E is driven low; when the advanced car position is at floors **5** or **13** conductor **220** connected to column driver F is driven low; when the advanced car position is at floors **6** or **14** conductor **222** connected to column driver G is driven low; and, when the advanced car position is at floors **7** or **15** conductor **224** connected to column driver H is driven low.

The column drivers are all similar, and may be constructed as illustrated for column driver A shown in FIG. **4B**. Column driver A includes an inverter or NOT gate **230**, rectifier diodes **232**, **234**, and **236**, solid state switching devices **238** and **240**, such as NPN transistors, and resistors **242**, **244**, **246** and **248**. The decoder **88** is connected to the input of inverter **230** via conductor **210**, and the output of inverter **230** is connected to the base electrode b of transistor **238** via diode **232** which is poled to conduct current into the base. A source of unidirectional potential is also connected to the base electrode b of transistor **238** via resistor **242** and diodes **232**, with the source of unidirectional potential being represented generally by terminal **250**. The base electrode b of transistor **238** is connected to ground **252** via serially connected resistors **244** and **246**. The collector electrode c of transistor **238** is connected to output terminal F and thus to column conductor **90** of the matrix **72**, and its emitter electrode e is connected to the junction between resistors **244** and **246**, which junction is also connected to the base electrode b of transistor **240**. The collector electrode c of transistor **240** is connected to output terminal F via resistor **248**, and its emitter electrode e is connected to ground **252**. Diode **234** has its cathode and anode electrodes connected to ouput terminal F and ground **252**, respectively, and diode **236** has its cathode electrode c and anode electrode a connected to a source of unidirectional potential, represented by terminal **254**, and output terminal F, respectively. Diode **236** provides a clamp on the maximum voltage to which column **90** may rise.

In the operation of column driver A, when the output of decoder **88** connected to line **210** goes low, the inverter **230** provides base drive for transistor **238**, turning it on, which then provides base drive for transistor **240**, turning it on. Column conductor **90** of matrix **72** is thus connected to ground **252** via resistor **248** and transistor **240**. When the output from the decoder **88** to a column driver is high, the inverter provides a logic zero level to the base of transistor **238**, turning it off, which in turn turns transistor **240** off, and the associated column of the matrix is isolated from ground.

As hereinbefore stated, the power supply **78** connected to the row drivers is limited as to the maximum current that it will supply, providing a limited inrush current through the transistors of the row and column drivers. Thus, the transistors, or any other solid state switching devices in the row and column drivers may be selected on this basis, substantially reducing the cost of these devices. The solid state switching devices in the current limited power supply 78 are selected to have substantial dissipation capabilities since the voltage drop across them is quite high during the current inrush when a lamp is energized. However, economies are effected even in the selection of these solid state switching devices, as they need not be selected on the basis of continuously providing current for a shorted load. The power supply 78 is automatically shut down when a predetermined magnitude of load current persists for a predetermined period of time.

More specifically, the current limit and short circuit protection functions are performed by the power supply 78, a current limit delay circuit 84, and a driver inhibit circuit 86. The power supply 78 includes solid state switching devices 260, 262, 264, 266, 268 and 270, such as transistors, an inverter or NOT gate 272, voltage regulating diodes 274 and 276, such as ZENER diodes, rectifier diodes 278, 280 and 282, and resistors 284, 286, 288, 290, 292, 294, 296 and 298.

Transistors 260 and 262, which may be PNP and NPN transistors, respectively, are interconnected between a source of unidirectional potential, represented by terminal 80, and an output terminal BP. The base of transistor 260 is connected to terminal 80 via resistors 284 and 288, and the base is also connected to terminal 80 via Zener diode 274. The emitter electrode e of transistor 260 is connected to terminal 80 via resistor 288, and its collector electrode c is directly connected to the base electrode of transistor 262, and to the emitter electrode e of transistor 262 via bias resistor 286. The Zener diode 274 is selected, along with the value of resistor 288, to provide a predetermined maximum current output from this pair of transistors to terminal BP. In other words, the Zener diode 274 limits the base drive voltage which may be applied to transistor 260. The collector electrode c of transistor 262 is connected to terminal 80 via resistors 290 and 288, and its emitter electrode e is connected to output terminal BP.

Transistors 264 and 266, which may be PNP and NPN transistors, respectively, are interconnected between the source potential 80 and output terminal BP in the same manner as transistors 260 and 262, with the base drive to transistor 264 also being limited by the voltage across Zener diode 274. Using a 1N959 Zener for Zener diode 274 and about 20 ohms resistance for each of the resistors 288 and 296 in the emitter circuits of transistors 260 and 264, will cause the maximum current passed by each pair of transistors to output terminal BP to be about 375 mA. Other Zener diode ratings and resistor values may of course be chosen to obtain other maximum currents, as desired.

The short circuit protection function of power supply 78 includes transistors 268 and 270. Transistor 268, which may be an NPN transistor, has its collector electrode c connected to the Zener diode 274 via resistor 304, its emitter electrode e is connected to ground 312, and its base electrode b is connected to receive a signal from current limit delay circuit 84 via inverter 272 and a diode 278. Inverter 272 is connected between an input terminal 313 and the anode electrode a of diode 278. The cathode electrode c of diode 278 is connected to the base of transistor 268. The anode of diode 278 is connected to a source of unidirectional potential, represented by terminal 314, via resistor 300. The base electrode b of transistor 268 is also connected to ground 312 via bias resistor 302.

Transistor 270, which may be an NPN transistor, has its base electrode b connected to ground 312 via resistor 308, and also to the emitter electrode e of transistor 266 via diode 282, Zener diode 276 and diode 280. The cathode of diode 282 is connected to the base electrode b of transistor 270, the anode of diode 282 is connected to the anode of Zener diode 276, the cathode of Zener diode 276 is connected to the anode of diode 280, and the cathode of diode 280 is connected to the emitter of transistor 266. The junction between Zener diode 276 and diode 280 is connected to terminal 80 via resistor 306. The collector electrode c of transistor 270 is connected to a source of unidirectional potential, represented by terminal 316, via resistor 310, and also to the output terminal 318, which provides a signal for the current limit delay circuit 84. The emitter electrode e of transistor 270 is connected to ground 312.

As long as the signal from the current limit delay circuit 84, which is applied to input terminal 313 of power supply 78 is a logic zero, the output of inverter 272 will be high and transistor 268 will be turned on, connecting the Zener diode 274 to ground 312 via resistor 304, and allowing the power supply 78 to operate normally. When the power supply 78 is operating with a normal load current, the transistors which supply current to the output terminal BP are saturated and have a low dissipation. The Zener diode 276 is selected such that the voltage at the emitters of transistors 262 and 266, when they are supplying normal load current, is high enough to exceed the breakdown voltage of the Zener and transistor 270 is turned on, providing a logic zero signal at output terminal 318. During lamp turn on, and under short circuit conditions, the transistors supplying current to the output terminal BP are forced out of saturation and their dissipation increases, dropping the voltage at the emitter electrodes of transistors 262 and 266 below the breakdown voltage of Zener diode 276. Transistor 270 thus turns off and the signal at output terminal 318 goes to a logic one, indicating a current limit condition. Current limit delay circuit 84 receives this current limit indication signal and distinguishes between the normal current inrush during turn on of a lamp, from a short circuit condition, by timing the duration of the current limit signal. If the high current indication signal ceases before circuit 84 times out, no protective action is taken by circuit 84. If the high current indication signal for power supply 78 continues until circuit 84 times out, circuit 84 provides a logic one signal to the input of inverter 272 of power supply 78, turning transistor 268 off and shutting down the power supply 78.

Delay circuit 84 also removes the shorted load from the power supply 78 by providing a signal for driver inhibit circuit 86 which in turn provides driver inhibit signals for the position sector decoding circuit 82, removing the row enable signals from the row drivers. Removing the shorted load from the power supply 78 enables the power supply 78 to be returned to normal status to await a change in car position to another floor, which presumably will not have a shorted lamp circuit associated with it. A change in the advanced car position of the elevator car resets the driver inhibit circuit 86 to reenable the correct row drivers with the position sector signals.

A current limit delay circuit for providing the delay function **84** shown in FIG. **3** is illustrated in FIG. 4A. Delay circuit **84** includes a time delay device **330**, such as Texas Instruments retriggerable monostable multivibrator SN **74122**, NAND gates **332, 334, 336** and **338**, a flip-flop **340**, which may be of the cross coupled NAND gate type, having NAND gates **342** and **344**, inverter or NOT gates **346** and **348**, a source of unidirectional potential represented by terminal **350**, a resistor **352**, and a capacitor **354**. Terminal **350**, resistor **352** and capacitor **354** are connected to device **330** to establish the required time delay. A lamp filament will heat up and settle to its steady state current in less than 200 ms. Thus, the delay device and its external timing capacitor and resistor may be selected to provide a delay of 200 ms. before it times out. Its output terminal $\overline{Q}$ is held low as long as device **330** does not time out. If the current limit signal persists for longer than **200** ms., $\overline{Q}$ goes high.

NAND gate **332** has an input connected terminal **318** of power supply **78** via inverter **346**, an input connected to the output of NAND gate **344**, which will be called the $\overline{B}$ output of flip-flop **340**, and an input connected to clock S2S. Clock S2S is shown in FIG. 12A of the second incorporated application. The output of NAND gate **332** is connected to the A1 input of device **330**.

NAND gate **334** has an input connected to receive clock signal S2S, an input connected to the B output of flip-flop **340**, and its output is connected to the A2 input of delay device **330**.

NAND gate **336** has an input connected to the $\overline{B}$ output of flip-flop **340**, and input connected to output terminal **318** of power supply **78**, and an input connected to the $\overline{Q}$ output of delay device **330**. Its output is connected to the set input of flip-flop **340**, i.e., to an input of NAND gate **342**.

NAND gate **338** has an input connected to terminal **318** of power supply **78** via inverter **348**, an input connected to the B output of flip-flop **340**, and its output is connected to the reset input of flip-flop **344**, i.e., an input of NAND gate **344**.

The B output of flip-flop **340** is additionally connected to input terminal **313** of power supply **78**, and its $\overline{B}$ output is additionally connected to the driver inhibit circuit **86**.

The driver inhibit circuit **86** includes a flip-flop **360** which may be of the cross coupled NAND gate type, having NAND gates **362** and **364**, and inverter or NOT gates **366** and **368**. The set input to flip-flop **360**, i.e., an input of NAND gate **362**, is connected to the $\overline{B}$ output of flip-flop **340** of the delay circuit **84**, and the reset input of flip-flop **360**, i.e., an input of NAND gate **364**, is connected to receive signal $\overline{PCR}$. Signal $\overline{PCR}$ goes low each time the advanced car position signal AVP0-AVP6 changes floor numbers, with the development of signal $\overline{PCR}$ being illustrated in the first incorporated application. The set output of flip-flop **360**, i.e., the output of NAND gate **362**, is connected to the AVP4 inputs of AND gates **195** and **197** via inverter **366**, and to the $\overline{AVP4}$ inputs to AND gates **191** and **193** via inverter **368**. Thus, when flip-flop **360** is reset, the driver inhibit output signals from inverters **366** and **368** are at the logic one level and have no circuit effect. When flip-flop **360** is set, however, all the AND gates **191**, 193, 195 and **197** are inhibited and thus all row drivers are inhibited.

The operation of the current limited power supply **78**, delay circuit **84**, and driver inhibit circuit **86** will now be described. When a row driver and column driver are energized to provided voltage for operating a hall lantern and a car position lamp, if car position lamps are included in the matrix, the normal inrush to the lamps is limited by action of Zener diode **274** in the power supply **78**, but the inrush drives transistors **262** and **266** out of saturation to drop the voltage at their emitter electrodes below the breakdown voltage of Zener diode **276**. Transistor **270** thus cuts off and terminal **318** goes to logic one. The output of NAND gate **332**, which was switching high and low at the rate of clock signal S2S is now held high by virtue of inverter **346** which now applies a logic zero to an input of NAND gate **332**. The $\overline{B}$ output of flip-flop **340** is high at this time. The high output of NAND gate **332** starts the timing interval of delay device **330**, such as the hereinbefore mentioned 200 ms. If the high current indication was due to a normal current inrush of a cold lamp, the current settles to a value, before delay device **330** times out, which will raise the voltage at the emitter electrodes of transistors **262** and **266** above the breakdown voltage of Zener diode **276**, turning transistor **270** on, and applying a logic zero signal to inverter **346** which in turn applies a logic one to the input of NAND gate **332**, and NAND gate **332** once again starts switching at the clock rate to prevent delay device **330** from timing out. Therefore, the high current indication at terminal **318** does not result in any protective action being taken by the current limit delay circuit **84**, as long as the high current indication disappears before the delay device **330** times out.

Now assume that a connected lamp filament fails in a shorted mode, or the energized lamp circuit is otherwise shorted. The high current indication at output terminal **318** remains high, causing delay device **330** to time out, and the $\overline{Q}$ output, which had been held low, goes high. All inputs to NAND gate **336** are now high, the output of NAND gate **336** goes low and flip-flop **340** is set, changing its B output to a logic one and its $\overline{B}$ output to logic zero. The B output of flip-flop **340** applied to input terminal **313** of inverter **272** turns transistor **268** off and shuts down the power supply **78**. The high B input to NAND gate **334** switches the output of NAND gate **334** at the clock rate to hold $\overline{Q}$ high. The $\overline{B}$ output of flip-flop **340** goes low, setting the flip-flop **360** in the driver inhibit circuit **86**, providing a logic one input to inverters **366** and **368**, which thus provides logic zero inputs to all of the AND gates of position sector decoder **82**. All of the row drivers are thus disabled, disconnecting the shorted load from the power supply **78**. As soon as the shorted load is disconnected from the power supply **78**, the voltage across Zener diode **276** exceeds its breakdown voltage rating due to its connection to terminal **80** via resistor **306**. When Zener diode **276** breaks down, base drive is provided for transistor **270** and the current limit signal goes to logic zero. When terminal **318** goes low, NAND gate **338** switches its output to logic zero resetting flip-flop **340**. Signal B goes low to turn on transistor **268** and start up the power supply **78**. Signal $\overline{B}$ goes high to enable flip-flop **360** and also enable NAND gate **332** which starts switching its output at the clock rate returning $\overline{Q}$ to logic zero. The power supply **78** is thus placed back into operation, but at this point there is no load connected to it. When the elevator car changes its advanced car position, signal $\overline{PCR}$ goes low to reset flip-flop **360**, removing the inhibits from the AND gates in decoder **82**. Thus, the complete circuit is returned to normal when the advanced car position of the elevator car is changed.

FIG. 5

FIG. **5** is a partially schematic and partially block diagram of a new and improved matrix **380** which illustrates how the matrix **72** shown in FIG. **4B** may be extended to a structure having up to **128** floors when used only for up and down hall lanterns, or proportionately less when used in combination with a car position indicator. Like reference numerals in FIGS. **4A**, **4B** and **5** indicate like components.

As illustrated in FIG. **5**, a hall lantern matrix for **31** floors may be constructed by adding two additional row conductors **382** and **384** to the matrix shown in FIG. 4B, and two additional row drivers G and H. Rows **106**, 108, 110 and **112** would accomodate down hall lanterns for floors **1–7**, **8–15**, **16–23** and **24–31**, respectively, while rows **114**, **116**, **382** and **384** would accomodate up hall lanterns for floors **0–7**, **8–15**, **16–23** and **24–30**, respectively. Row drivers A and E would be enabled by position sector signal **PSEC0**, row drivers B and F by signal **PSEC1**, row drivers C and G by signal **PSEC2**, and row drivers D and H by signal **PSEC3**. No change would be required in the column driver portion of the circuit.

The matrix may be extended to **64** floor capability by adding **8** additional row drivers A′ through H′ and associated row conductors **106′**, **108′**, **110′**, **112′**, **114′**, **116′**, **382′**, and **384′**. No additional column conductors or column drivers are required to extend the matrix to **64** floors. The position sector signals are connected to the same row drivers as hereinbefore described. The only change required is to enable row drivers A′ through H′ with AVP5 instead of $\overline{\text{AVP5}}$. It will be noted from FIG. **2** that $\overline{\text{AVP5}}$ will enable floors **0–31**, while AVP5 will enable floors **32–63**.

The number of floors which may be accomodated may be extended from **64** up to **128** by adding eight additional column drivers A′ through H′, and a decoder **88′**. No additional row drivers would be required to extend the matrix from **64** floors to **128** floors. The only change required in the column driver circuitry is to enable the decoder **88′** with $\overline{\text{AVP6}}$ instead of AVP6. It will be noted from FIG. **2** that AVP6 is in only two states for **128** floors, and thus may be conveniently used to switch from one set of column drivers to the other when the advanced car position changes from floor **63** to floor **64**. The position sector signals also repeat to automatically enable the proper row regardless of which set of column drivers are operative. For example, signal **PSEC0**, in addition to enabling floors **0–7**, also enables floors **64–71** associated with the same row **106** of the matrix. Thus, all of the **7** bits of the advanced car position signal AVP0-AVP6 are utilized to selectively enable the correct row and column of a matrix to light a lamp associated with the advanced car position of the elevator car.

In summary, there has been disclosed a new and improved elevator system which includes hall lantern apparatus constructed and arranged to enable solid state switching devices to be economically used in a current limited and protected manner which assures long operating life. A power supply for the hall lamps is provided which limits current inrush to the lamps, permitting the solid state switching devices in the lamp driver circuits to be specified with this maximum current in mind. The limited dissipation also protects these devices in the event of a shorted load.

The current limiting solid state switching devices are selected to withstand the current inrush to the lamps, but are protected against supplying short circuit currents for longer than about 200 ms, by shutting down the power supply when the load draws the predetermined maximum current for a period longer than the time required for the inrush lamp current to settle below the predetermined maximum value.

The invention, however, does not disable the complete hall lantern apparatus, but merely shuts down the power supply when it is connected to the specific lantern circuit which contains the short circuit. As soon as the elevator car moves away from the floor associated with the shorted hall lantern, the power supply and driver circuits are returned to normal.

We claim as our invention:

1. An elevator system, comprising: a building having a plurality of floors, an elevator car mounted for movement in said building to

serve the floors, hall lamp means disposed at the least certain of the floors

of the building served by the elevator car, power supply means, driver means responsive to predetermined actions of said

elevator car to selectively connect said hall

lamp means to said power supply means, said power supply means providing electrical current for

the selected hall lamp means, said power supply means including means limiting the current supplied to a selected hall lamp means to a predetermined maximum value which is less than the magnitude of the normal inrush current of said hall lamp means, and greater than the normal operating current of said hall lamp means,

current limit signal means responsive to the current supplied by the power supply means, said current limit signal means providing a current limit signal during the time said power supply means is providing the predetermined maximum value of current to the hall lamp means,

and protective means responsive to said current limit signal, said protective means providing a shutdown signal when the current limit signal persists for a period of time which exceeds the time required for the normal inrush current to said hall lamp means to settle to the normal operating current,

said power supply means including means responsive to said shutdown signal which causes said power supply means to discontinue providing current to said hall lamp means.

2. The elevator system of claim **1** including driver inhibit means, said driver inhibit means being responsive to the shutdown signal to inhibit the driver means and disconnect the selected hall lamp means from the power supply means, and to continue to inhibit the driver means following the termination of the shutdown signal until reset.

3. The elevator system of claim **2** wherein the current limit signal means includes means responsive to the disconnecting of the selected hall lamp means from the power supply means, to terminate the current limit signal, the protective means includes means responsive to the termination of the current limit signal which terminates the shutdown signal, and the power supply means includes means responsive to the termination of the shutdown signal which returns the power supply means to its operative condition.

4. The elevator system of claim 3 including means resetting the driver inhibit means responsive to the elevator car moving from the floor position at which the shutdown signal was initiated, allowing the driver means to again selectively connect hall lamp means to the power supply means.

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