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Dixon, Jr. et al.

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[45] **Nov. 20, 1973**

[54] **ELEVATOR ELECTRONIC POSITION DEVICE**

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[73] Assignee: **Reliance Electric Company,** Cleveland, Ohio

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[21] Appl. No.: **251,793**

[52] **U.S. Cl.** ..... **187/29 R**

[51] **Int. Cl.** **B66b 1/18**

[58] **Field of Search** 187/29; 318/603

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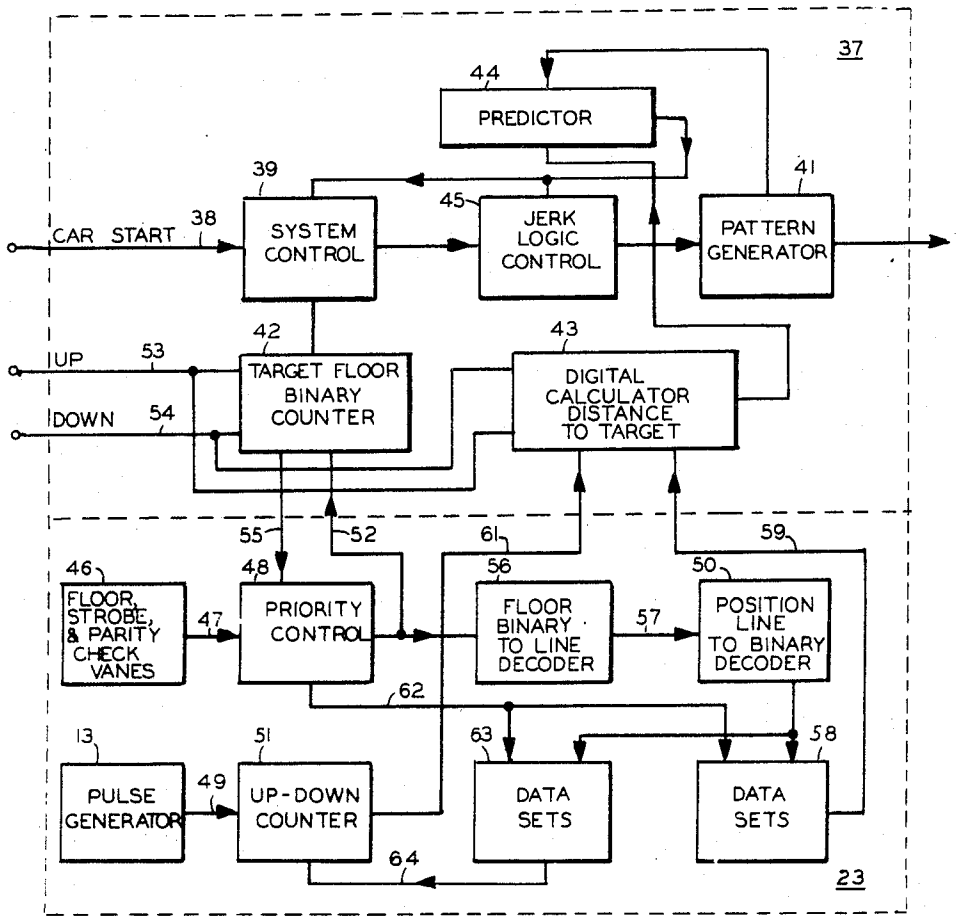
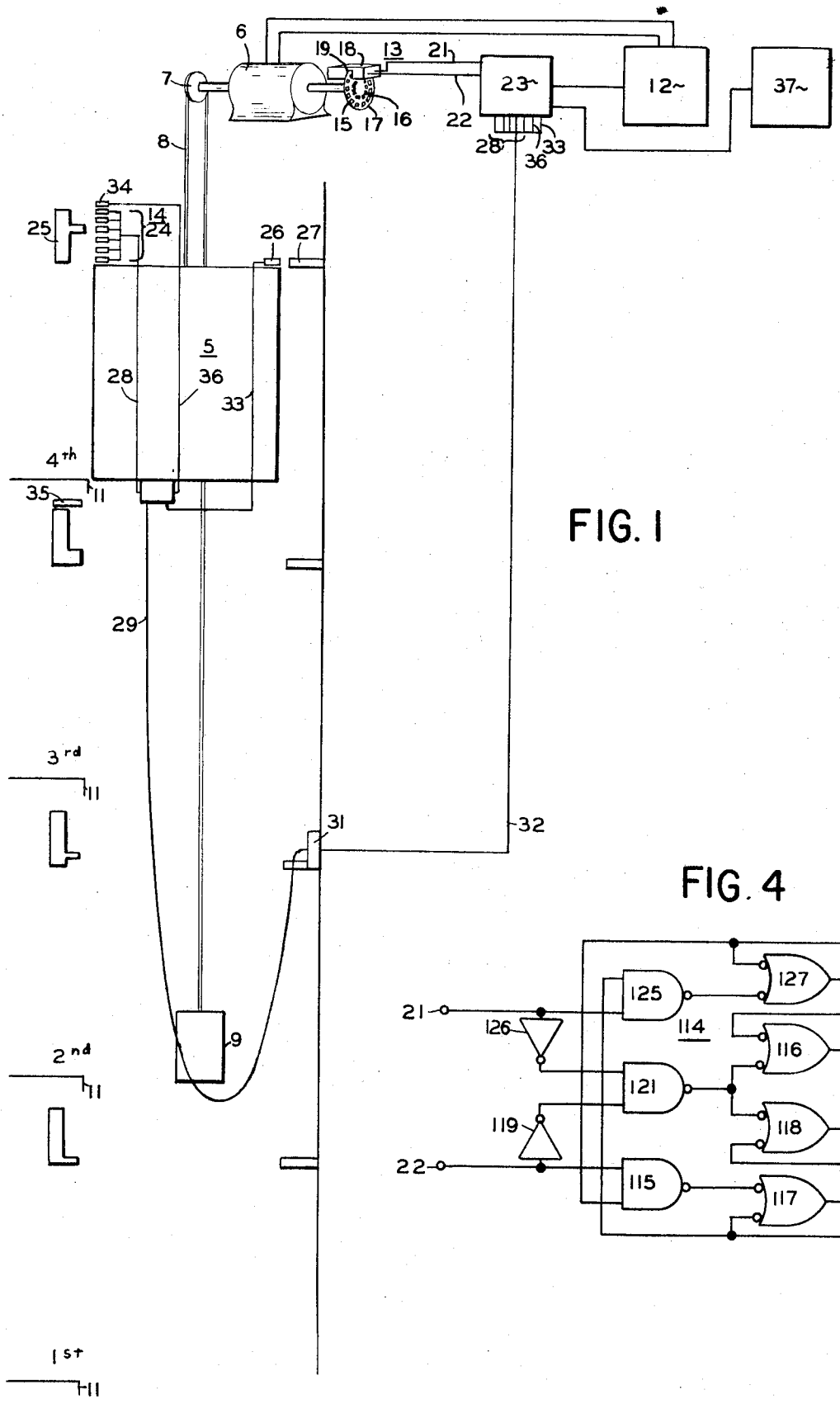
Assistant Examiner—W. E. Duncanson, Jr.
Attorney—Wilson & Fraser

[57] **ABSTRACT**

An electronic (solid state) circuit provides digital signals indicating actual car position during travel, target floor or destination position, and actual floor number position of the car when the car is at rest. Actual car position is provided in 0.01 foot increments as a count from a counter operatively coupled to the car and checked as the car reaches predetermined locations along its travel. Correction means correct any count error when position is checked. Actual floor position is decoded from the count. Advance of the car transfers the target floor at appropriate times. Target floor signals and actual car position signals are maintained mutually exclusive by interlocks to enable common circuits to be employed for both.

20 Claims, 5 Drawing Figures

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4th
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3rd
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32
2nd
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1st
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FIG. 1

FIG. 4

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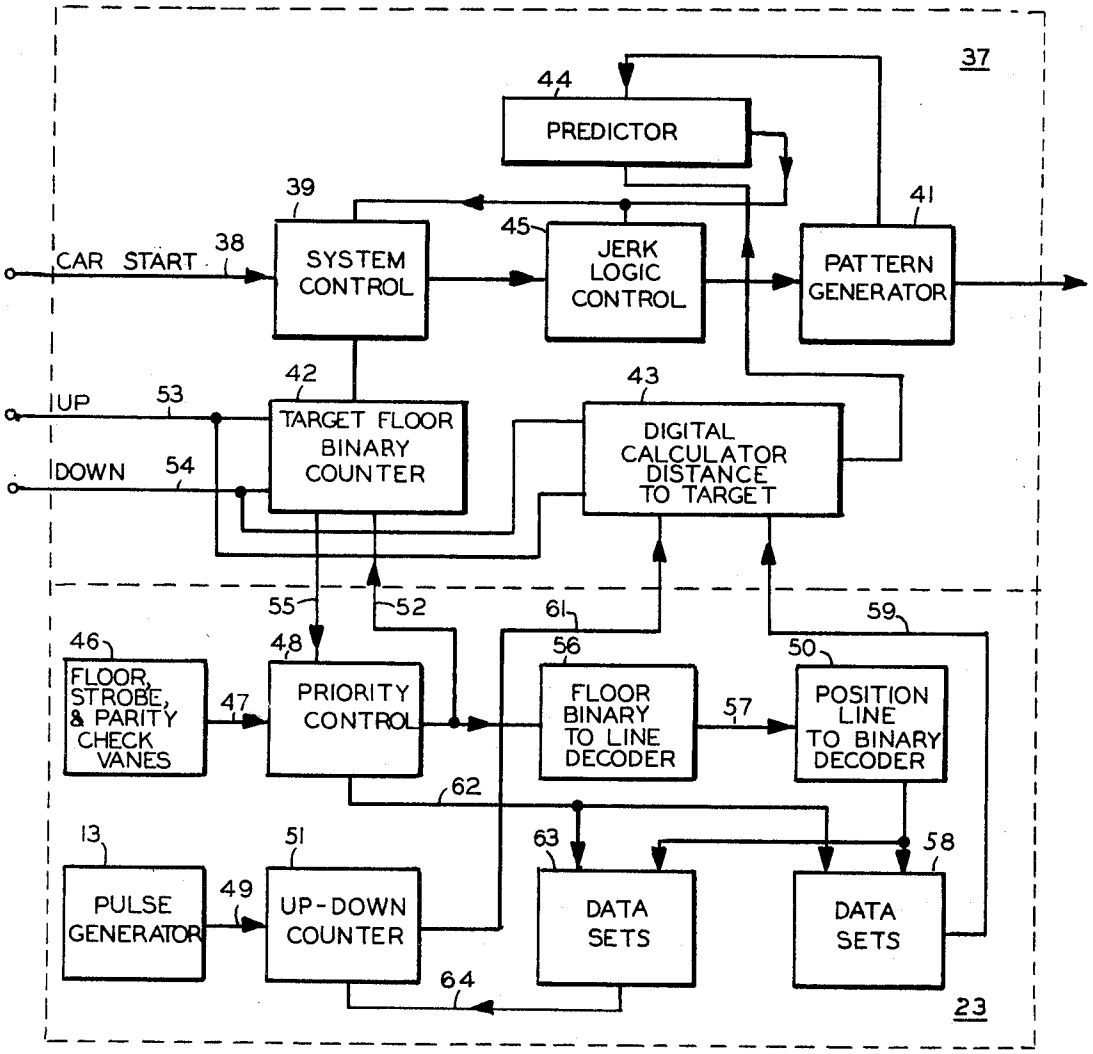
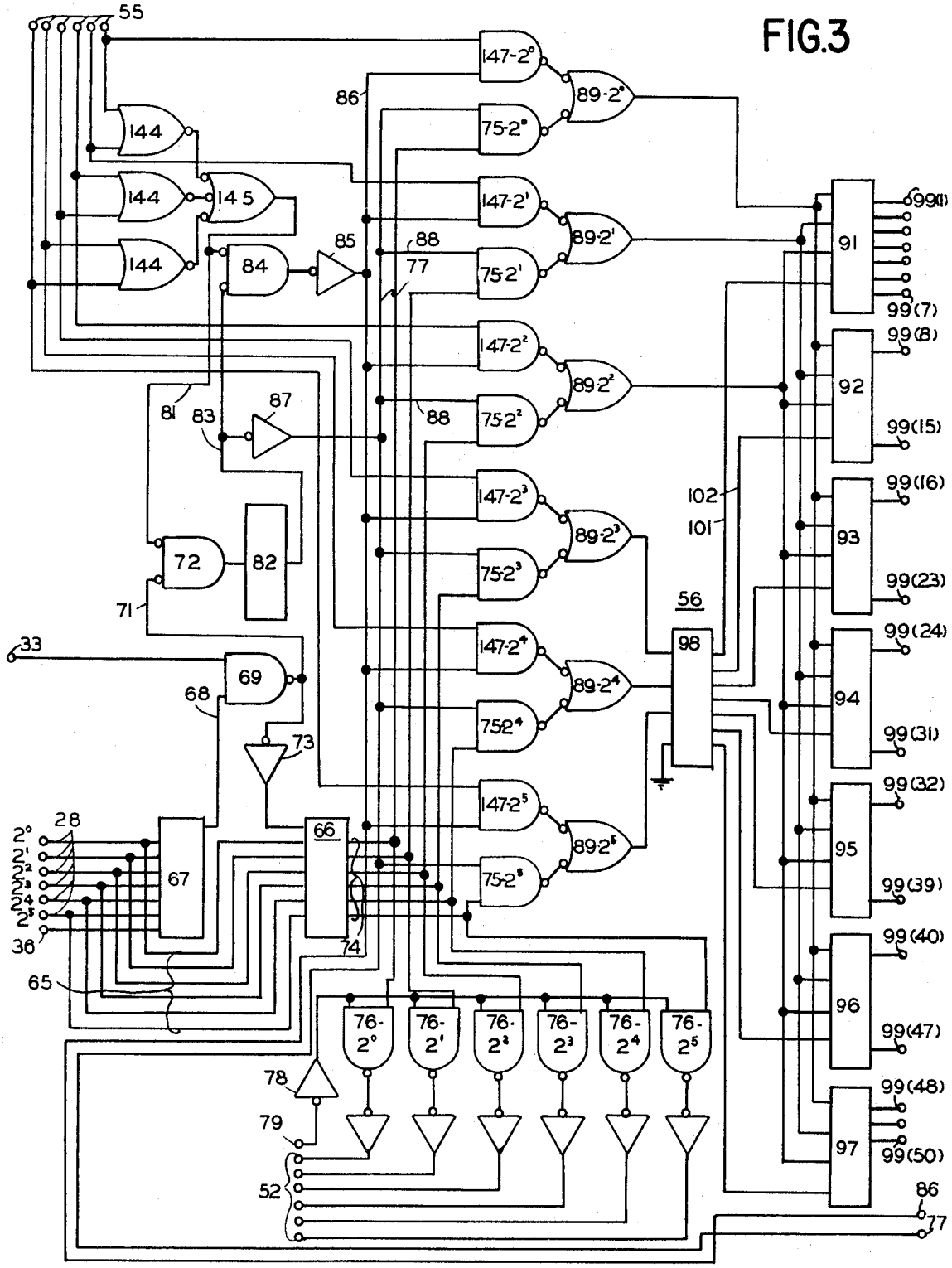

37
44
PREDICTOR
39
41
45
CAR START
38
SYSTEM CONTROL
JERK LOGIC CONTROL
PATTERN GENERATOR
42
43
UP
53
TARGET FLOOR BINARY COUNTER
DIGITAL CALCULATOR DISTANCE TO TARGET
DOWN
54
55
52
61
59
46
48
56
50
FLOOR, STROBE, & PARITY CHECK VANES
47
PRIORITY CONTROL
FLOOR BINARY TO LINE DECODER
57
POSITION LINE TO BINARY DECODER
62
13
51
63
58
PULSE GENERATOR
49
UP-DOWN COUNTER
DATA SETS
DATA SETS
64
23

FIG. 2

FIG.3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52
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98
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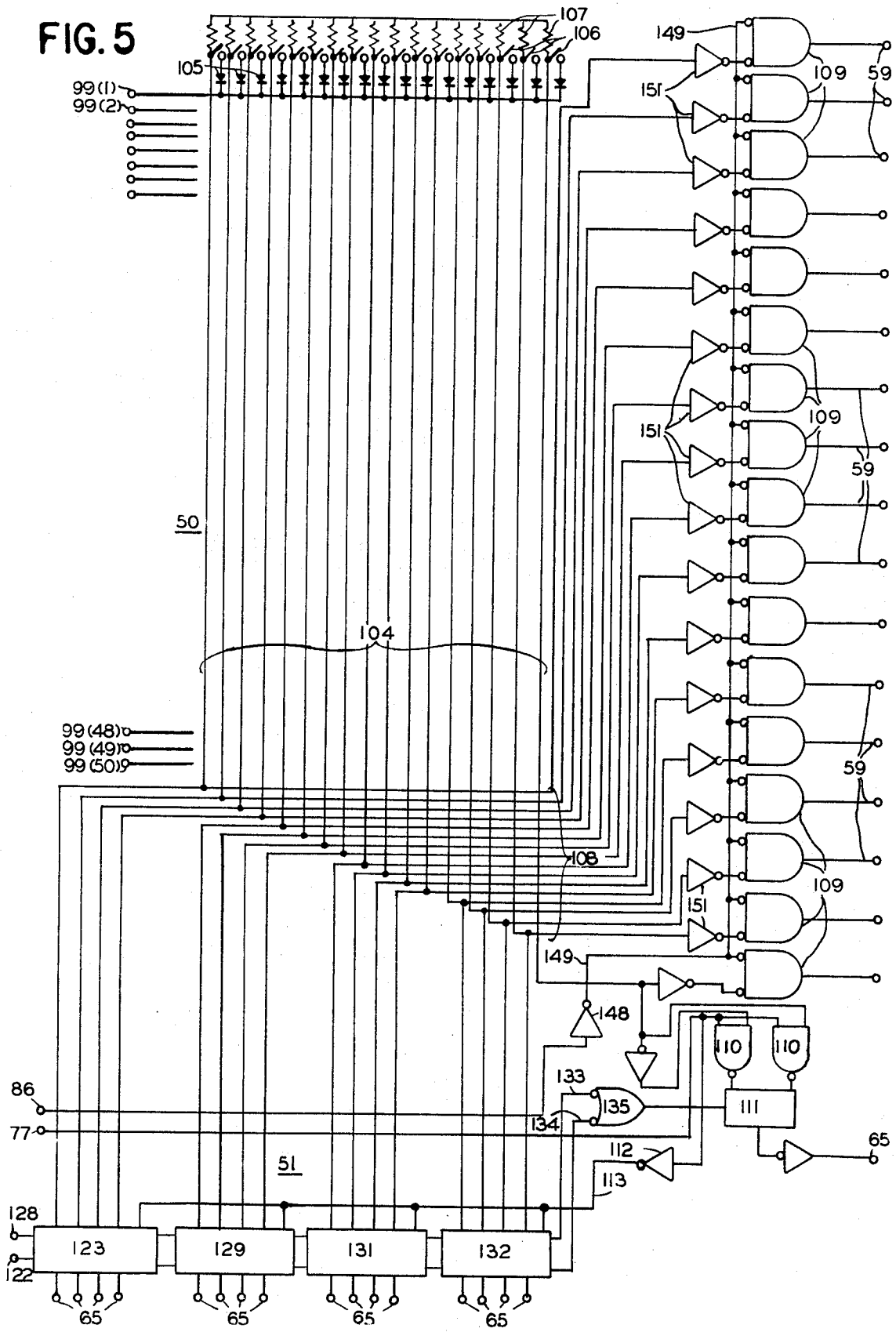
99(1)
99(7)
99(8)
99(15)
99(16)
99(23)
99(24)
99(31)
99(32)
99(39)
99(40)
99(47)
99(48)
99(50)
86
77

FIG. 5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99(1)
99(2)
149
109
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151
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99(48)
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99(50)
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148
110
133
135
111
134
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ELEVATOR ELECTRONIC POSITION DEVICE

CROSS REFERENCES TO RELATED APPLICATIONS

This electronic position device is utilized to provide digital signals indicating car position, target position and floor number at which a car is stopped to a predictive control pattern generator system shown in U.S. patent application Ser. No. 251,810 filed herewith in the name of E. O. Gilbert et al. and entitled "Predictive Elevator Control."

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to means for translating the location of an elevator car along its path of travel to signal forms useful in the hoist motor control, call response, indicator and supervisory controls for the car and any other cars with which it may be grouped for interrelated control purposes.

2. Description of the Prior Art

Heretofore it has been known to develop position control relationships between elevator cars and the landings which they serve by means of mechanical devices which move a contact actuating or commutating structure over a scaled down path of elevator travel. Alternatively elevator true position, lead position and floor positions have been scaled to potentials to provide analogue signals developed by mechanical devices for control of hoist motor speeds in conjunction with mechanical commutating devices scaled to elevator position for operating switches in circuits associated with car position. Bruns, U.S. Pat. No. 2,699,226 of Jan. 11, 1955 is an example of one such system. A potentiometer driven by motion of an elevator car to provide car position signals is also disclosed in the system of Bosshard U.S. Pat. No. 3,146,857 which issued Sept. 1, 1964.

Magnetic memories have been employed to generate car position signals controlling slowdown of an elevator approaching a landing at which it is to stop as shown in Gott et al., U.S. Pat. No. 2,846,026 which issued Aug. 5, 1958. Such means are usually augmented for the long distances to be traveled by the car by coarser mechanically driven commutating devices.

Bruns et al., U.S. Pat. No. 3,414,088 which issued Dec. 3, 1968 discloses a binary encoded position signal means derived from a perforated tape extending between the car frame and the counterweight and over a sheave which directs it past a photoelectric reading mechanism. A unique position code is developed for each car position by the arrangement of five bit generating perforations across the tape for each position. These position signals represent true car position, however, means are provided to shift effective car position to superimpose a slowdown distance advance commensurate with the speed of travel in decoding the signals.

A counter for car level determination is disclosed in McDonald et al., U.S. Pat. No. 3,370,676 entitled "Digital Control for Mine Hoist System" which issued Feb 27, 1968. In that disclosure car position is related to a given destination through a coincidence gate which imposes a preset on a counter of a number of pulses corresponding to the travel distance of the car to the destination. As the car advances toward that destination the count is reduced. When the count reaches predetermined levels, slowdown steps are introduced in the motor controls. Three such steps are proposed.

The above systems offered many disadvantages. The accuracy of many mechanical floor selectors is such that a substantial portion of car travel had to be controlled from switches actuated in the hatchway in response to actual car position. Mechanical selectors are limited in the range of travel they serve by size restrictions. Wear alters adjustment and the precision of control of mechanical selectors. Such selectors are expensive as to both first cost and maintenance.

SUMMARY OF THE INVENTION

This invention relates to elevator controls and more particularly to means for defining the location of an elevator car and its destination for control of the drive mechanisms for the car.

The floor at which a car is positioned is indicated by a binary coded signal, of six bits in the example, and its location along the car hatchway is indicated by a digital count, of seventeen bits in the example. Characteristic binary coded signals are generated for each alignment of the car with each of a plurality of check points and are issued to the system as a starting position of the car when the car is stopped at a floor and as a checkpoint in car travel as the car passes the floors during each run. Car position is also established as a count accumulated from a pulse generator drive by the hoist sheave over which the cars hoisting cables are carried.

Signals are issued to associated supervisory and hoist motor control in both the six bit and seventeen bit codes to indicate car position and in response to a target floor update request from the associated control, a six bit target floor address is encoded to the seventeen bit position code.

Common coding and decoding equipment is utilized for the several signals. Separation of those signals is afforded by a priority control which interlocks the equipment according to the signal to be considered at the moment. When the car is running, pulses are issued to the counter accumulating car position count to indicate direction of travel, and thus direction of count accumulation, and the traverse of given increments of travel, one hundredth of a foot per pulse count in the example. A check of the count is made as the car passes checkpoints along the hatchway. A six bit binary code signal is gated by a strobe signal issued when the car is precisely level with the checkpoint, provided a parity check is satisfied, to be encoded to lines representing the individual floors and thence to the seventeen bit position code compatible with the car's position as indicated by its pulse counter. The seventeen bit encoded car position signal is applied to the counter at this time by enabling inputs to the counter presets. If the count is correct, no change of count results. However, if count is lost as by a missed or extra pulse or by cable slippage or stretch, it is corrected by the check signal.

Advantageously, the car position checkpoints are coincident with the landings served by the car. Thus, the binary coding means also supply the home station data in six bit code to the associated drive motor controls, the predictive control of the aforenoted Gilbert et al. patent application, provided an enabling signal indicates the car is stopped.

The predictive controls employ the encoder to define the target floor position in the 17 bit code. As the car advances, the target floor data is updated when no stop

signal is imposed for the current target floor and the car passes the location from which it can stop at that floor, considering its speed and the jerk, acceleration and velocity constraints imposed on its control. A request for new target floor data is issued as a six bit binary code in a brief window during which gating of the car position code signals is inhibited and such signals are held in storage. During the address window, the target signal is encoded by the encoder and routed to the predictive controls while the encoder signals to the car position counter are inhibited. If a car position check signal is coincident with the data request window, no loss of information is experienced since the data request interval is of much shorter duration than the position check window. Thus in practice a 20 microseconds data request window has been employed while an enabling strobe signal is present for 500 microseconds where it is generated for car travel of 0.01 feet and the car is traveling at 20 feet per second. Thus this invention permits two coding systems to be utilized compatibly encoding, decoding and synchronizing them with suitable interlocks to enable a single encoding means to process signals from several sources and signals from a given source to several destinations.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic of an elevator hatchway showing four typical landings, the car position sensing means for issuing signals indicative of actual car position at the landings, and the means for developing the digital count of car position from the hoist mechanism;

FIG. 2 is a block diagram of the system showing its relationship to a predictive control;

FIG. 3 is a logic diagram of the priority controls, the binary to line floor encoder, the target floor request controls, and home station identification for manipulating six bit binary signals and up to 50 lines representing a 50 landing capacity for floor position encoding;

FIG. 4 is a logic diagram of a direction sensing circuit responsive to the pulse sequencing utilized to control the car position count pulses; and

FIG. 5 is a logic diagram which when placed in side by side relationship to FIG. 3 with like numbered leads coupled discloses the digital car position counter, car position outputs, and count correction means and their relationships to FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The elevator car **5** represented in FIG. 1 is positioned by a hoist motor **6** driving a sheave **7** over which are trained hoist cables **8** coupled to the car **5** and its counterweight **9.** Four typical landings **11** are illustrated, as the first through fourth landings, each having access to car **5** when it is stopped with its floor in registry with the landing sill. Control mechanism **12** for the hoist motor **6** control the starting and stopping of the car according to service requirements imposed conventionally by car and hall calls and supervisory equipment (none of which is shown) and according to car position, speed and direction of travel.

Car position according to this invention is represented by digital signals from two sources, a pulse generator **13** which indicates the displacement which the hoist mechanism imparts to the car as rotation of the sheave **7** and a car position check signal generator **14** which issues a binary signal identifying the checkpoints, advantageously each floor, when the car is at predetermined positions along the hatchway.

The pulse generator **13** can comprise an opaque disc **15** coupled to rotate with the hoist sheave **7** and provided with two circular arrays of evenly spaced windows **16** and **17** concentric with the axis of rotation of disc **15.** The windows of the inner array **16** are offset radially from the windows of the outer array. A reading head **18** is provided as a housing having a slot **19** mounted so that the periphery of the disc **15** and windows of arrays **16** and **17** are carried through the slot as the disc **15** is rotated about its axis. Two sources of radiant energy (not shown), which can be visible light, are positioned along a radius of disc **15** on one side of the slot **19** within head **18.** A sensor (not shown) is maintained in alignment with each source on the opposite side of the slot **19** and so located that energy projected from the respective source is projected along a path exclusively in registry with the arc through which a respective one of each of the window arrays **16** and **17** is passed during disc rotation. In this manner rotation of sheave **7** is represented by two trains of pulses. The sequence of the pulses in a given train indicates travel direction, i.e., the initiation of a pulse from the inner array **16** before or following the initiation of a pulse from the outer array **17.** Electrical pulse signals are transmitted on leads **21** and **22** from the respective energy sensors to the car position controls **23** shown in more detail in FIGS. **3, 4** and **5.**

Car checkpoint signal generator **14** is an array of position sensors **24** which may be magnetic switches of the reed type (not shown) operatively associated with suitable magnets (not shown) mounted on car **5** so that the proximity of a ferromagnetic vane **25** secured in the hatch to the sensor **24** alters the condition of the switch to transfer between a closed and an open condition. Such operating association can be confined to an accurately defined and narrow range of relative positions between the sensor **24** and vane **25.** An array of sensors **24** maintained in a vertical column (in alignment parallel to the path of travel of the car) can be carried past cooperating vanes **25** as the car is moved along the path of travel so that the sensors are operated in unique combinations for each checkpoint. The vanes **25** can be coded either as group mounted individual vanes or as a unitary vane assembly having selected areas with car position along the hatchway to operate coded combinations of the sensors **24** indicating precise car position. In the example, the car position coding is arranged to be effective when the car passes a zone of 0.01 inch of travel aligned with its floor at each landing sill as indicated by a strobe sensor **26,** mounted on the car out of alignment with sensors **24** along the travel path of car travel, and operated by strobe vanes **27,** mounted in the hatchway properly oriented with respect to each landing. Thus as the car runs past a landing and while it is stopped in registry with its landing, a coded combination of sensors **24** are operated to issue signals on leads **28** to the position control **23.** Leads **28** are represented as coupled to control **23** through a traveling cable **29** to a junction box **31** connected by cabling **32** to control **23.** Strobe lead **33** is cabled with lead **28** to control **23.**

In order to detect malfunctions in any sensor **24** the system is provided with an odd parity checker whereby an enabling signal will gate the binary six bit code from sensors **24** only if an odd number of such sensors are

operated. Those checkpoints represented by code signals requiring operation of an even number of sensors **24** are augmented by an odd parity sensor **34.** Thus, when the car is at floors one and two its position is represented by a single operated switch as (000001) and (000010) respectively. However, at floor three an even number of sensors **24** are operated as (000011) hence a parity vane **35** secured in the hatchway at floor three actuates parity sensor **34** to issue a parity check signal on lead **36.**

Description of FIG. 2

The block diagram of FIG. **2** represents the relationship of the position device of this invention to a predictive control **37** of the type disclosed in the aforementioned E. O. Gilbert et al. application which establishes a control pattern for a variable voltage hoist motor control for an elevator car. Car start and stop signals can be issued control **37** on lead **38** from the car supervisory control (not shown) to the system control **39.** Start signals are imposed when the car is conditioned to run and has received a run signal as where there is a call to be served and the door and gates are closed. Stop signals are represented by an absence of a start signal as where a call is registered for the current target floor for a moving car and the car has reached a position at which its slowdown is initiated.

Predictive control **37** controls a pattern generator **41** for the car hoist motor control. It indicates the current target floor as a binary count in binary target floor counter **42,** calculates the distance between the car and the target floor in calculator **43** and by predictor **44** it predicts the point in travel from which the pattern signal can stop the car when subjected to constraints of jerk, acceleration and velocity. Such predictions involve predictions of the stopping position which are made repetitively at a rapid rate by generating a position based pattern of slowdown in an interval which is short compared to the interval in which the actual position pattern controlling the hoist motor is generated. The predicted pattern can be generated at a rate one thousand times the actual pattern with its characteristics slightly degraded from the actual pattern so that it predicts a stopping position slightly in advance of the actual stopping position which could be achieved by the pattern, e.g., a few hundredths of a foot in advance of the target floor. When the predictor **44** predicts the pattern can be stopped from the current pattern position in a distance equal to the distance the the car has to go to a target floor at which it is to stop, it actuates jerk logic **45** to impose a slowdown signal on the pattern generator.

Three control states determine the pattern signal, positive jerk, negative jerk, and no jerk. In accelerating the pattern positive jerk is imposed by **45** until the acceleration is to be reduced. Then negative jerk is imposed until the acceleration is zero at maximum velocity for a full speed run or until the negative acceleration constraint is achieved where a stop is to be made for a short run. In the stopping mode the predictor continues to repetitively predict the stopping distance of the pattern from the current pattern position and compare it with distance the car has to go to the target floor. If that distance is less than the distance to go by an amount preset in the control it causes the jerk logic **45** to issue positive jerk to the pattern generator **41.** If it is greater by an amount preset in the control, it causes the jerk logic **45** to issue negative jerk to the pattern generator **41.** Thus the predictor has the capability to alter the jerk logic input following each prediction through the slowdown of the pattern to the final stop.

Location of the car at a checkpoint and target floor location data are supplied the predictive control from the hatch vanes **46** on inputs **47** to the priority control **48,** and from the hoist mechanism pulse generator **13** on input **49** to the up-down counter **51.** When the car is stopped at a landing, priority control **48** routes the six bit checkpoint location signal over input **52** from vanes **46** to the counter **42** in the predictive control to preset that counter for the home floor address to be utilized in the next run. Upon issuance of a car start signal, the counter **42** advances one floor in a direction dependent upon the direction setting for the car at leads **53** and **54,** thereby establishing a new target floor in binary code. This floor data is transposed to the line code of the up-down counter **51** representing car position by input **55** to priority control **48** which routes it through floor binary to line decoder **56,** input **57** for line to binary position decoder **50,** thence to data sets **58** and input **59** of calculator **43.** 50 floors are represented as 50 lines in decoder **56** and are translated to a 17 bit code of position compatible with the position pulse count of counter **51** for those floors by decoder **50.** This seventeen bit position code is employed in the arithmetic performed in calculator **43** to ascertain car distance to go to the target floor in view of the position of the car as issued in the same code from counter **51** over input **61.**

Priority control **48** includes floor signal temporary storage means to store the binary coded floor signal from vanes **46,** strobe signal responsive means and parity check means. It defines two operating modes, a target mode and a car position check mode. The target mode is effective when only the predictive control indicates the need to change target floors and only for a brief interval as enabled by the predictive control **37.** During that interval the binary counter **42** has its output on **55** encoder **56** and **50** and data sets **58** are enabled to pass the code to calculator **43** by the signal from priority control **48** on lead **62.** At this time the data sets **63** coupling decoder **56** to inputs **64** of the up-down counter **51** are inhibited.

Counter **51** can be reset if necessary. As the car advances along its hatchway vanes **46** code, strobe and parity check a binary code which priority control **48** advances to decoders **56** and **50** while issuing a signal on lead **62** enabling data sets **63** for the car position check mode of operation while inhibiting data sets **58.** In the car position check mode data sets **63** pass the seventeen line encoded car position check on the reset inputs **64** to up-down counter **51** to correct a miscount if one exists.

Description of FIGS. 3, 4 and 5

Logic diagrams of the position control **23** are shown in FIGS. **3, 4** and **5.** Actual car positions at checkpoints provide inputs from the magnetic reed switch sensors **24** in binary code as shown in FIG. **3** with the several leads **28** designated as to their binary coding by legends showing the binary digit they represent. These designations are utilized as reference character suffixes on gates to be discussed. Parity check input lead **36** and strobe input lead **33** are also shown in the car checkpoint inputs. Car travel inputs are in the form of the

pulse combinations on leads 21 and 22 of FIG. 4 as derived from pulse generator 13. The pulse count on leads 65 of FIG. 5 provide the traveling car position input 61 to calculator 43 from up-down counter 51. FIG. 5 also discloses in fragmentary form the matrix which forms the line or floor to seventeen bit position coder 50. Home station signals are issued at leads 52 of FIG. 3 and target data requests are received on leads 55 to couple the target floor binary counter 42 and the priority control 48 of position control 23.

Priority control 48 as depicted in FIG. 3 establishes the target mode in response to a target floor data request on inputs 55 thereby giving the target mode precidence over the car position check mode for the brief interval of a data request. When a car position check occurs it is stored by latch 66 until the next check occurs. The car position check mode will be considered first.

Position signals generated by car alignment with a floor are imposed at inputs 28 and passed to parity checker 67. An odd parity check has been employed with parity check input 36 coupled to checker 67. If the odd parity checker is satisfied, an enabling 1 is issued on lead 68 to NAND 69. With the car aligned with the floor,a 1 is imposed on strobe input 33 in coincidence with the 1 on 68 to issue a 0 on lead 71 and enable NOR 72 in the interlock between the target mode and the car position check mode controls. The 0 on lead 71 is applied through inverter 73 to enable or clock the eight bit bistable latch constituting storage 66. As will be described, a target floor data request at least 55 inhibits NOR 72 by imposing a 1 on its other input.

Storage 66 issues the binary coded car position to leads 74 when clocked by the 1 from inverter 73. Thereafter, the signals on leads 74 are maintained until the next enabling signal from 73. The coded signals in leads 74 are passed to the position check input gates 75 to binary to lines decoder 56 and to home floor address gates 76. NANDs 75–2^0 through 75–2^5 and 76–2^0 through 76–2^5 for the respective binary digits represented by the suffix are gated provided the car position check mode is effective as indicated by a 1 on lead 77. The binary coded, home floor address is issued on outputs 52 to target floor binary counter 42 only when the car is at rest as indicated by the enabling signal applied to all of the NANDs 76–2^0 to 76–2^5 by inverter 78 when a 0 is imposed from the car control (not shown) at input 79.

Car position check is enabled provided the target mode is not instituted by a signal on inputs 55. Absent the target mode, lead 81 is 0 so that the gating of NAND 69 causes NOR 72 to issue a 1 to the mono stable multivibrator 82. Mono stable 82 issues a 0 on lead 83 for one hundred microseconds, thereby inhibiting NAND 84 to prevent a target mode signal issuing through inverter 85 as a 1 on lead 86, while developing an enabling 1 in inverter 87 for a car position check synchronizing signal on lead 77. Each branch lead 88 from lead 77 applies an enabling 1 to its car position check NAND 75 of the group 75–2^0 to 75–2^5 whereby a 0 is gated to the NAND 89 for that digit. NANDs 89–2^0 to 89–2^5 thereby issue 1 to the respective binary inputs of the binary to octal decoder sections 91 through 98 of decoder 56. Thus leads 77 and 86 function as the input 62 from the priority control 48 of FIG. 2 to synchronize in a mutually exclusive manner data sets for the car position check mode and the target mode. The family of gates 75 with NANDs 110 and inverter 112 (to be discussed) function as data sets 39 of FIG. 2 while gates 147 and 109 function as data sets 41.

The decoder arrangement is illustrated for fifty individual outputs 99 each of which can exhibit a 1 representing the floor under consideration. The floors with which each lead 99 is associated are indicated by parenthetical suffixes. Only typical leads 99 are shown including those representing the lowest and highest floors represented by each decoder section from FIG. 3 and in FIG. 5 the matrix is shown with its cross connections only for the first floor at 99 (1). In the case of the more significant binary bits, 2^3, 2^4 and 2^5, they are distributed through seven outputs of the four line to 10 line decoder section 98 to the respective sections 91 through 97.

Primary decoder section 98 provides an enabling signal to only one of the final section decoders for any given binary input. With no input 2^3, 2^4 or 2^5, section 98 issues an enabling 1 on lead 101 to section 91 whereby outputs one to seven are responsive to signals 2^0, 2^1 and/or 2^2. Lead 102 is 1 to enable section 92 for outputs eight to 15 in response to a 2^3 input to 98. Each of sections 93 through 96 adds eight outputs to output 47 lines 99 and section 97 provides outputs 48 through 50.

Lines to binary position decoder 50 in FIG. 5 is a patch board which enables the floor number outputs on leads 99 to be coded to the 17 bit floor position counts of the floors served by the car on buses 104, as typified for floor one at lead 99 (1), through cross couplings from binary to lines decoder output leads 99. Each of leads 99 is coupled to a suitable positive source through a resistor by means shown only for 99 (1). Thus a binary one results in the lead 99 (1) going low. This signal is coupled through diodes 105, switches 106 and resistors 107 to the respective code buses 104 for those buses having closed switches 106. A manually set up count is established through selective closure of switches 106 between each of the decoder output leads 99 and the code buses for the count of up-down counter 51 representing the location of the floor of the output lead whereby a count signal representing the location of the respective landing is developed in the seventeen bit code and is issued to the distributors 108.

Distributors 108 pass the code signal to the target floor output NANDs 109 when the system operates in target floor address mode to be described and to the up-down counter 51 which provides car position data when the system operates in the car position check mode.

Enabling of the car position check mode for the assumed condition of the approach and stop of a car at a target floor involves the issuance of the 0 on lead 83 by the one shot 82 as described in the gating of NANDs 75. The 100 microsecond 1 on lead 77 to NANDs 110 in the inputs of flip flop 111 and to line driven inverter 112 which imposes a 0 on reset enabling lead 113 enables the check position signal to be applied to counter 57. The 0 on lead 113 and the enabling of NANDs 110 permits the 17 bit code signal on the distributors 108 to the respective 17 stages of counter 51 to be effective in establishing the count of the floor position for the car in counter 51. If the count was correct, no change of count occurs in response to the momentary reset signal of the car position check mode. However, if an incorrect count is present, for example due to a missed

pulse, an extra pulse from a spurious signal, cable slip or cable stretch, the counter **51** will be reset to the target floor count.

The target floor count is retained as the count representing the car's position at the initiation of its next trip. Motion of the car alters the count in the counter **51** from this home floor counter either as an addition, usually for up travel and assumed in the following examples, or a subtraction of count.

Consider the travel of the car downward from the fourth floor. As disc **15** of car position signal generator **14** rotates the windows of inner array **16** initiate registry with their light source and sensor before those of outer array **17** so that a positive goint of 1 pulse is initiated on **22** before a 1 is initiated on **23.** The two pulses subsequently overlap in time relationship. Thereafter the pulse as **22** is terminated before the pulse on **23.** Each pulse sequence is followed by a period in which neither lead has a pulse and as the car proceeds the above cycle is repeated. Up-down pulse circuit **114** responds to a 1 on **22** while **21** is 0 by gating NAND **115** (assume its input from NAND **116** is high) to issue a 0 to NAND **117.** NAND **117** issues a 1 to NAND **118.** The second input to **118** is 1 since the 1 on lead **22** inverted by inverter **119** to a 0 on NAND **121** produces a 1. The coincident 1's to NAND **118** issue a clocking 0 to subtract input **122** of the first stage of counter **51** at section **123** to reduce the count by one. The 0 on lead **124** from NAND **118** to NAND **117** seals the output of **117** and holds the signal at **122.**

As the 1 pulse appears at **21** in overlapping relation to the pulse on **22** it has no effect since the 0 on **124** holds NAND **125** 1 and the inverter **126** applies to 0 to NAND **121** without effect.

Occlusion of the sensor to **22** as the disc rotation continues causes **22** to return to 0 while **21** retains a 1. This makes **115** issue a 1 with no effect since the 0 from **126** to **121** holds **121** at 1 holding **118** at 0 to seal **117.**

Occlusion of both sensors to make both **21** and **22** 0 returns lead **122** to 1 conditioning counter **51** to receive the next count. As lead **21** goes to 0 inverter **126** issues a 1 so that coincident 1's are present on the inputs to **121.** This releases the latch to both **118** and **116** so that the 0 to **118** makes **122** 1. Each successive pulse sequence where the pulse on **22** is initiated before that on **21** results in a 0 clocking pulse on **122** to subtract from the count in counter **51.**

When the car runs upward, the pulse sequence is reversed on **21** and **22** so that **21** receives a pulse before **22** thereby gating a 0 through **125.** Since **124** is a 1 NAND **127** shifts from a 0 to a 1 output causing **116** to issue a 0 to lead **128.** NAND **121** receives a 0 from **126** at this time to place coincident 1's on the inputs of **116.** This state is continued until both of leads **21** and **22** go to 0 at which time **121** issues a latch releasing 0. Thus an up running car applies negative going clock signals to count add input lead **128** when the pulse on **21** is initiated before that on **22** to increase the count by one for each pulse sequence.

Counter sections **123, 129, 131, 132** and **111** are cascaded so that add or subtract pulses can be transmitted between adjacent sections. Since only one stage is represented in section **111** any change of state of the final stage in section **132** will result in a change of **111.** This is accomplished by oring the add and subtract outputs **133** and **134** in NOR **135** such that any signal change at those outputs changes the state of flip flop **111.**

Count outputs from counter **51** are passed from each of its 17 stages through output leads **65.** These count signals are 1 when the stage is on to represent a count and in some instances are inverted to a 0 on state for the predictive control **37.**

Since each pulse count represents 0.01 foot of motion of car **5** a ten floor height of travel changes the count in counter **51** by 1,000. Each car displacement of a floor height, no matter what its magnitude, is checked through the conditioning of the system in the car position check mode. This is done as the car is in registry with the landing and in the manner described. That is, the binary car position code from sensors **24** when strobe signal is present on lead **33** and when partiy checker **67** issues an enabling signal actuates the reset to the landing count for counter **51** as established in the patch board of line to binary position decoder **50** for each landing passed. As the car runs this reset is momentarily made effective by one shot **82** which places an enabling signal on lead **77** to gate the binary landing number through NANDs **75** to decoder **56** wherein it is decoded to one of 50 landings and causes coder **50** to develop the 17 bit code for the count appropriate for that landing height to be applied to the reset inputs of counter **51** from distributor leads **108.** Usually the reset count corresponds to the accumulated count in counter **51.** If it does not, the reset count dominates and the travel count is thereafter accumulated from that reset value. This accumulation begins with the next 0.01 foot of car travel, hence no count need be lost during the car position check mode of operation.

The target address is expressed in the same code as the car position by converting the binary six bit target address issued from the target floor binary counter **42** of the predictive control **37** to a 17 bit code. In operation, the predictive control seeks to run the car to the next landing at which it can be stopped within the jerk, acceleration and velocity constraints imposed upon it. That is the car effectively seeks to run to a target which is the closest floor at which it can be stopped considering its current operating state. A car in the initial phase of acceleration can stop at the floor next adjacent that from which it is starting. As its speed increases it may require one two or more full floor heights of deceleration to stop it hence its target floor is advanced one, two or more floors ahead of its actual position. Such target floor advances with the car until it coincides with a landing for which there is a stop signal. This advance occurs when the car reaches a condition in travel, velocity and acceleration from which it cannot be stopped for a call for the then current target floor. At such time a new target floor signal is issued by the predictive controls **37** (by means not shown) and the car position system is interrogated for the floor address in the 17 bit code by imposing the new floor address in a six bit binary code on leads **55** of FIG. **3.**

The interrogate signal appears at leads **55** for a brief interval, e.g., 20 microseconds as one or more logical 1's to gate one or more NORs **144** to issue a 0. The resultant 0 causes NAND **145** to issue a 1 on lead **81** thereby causing NOR **72** to inhibit mono stable multivibrator **82** and the car position check mode while gating NOR **84** to cause inverter **85** to issue an enabling 1 on lead **86.** This enables the NAND gates **147** to the de-

coder input NANDs **89** and through inverting driver **148** of FIG. **5** to lead **149** the target position output NORs **109.** The binary code signals for the target floor are ored with the car position signals so that the same coding manipulations by the binary to line decoder **56** and patch board of the line to binary position decoder **50** are applied to the target floor signal as the car position check signal. The target floor count appears on coded buses **104** and distributor leads **108** as logical 1 for "on" states. An inverter **151** is provided in each coded input to NORs **109** to to present coincident 0's and gate those NORs of the distributors coded "on." Since the car position check circuits are inhibited at this time and the target floor address output NORs **109** are enabled, the coded count for the target floor appears through the gated NORs **109** at their outputs **59** as logical 1 signals. The resultant target floor address is employed in computing the distance the car has to go on the current trip and controlling the slowdown for a stop in the predictive control **37** (all by means not shown).

It is to be appreciated that the detailed disclosure is to be read as illustrative of this invention and not in a limiting sense. The invention lends itself to applications other than elevator controls, for example it could apply to the position control of vehicles traveling along generally horizontal paths. While it has been shown as effective in both directions of travel, the position control could be employed advantageously with control of an object traveling in but a single direction as in a closed path. Elements other than the specific devices disclosed can be employed in the position control to perform the functions disclosed and to augment those functions.

In general the invention comprises a position control for an object having a predetermined path of travel in which an impulse is generated in response to a given increment of travel of the object and the position of the object is monitored by counting those impulses with a counter having its count scaled to the position of the object. The control includes check means wherein the count of the counter is scaled to one or more check station positions of the object, advantageously each landing served by an elevator car, to develop a predetermined count for respective check stations when the car is at those stations. A check means, which may be a group of switch means developing a binary code signal unique for each check station position of the elevator car, is responsive to the position of the object at the respective check stations, and actuates signal generating means to generate a count signal representing position in the scale of the counter. The signal from the signal generating means is compared with that in the counter. If a disparity exists the counter can be corrected to the check station signal.

A check station code, illustrated as a six bit binary code, which corresponds to a target position definition code can be employed to advantage wherein the decoding and gating mechanisms of the position control have multiple functions. In an elevator system the check station signal switches can also generate home station target floor signals when the car is stopped. In addition, the check station code decoding mechanisms which produce corresponding position counts in a different code can be utilized to provide position counts in that different code for target station data. These multiple functions are accomplished by coupling means which are selectively and are mutually exclusively interlocked as in the described target mode and floor check position mode in the application of these position controls to elevators. Such multiple utilizations also lend themselves to other forms of object position controls.

Flexibility of application of the position controls is also afforded by the means of selectively altering the count signals generated for any given check station signal as illustrated in FIG. **5** by switches **106** in the line to the distributor matrix.

In view of the above scope of applications and variations of this invention it is to be understood that the detailed disclosure can be varied without departing from the spirit or scope of the invention. What we claim is:

1. A position control for an object having a predetermined path of travel comprising means coupled to the object for generating an impulse in response to a given increment of displacement of the object; a counter having upper and lower count limits for accumulating said impulses and having its count in a second code scaled to the position of the object, said count being scaled to provide a predetermined count other than said limits for a check station of the object along its path; check means responsive to the positioning of said object at the check station along its path of travel; means included in said check means for generating a unique signal in a first code for said check station; means generating a count signal in said second code in response to said check means which corresponds to the predetermined count of said counter; and means to compare said check means generated count signal with the count accumulated in said counter.

2. A position control according to claim **1** wherein said means to compare includes means to correct the accumulated count in said counter to the predetermined count.

3. A position control according to claim **1** including means indicating the direction of travel of the object along its path of travel; and wherein said counter is an up-down counter and accumulates impulses in an ascending and descending count depending upon the direction of travel indicated by said indicating means.

4. A position control according to claim **1** wherein the object is an elevator car and said check station is a landing of a structure served by said elevator car.

5. A combination according to claim **1** including means to selectively alter the count signal generated in said count signal generating means which is generated in response to said check means.

6. A position control according to claim **1** wherein said means to compare includes encoding means to encode said first code to said second code.

7. A position control according to claim **6** including means to generate a destination position signal for said object in said first code; and means to selectively apply said first coded destination position signal to said encoding means.

8. A position control according to claim **6** including means selectively to generate any of a plurality of destination position signals for said object in said first code; and means to selectively apply said first coded destination position signal to said encoding means.

9. A position control according to claim **1** including a plurality of spaced operating stations for said object along said path; and wherein said given increment of displacement of the object is less than the least spacing between said spaced stations.

10. A position control for an object having a predetermined path of travel comprising means coupled to the object for generating an impulse in response to a given increment of displacement of the object; a counter for accumulationg said impulses and having its count in a second code scaled to the position of the object, said count being scaled to provide unique predetermined counts for each of a plurality of predetermined check stations for the object along its path of travel; check means responsive to the positioning of the object at each of said plurality of predetermined check stations along its path of travel; means included in said check means for generating a unique signal in a first code for each of said check stations; means generating a count signal in said second code which corresponds to said unique predetermined count of said counter in response to said check means operation responsive to the positioning of the object at the corresponding check station; and means to compare said check means generated count signals with the count accumulated in said counter.

11. A position control according to claim 4 wherein said object is an elevator car; wherein said check stations are landings of a structure served by said elevator car; wherein said check means generates landing designations in a first code; and wherein said count signals are position designations.

12. A position control according to claim 4 including first means to generate check station signals in response to said check means; output means to issue home station signals for said object; coupling means coupling said means to generate check station signals to said home station signal output means in response to the stop of said object at a respective check station.

13. A position control according to claim 4 including first means to generate check station signals in response to said check means; signal storage means coupled to said check station signal generating means to store check station signals; and coupling means between said signal storage means and said means generating a count signal.

14. A position control according to claim 4 including a plurality of first means selectively operable in a unique combination for each check station to generate check station signals in response to said check means; and a parity checker to enable said check station signal generation means.

15. A position control according to claim 5 first means to generate check station signals in response to said check means; second means to generate check station signals; a first coupling between said first means to generate check station signals and said count signal generating means; a second coupling between said second means to generate check station signals and said count signal generating means, a third coupling between said count signal generating means and said counter; a count signal output; a fourth coupling between said count signal generating means and said count signal output; first means for selectively enabling said first and third coupling means whereby the positioning of the object at a check station compares said check means generated signal with the count in said counter; and second means for selectively enabling said second and fourth coupling means whereby said second signal generating means produces a count signal at said count signal output.

16. A position control according to claim 5 including mutually exclusive interlock means between said first enabling means and said second enabling means.

17. A position control according to claim 4 including a plurality of first switching means selectively operable in a unique combination for each check station to generate check station binary signals in response to said check means; a binary-to-line decoder coupled to said check station binary signal generating means; and wherein said count signal generating means comprises a line-to-binary position count decoder coupled to said binary-to-line decoder.

18. A combination according to claim 17 including means to selectively alter any of the position counts for respective lines as developed in said line-to-binary position count decoder.

19. A combination according to claim 4 including means to selectively alter any of the unique predetermined count signals generated in said count signal generating means which is generated in response to check means for respective check stations.

20. A position control according to claim 4 wherein the object is an elevator and the check stations are landings of a structure served by the elevator car; including a plurality of first means selectively operable in a unique combination for each check station to generate check station signals in a binary code in response to said check means; a parity checker to enable said check station signal generation means; a signal storage means coupled to said check station signal generation means to store check station signals; home station output means to issue home station signals for said elevator car; home station signal coupling means coupling said signal storage means to said home station output means in response to the stop of said elevator car at a respective check station; second means to generate check station signals in a binary code; said count signal generating means comprising a check station binary-to-line decoder coupled to a position count line-to-binary decoder; a first coupling between said storage means and said count signal generating means; a target check station signal generating means to identify the landing to which the elevator car is traveling; a second coupling between said target check station signal generating means and said count signal generating means; a third coupling between said count signal generating means and said counter; a target station position count signal output; a fourth coupling between said count signal generating means and said target station position count output; first means for selectively enabling said first and third coupling means whereby the positioning of the elevator car at a check landing compares said check means generated position count signal with the count in said counter; second means for selectively enabling said second and fourth coupling means whereby said target landing position count issues at said target position output; and mutually exclusive interlock means between said first enabling means and said second enabling means.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,773,146

DATED : November 20, 1973

INVENTOR(S) : George S. Dixon, Jr.; Edward O. Gilbert; and Gerald D. Robaszkiewicz

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 28,	"drive" should be - - driven - -.
Column 3, line 20,	after "compatibly" insert - - by - - .
Column 9, line 7,	"counter" should be - - count - -.
Column 7, line 22,	after "36" insert - - also - - .
Column 7, line 31,	"least" should be - - leads - - .
Column 11, line 11,	delete "to", second occurrence.
Column 13, line 22,	"4" should be - - 10 - - .
Column 13, line 29,	"4" should be - - 10 - - .
Column 13, line 36,	"4" should be - - 10 - - .
Column 13, line 43,	"4" should be - - 10 - - .
Column 13, line 50,	"5" should be - - 11 - - .
Column 14, line 5,	"5" should be - - 11 - - .
Column 14, line 8,	"4" should be - - 10 - - .
Column 14, line 21,	"4" should be - - 10 - - .
Column 14, line 26,	"4" should be - - 10 - - .

Signed and Sealed this

ninth Day of *December 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

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Column 13, line 43,	"4" should be - - 10 - - .
Column 13, line 50,	"5" should be - - 11 - - .
Column 14, line 5,	"5" should be - - 11 - - .
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