

Description

The present invention relates to elevator systems and to encoding and locating the position of the elevator cars in an elevator system. More particularly the invention relates to a primary position transducer system for determining the location of an elevator car in an elevator system.

In an elevator system, one or more cars travel up and down the length of the elevator run, moving between the floors of the building carrying passengers.

In order to, *inter alia*, stop smoothly and level with the landing at each floor, it is important to know the precise location of the car at all times. To provide this information to the elevator controller system, a digital readout device known as a Primary Position Transducer or "PPT" is used.

For mid- and low-rise installations, a reader device mounted on the car and a vertical steel tape that runs the length of the hoistway are used to establish the car's position. Either steel vanes and/or magnets are mounted on the tape at precise locations with respect to the floor level of each landing.

For an example of a prior art position transducer system used with an elevator system, note our U.S. Patent 4,384,275 entitled "High Resolution and Wide Range, Shaft Position Transducer Systems" of Masel et al, in that patent two rotary position transducers are coupled to each other and to the shaft being rotated. Both of the transducers include one or more coded disks having sensing indicia forming tracks thereon that rotate a plurality of times in response to the rotations of the shaft, one of the transducers rotating at a different speed than the other. Each transducer produces signals, which are individual to the respective transducer and are the same for each rotation of the respective transducer.

The Masel patent includes:

sensing means related to each track for sensing the indicia thereon to provide signals indicative of the rotation of the disk from a rotational reference position; and

signal processing means interconnected to the sensing means responsive to the signals corresponding to the coded tracks for providing a binary signal representation of the angular position of the disk and responsive to the signals corresponding to the coded tracks to provide, as a function of the number of coded track indicia which have been sensed indicated thereby, a binary signal representation of the number of revolutions that the disk has rotated from the rotational reference position.

Also, GB-A-2165966 discloses a position control system for an elevator according to the preamble of claim 1, wherein the position of the elevator in the shaft is detected using a plurality of pulse encoders which each generate pulse signals in accordance with the movement of the cage. The pulse signals of each of the encoders are compared and, if the difference between them exceeds a predetermined value, operation of the elevator is checked. Thus, if one encoder malfunctions, the cage is stopped so that it is not controlled on the basis of an erroneous pulse signal.

Some additional patents which may be of interest are U.S. Patents 4,041,483 entitled "Absolute Incremental Hybrid Shaft position Encoder" of Groff issued August 9, 1977; and U.S. Patent 3,885,209 entitled "Two Speed Control System" of Lazarus issued May 20, 1975. In the latter patent first and second transducers are connected to first and second rotatable shafts, respectively, with the shafts coupled to each other through a single mesh of gears. The transducers are electrically coupled in cascade to enable the first to provide a "fine" indication of the angular position of the first shaft, while the second provides a "coarse" indication of the number of revolutions of the same first shaft.

According to the invention there is provided an elevator system, in which there is at least one elevator car whose speed is controlled by a motion control subsystem and in which there is included a transducer system (PT) for determining the vertical position of the car in the elevator run by providing a binary representation of the number of revolutions made by a rotatable shaft to which a transducer is connected, said transducer system including;

a first encoder element having one coarse indicium and a first large number of fine indicia thereon; characterized by

a pair of fine sensing means oriented with respect to said fine indicia to provide, for each revolution of said shaft, a series of pairs of fine signals in quadrature relation to each other;

a pair of coarse sensing means, one being responsive to said coarse indicium to provide one coarse signal;

a second encoder element disposed to said shaft in a manner to rotate one more time than said first encoder element as said first encoder element rotates a second large number of times, of the order of said first large number, across a range of permissible elevator positions, said second encoder element having a coarse indicium thereon related to the other of said coarse pair of sensing means for providing a second coarse signal in quadrature with said one coarse signal for each revolution of said shaft;

a first signal processing means responsive to said fine signals and to said coarse signals for providing a

first elevator position signal as the summation of coarse positions indicated by the number of said fine indicia sensed between provision of one of said coarse signals and the provision of the other of said coarse signals in each revolution of said shaft, with fine positions indicated by the accumulation within each revolution of said shaft of the number of said fine indicia sensed in such revolution of said shaft;

5 a second signal processing means responsive to said fine signals for providing a second elevator position signal as the summation of said fine signals as said elevator travels within said range of permissible elevator positions; and

means for comparing said first elevator position signal with said second elevator position signal and for providing a fault signal indicating a fault in the event the positions indicated by said first and second
10 elevator signals differ by more than a predetermined magnitude.

The "smart" primary position transducer ("SPPT") system of the preferred embodiment is a subsystem of the car control system for each car for the overall elevator system.

The SPPT apparatus includes an input shaft coupled to a primary encoder disk. Coupled to the shaft through gearing are one or more encoder disks that perform the function of turns counting, as well as
15 additional functions.

Each disk contains multiple tracks, and each of these tracks is sensed by a sensor. An alternate sensing means is the use of two or more independent sensors per track. An important aspect of the invention is to have two or more essentially independent means of performing the key sensing functions.

The read heads of the SPPT can be divided into a primary set and a secondary set. Each set of
20 sensors is used to feed an independent processor. Within each set of sensor signals, cross checks are performed to ensure the integrity of the system. For example, a cracked or broken glass disk could be detected.

As noted, an important aspect of the invention is for the sensors to be independent. Although multiple tracks on multiple disks are preferred, it is possible to use, for example, a single disk with a sufficient
25 number of tracks, if multiple sensors are included with the single disk.

The sensible indicia are preferably in the form of optical tracks, although magnetic sensing or hole sensing, etc., could be used. Also, the principles of the invention can be realized in a multi-winding resolver system, etc., and, hence, the use of a disk, although preferable, is not mandatory to the invention.

In a preferred embodiment the present invention provides means for finding two or more independent
30 position and velocity signals and derivatives of these signals with an instrument having a common input shaft. There are many possible embodiments to do this, including for example:

1 An incremental system using a single encoder disk and two or more read heads.

2. A quasi-absolute system using differential gearing that is capable of two independent position and speed signals.

35 3. An absolute system, including a main disk attached to said input shaft; additional absolute encoders coupled to the input shaft through gears determining the turns of the main shaft; and at least two independent position and velocity output signals being obtained with the use of independent sets of read heads located circumferentially about each disk, a primary output signal being used to run the elevator and the other, secondary, output signal being used for normal terminal protection for the elevator car travel. A combination of the primary and secondary velocity signals may be used to derive a door zone speed check signal in compliance with the ANSI A-17.1 Elevator Code, which requires that an
40 independent means be used to check speed in the door zone. By equipping the system with a third set of sensors, it is possible to obtain an independent position signal useful for verifying that the elevator is in the door zone before the doors are opened.

45 By the use of additional sensor assemblies, a fourth independent set of position and velocity information could be generated for the purpose of meeting the emergency terminal stopping requirements of the A-17.1 code.

Each set of sensors needs to work with an independent processor system. In situations where a composite signal is produced from two processors, such as for the door speed check signal, it is essential
50 to buffer the connections from the processors to the common circuitry, so that a failure in one processor cannot affect the operation of the other.

The basic concept followed in this new class of instruments is to provide independent signals when a common input shaft is used. One interpretation of independence is that a failure in one channel cannot affect any other channel. To guard against a disk fracture, etc., affecting two or more channels, the "health"
55 of each channel is monitored. Any severe malfunction on one channel will cause an emergency stop of the elevator. Also, the system receiving the primary and secondary signals will initiate an emergency stop if excessive disagreement exists between the primary and secondary channels.

Thus, the primary and secondary position channels are made independent of one another in the SPPT of the present invention. The sensor devices, such as photo-transistors or coils, used for the primary and secondary position determinations are made independent of each other. With the approach(es) of the present invention a failure in one of the sensor devices will not cause a failure in any other sensor device.

The "health" of the disks used for quasi-absolute encoding are checked by checking the symmetry of the coarse tracks.

Absolutely encoded disks are usually encoded using the "Gray" code, and errors can be detected if more than a single bit changes at one time. Also, in absolutely encoded systems the turns counting encoders can be used for safety checking.

In the preferred embodiment the "smart" primary position transducer system is driven by, for example, a steel selector tape attached to the elevator car, using a quasi-absolute transducing system preferably with battery backup. In each transducer, primary and secondary position signals preferably are each found by two methods and compared to maximize the likelihood of correct position determination.

The "smart" aspects of the PPT additionally use two independent channels for position and velocity information for the car with which it is associated.

The SPPT includes preferably two encoders coupled by, for example, 256:257 gearing. The encoders preferably are of identical design, and in the preferred embodiment contain two fine (1024 ppr) tracks, and two coarse (1 ppr) tracks. Each pair of tracks produce signals that are in quadrature with each other.

The directly-driven encoder is termed the "primary encoder" and is connected directly to an appropriately toothed gear, for example, a two hundred and fifty-six (256) tooth gear. The other encoder is termed the "secondary encoder" and is connected to the primary encoder by means of a different toothed gear, for example, a two hundred and fifty-seven (257) tooth gear. The difference in the number of teeth in the gears used for the otherwise identical two transducers produces a non-1:1 ratio, namely in the preceding example, a 257/256 ratio of secondary to primary.

The main and quadrature fine track signals are processed by external circuitry, well known to those of ordinary skill in the art. This processing results in a "x4" (four times) frequency multiplication, and a determination of the direction of rotation.

The exemplary encoder disks used with the transducer have a range of an exemplary two hundred and fifty six (256) revolutions with, for example, twelve (12) bit per revolution encoding on the primary channel and, for example, at least eight (8) bit per revolution encoding on the secondary channel.

The two channels preferably use independent parts except, for example, the input shaft and encoder disks. This leads to very high reliability and a very low probability of any undetected failures.

This two channel integrated elevator position/velocity transducer system provides economical performance of the following important elevator control functions:

- normal position control;
- normal terminal protection; and
- door zone protection.

Signals representing the position and velocity of the respective car may be determined and generated in the following manner:

The determination of position for the primary channel requires the finding of coarse position and then adding incrementally derived fine positions to it. Further, for reasons of elevator safety, a redundant secondary position is desired. This is accomplished using hardware that is independent of that used for the primary position.

Primary position as a HEX number consists of: $PRI_POS = COARSE_PRI_POS * 1000 + FINE_PRI_POS$ where $FINE_PRI_POS$ is derived from the XY counts and equals "000" at the end of each coarse primary position determination cycle; where the fine track of the primary encoder is "X", the quadrature track is "Y", and the times four ("x4") composite signal is called "XY".

Two basic techniques exist for determination of primary position (PRI_POS) and secondary position (SEC_POS), once the transducer system is initialized.

The first technique is to update the coarse position based upon the fine position. When $FINE_PRI_POS = 1000$, the coarse position is incremented by one count and $FINE_PRI_POS$ is reset to be equal to "000". More, generally $FINE_PRI_POS$ is divided by "1000" and the result is added to $COARSE_PRI_POS$, and $FINE_PRI_POS$ is reset to the local remainder.

If $FINE_PRI_POS$ goes negative, $COARSE_PRI_POS$ should be decremented and $FINE_PRI_POS$ reset accordingly. On an interim basis, the fine position should always be characterized by a magnitude and sign. When the reckoning for position is complete, then the fine position is always a positive number.

The second technique or method is to update the coarse position directly by measurement based on coarse track readings. To do this $FINE_PRI_POS$ is set equal to the appropriate value immediately after

the completion of the update.

The absolute primary velocity (HEX) is computed from the PRIMARY POSITION. Thus:

$$\text{ABS_PRI_VEL}(N) = [\text{PRI_POS}(N-1) - \text{PRI_POS}(N-2)] * (1/1000) * (60/T)_{\text{HEX}}$$

where T = cycle time, which is measured in decimal seconds.

The secondary position as a HEX number consists of:

$$\text{SEC_POS} = (\text{COARSE_SEC_POS} * 1000 + \text{SEC_FINE_POS}) * (101/100)_{\text{HEX}}$$

where SEC_FINE_POS is derived from JK counts, and SEC_FINE_POS = 000 at the end of each coarse secondary position determination cycle; where the fine track of the secondary encoder is "J", the quadrature track is "K" and the times four ("x4") composite signal is called "JK".

The first method for determining SEC_POS is to update the coarse position based upon the fine position. When SEC_FINE_POS = FF0, the coarse position is incremented by one count and SEC_FINE_POS is reset to "000". More generally, SEC_FINE_POS is divided by "FF0" and the result is added to COARSE_SEC_POS, and SEC_FINE_POS is reset to the local remainder.

If SEC_FINE_POS goes negative, COARSE_SEC_POS should be decremented, and SEC_FINE_POS reset accordingly. On an interim basis, fine position should always be characterized by a magnitude and sign. When the reckoning for position is complete, then the fine position is always a positive number.

The second method is to update the coarse position directly by measurement. SEC_FINE_POS is set to be equal to an appropriate value immediately after completion of the update.

In like fashion for PRI_POS, the first method should always be used. The second method should be used whenever there are no direction reversals during the measurement process. Likewise, for both PRI_POS and SEC_POS, appropriate "disagreement" rules (explained more fully below) are used to maintain the integrity of the data.

The absolute secondary velocity (HEX) is computed from the SECONDARY POSITION. Thus:

$$\text{ABS_SEC_VEL}(N) = [\text{SEC_POS}(N-1) - \text{SEC_POS}(N-2)] * (1/1000) * (60/T)_{\text{HEX}}$$

where T = cycle time, which is measured in decimal seconds.

Polarity reversal is necessary as a practical matter to meet different transducer mounting situations. This may be accomplished by the following algorithms expressed in HEX (2's complement):

$$\begin{aligned} \text{PRI_POS} &= 100000 - \text{PRI_POS} \\ \text{SEC_POS} &= 100000 - \text{SEC_POS} \end{aligned}$$

The primary velocity and the secondary velocity given above in the calculation subsection must be reversed when a polarity reversal is indicated. This can be done by changing the sign bit.

A speed check signal preferably is provided in association with the transducer system for door-zoned safety check. The software used preferably stresses fault discovery and automatic recovery, and two independent serial links (e.g. RS-422 type) preferably are used to facilitate connection of the transducer system to the elevator controller system.

A discrete speed check signal is provided to indicate that the speed (the magnitude of velocity) is below a prescribed threshold called the speed check. This signal goes "high" whenever both the primary and secondary speeds are below the threshold speed. Otherwise, the signal is "low". It becomes active within, for example, one hundred (100 ms) milliseconds after power is applied to the transducer.

It is possible to set two check speeds in the range of, for example, eight to sixty-four (8-64 rpm) revolutions per minute in an EPROM as variables in a given building. The factory setting for the threshold can be, for example, 27.38 rpm (which is 145 fpm with a 20.231" diameter sheave). By means of jumpers one can choose an alternative check speed of, for example, 17.94 rpm (95 fpm). The speed check signals should be accurate to within at least ± 1.5 rpm and include, for example, a half (0.5) rpm of hysteresis.

With battery backup, position information is remembered for at least one hour (example) after building power failure. The data is updated in memory preferably at least every ten (10ms.) milliseconds (for example).

The primary advantages of the invention are its safety, reliability, exceptionally high resolution and accuracy, serviceability, and relatively moderate installation cost.

The invention may be practised in a wide variety of elevator systems, utilizing known technology in the light of the teachings of the invention, which are discussed in detail hereafter.

Other advantages will be apparent from the specification and claims and from the accompanying drawings, which illustrate an exemplary embodiment of the invention.

5 Figure 1 is a simplified diagram, partially broken away, of an exemplary known elevator system in which the exemplary embodiment of the smart position transducer system of the present invention may be incorporated.

Figure 2 is a simplified, schematic block diagram of an exemplary known car controller, which may be employed in the system of Figure 1, and in which the invention may be implemented.

10 Figure 3 is a simplified block diagram showing the interfacing of the motion control subsystem (MCSS) for the elevator car with its various related subsystems, including the exemplary "smart" primary position transducer's central processing unit (SPPT-CPU) and the primary position transducer (PPT) of the present invention.

Figure 4 is a schematic diagram providing the circuit detail for the buffered comparator shown in Figure 15 6, which provides the speed check function of the present invention.

Figure 5 is a functional block diagram of the "smart" primary position transducer circuit board assembly (SPPT CBA) of the exemplary embodiment of the present invention, showing the interfacing of its various elements through the Address/Data buses and I/O ports.

20 Figure 6 is a simplified block diagram of the exemplary electronic system for the "smart" primary position transducer (SPPT) of the present invention, the circuit detail for the buffered comparator of which is shown in Figure 4.

Figure 7 is a simplified, electro-mechanical block diagram of a second embodiment SPPT using absolute encoders.

For the purposes of detailing an exemplary application of the present invention, reference is made to 25 our U.S. Patent 4,363,381.

The preferred application for the present invention is in an elevator control system employing a micro-processor-based group controller dispatcher using signal processing means, which communicates with the cars of the elevator system to determine the conditions of the cars, particularly their vertical positions in the building, and, for example, responds to hall calls registered at a plurality of landings in the building serviced 30 by the cars under the control of the group controller.

It is noted that Figures 1 & 2 hereof are substantively identical to the same figures of the '381 patent. For the sake of brevity the elements of Figures 1 & 2 are merely outlined or generally described below while any further, desired operational detail can be obtained from the '381 patent, as well as other of our prior patents.

35 In Figure 1, a plurality of exemplary hoistways, HOISTWAY "A" 1 and HOISTWAY "F" 2 are illustrated, the remainder not being shown for simplicity purposes. In each hoistway, an elevator car or cab 3, 4 is guided for vertical movement on rails (not shown).

Each car is suspended on a steel cable 5, 6, that is driven in either direction or held in a fixed position by a drive sheave/motor/brake assembly 7, 8, and guided by an idler or return sheave 9, 10 in the well of 40 the hoistway. The cable 5, 6 normally also carries a counterweight 11, 12, which is typically equal to approximately the weight of the cab when it is carrying half of its permissible load.

Each cab 3, 4 is connected by a travelling cable 13, 14 to a corresponding car controller 15, 16, which is typically located in a machine room at the head of the hoistways. The car controllers 15, 16 provide operation and motion control to the cabs, as is known in the art.

45 In the case of multi-car elevator systems, it has long been common to provide a group controller 17, which receives up and down hall calls registered on hall call buttons 18-20 on the floors of the buildings and allocates those calls to the various cars for response, and distributes cars among the floors of the building, in accordance with any one of several various modes of group operation. Modes of group operation may be controlled in part, for example, by a lobby panel ("LOB PNL") 21, which is normally connected by suitable 50 building wiring 22 to the group controller in multi-car elevator systems.

The car controllers 15, 16 also control certain hoistway functions, which relate to the corresponding car, such as the lighting of "up" and "down" response lanterns 23, 24, there being one such set of lanterns 23 assigned to each car 3, and similar sets of lanterns 24 for each other car 4, designating the hoistway door where service in response to a hall call will be provided for the respective up and down directions.

55 In the prior art the position of the car within the hoistway is derived from a primary position transducer ("PPT") 25, 26. Such a transducer is driven by a suitable sprocket 27, 28 in response to a steel tape 29, 30, which is connected at both of its ends to the cab and passes over an idler sprocket 31, 32 in the hoistway well.

Similarly, although not required in an elevator system to practice the present invention, a secondary position transducer ("SPT") 33, 34 may be employed for obtaining additional detailed positional information at each floor for more door control and for verification of floor position information derived by the "PPT" 25, 26. Or, if desired, the elevator system in which the present invention is practised may employ inner door zone and outer door zone hoistway switches of the type known in the art.

All of the functions of the cab itself may be directed, or communicated with, by means of a cab controller 35, 36 in accordance with the present invention, and may provide serial, time-multiplexed communications with the car controller, as well as direct, hard-wired communications with the car controller by means of the traveling cables 13 & 14. The cab controller, for instance, can monitor the car call buttons, door open and door close buttons, and other buttons and switches within the car. It can also control the lighting of buttons to indicate car calls and provide control over the floor indicator inside the car, which designates the approaching floor.

The cab controller 35, 36 may interface with load weighing transducers to provide weight information used in controlling the motion, operation, and door functions of the car.

An additional function of the cab controller 35, 36 is to control the opening and closing of the door, in accordance with demands therefor, under conditions which are determined to be safe.

The makeup of microcomputer systems, such as may be used in the implementation of the car controllers 15, 16, a group controller 17, and the cab controllers 35, 36, can be selected from readily available components or families thereof, in accordance with known technology, as described, for example, in various commercial and technical publications. The software structures for implementing the present invention, and peripheral features which may be disclosed herein, may be organized in a wide variety of fashions.

The foregoing is a description of an elevator system in general, and, as far as the description goes thus far, is equally descriptive of elevator systems known to the prior art, as well as an exemplary elevator system which could incorporate the teachings of the present invention.

The "smart" primary position transducer's central processor unit (SPPT-CPU) used in the present invention is a subsystem of the overall modular control system for the elevator system. It is designed to perform a number of tasks related to the position and velocity of the elevator with which it is associated and the status of the SPPT system as well.

The major function of the SPPT-CPU is to transform the accumulated pulse train signals received from the encoders into position and velocity information. This information, along with speed check and battery status, are communicated to the motion control subsystem (MCSS-CPU) for the elevator upon request.

As can be seen in Figure 3, the SPPT (which includes the encoder assembly or PPT) interfaces with the motion command subsystem (MCSS) and the power supply subsystem (PSSS, not shown) of the MCSS. In essence the SPPT is made up of the SPPT's CPU and the encoder assembly or PPT.

The SPPT-CPU hardware is comprised of two identical circuits for the counting and Storage of transducer inputs, configured into, for example, six basic elements. These exemplary basic elements include one circuit board assembly (CBA), one position transducer (PT), one position transducer housing, one battery backup, and two cable assemblies - one (W1, W2) for the encoder signal and the other (W3) for the power signal.

The exemplary CBA for the SPPT-CPU includes three connectors, two ten pin connectors (W1, W2) to the transducer encoder and a twenty-six pin connector (W3) to the MCSS-CPU and its power supply and backup battery. Through the latter connector (W3) the CBA interfaces with the primary position transducer (J2), the secondary position transducer (J1), the power supply and the battery backup (J3).

The J2 connector (PPT) receives the pulse train used to determine the position and direction of the travel of the elevator car. The secondary PT is mainly a backup system (through J1) to provide slowdown, if the PPT signals are lost when approaching either terminal landing.

All position and velocity signals can be in the form of "RS-422" serial communication.

Figure 5 shows the functional blocks of the SPPT CBA, showing the interfacing of its various elements through the Address/Data buses and I/O ports. The exemplary SPPT-CPU board includes:

- an 80C31 micro-controller;
- 128-byte internal RAM;
- synchronized encoder circuitry;
- a 20 bit pre-load up/down counter;
- 24 bit latched pre-load count and status;
- latched address/data multiplexed;
- coarse count and edge detect circuitry;
- watchdog circuitry;

- 8K X 8 program memory (EPROM); and
- devices select and serial communication interfaces; all as more particularly detailed in Figure 5. The secondary processor is similar, with the signals "J", "K", "B" and "A90" being substituted for the signals "X", "Y", "A" and "B90" of Figure 5, respectively.

- Encoders -

The PPT of the exemplary embodiment can use the same mechanical connections and electrical signals of its predecessor units.

The PPT includes two encoders coupled by, for example, 256:257 gearing. The encoders preferably are of identical design, and in the preferred embodiment contain two fine tracks each having one thousand and twenty four (1024) pulses per revolution (ppr), and two coarse tracks each having one ppr.

Each pair of tracks produce signals that are in quadrature with each other. Further, the registration between the coarse and fine tracks is controlled.

The directly-driven encoder is termed the "primary encoder" and is connected directly to an appropriately toothed gear, for example, a two hundred and fifty-six (256) tooth gear. The other encoder is termed the "secondary encoder" and is connected to the primary encoder by means of a different toothed gear, for example, a two hundred and fifty-seven (257) tooth gear. The difference in the number of teeth in the gears used for the otherwise identical two transducers produces a non-1:1 ratio, namely in the preceding example, a 257/256 ratio of secondary to primary.

Exemplary signal definitions for the two encoders are outlined below

Primary Encoder

- "X" - 1024 ppr fine track;
- "Y" - 1024 ppr fine quadrature track
- "A" - 1.0 ppr coarse track
- "A90" - 1.0 ppr coarse quadrature track.

In the case of the secondary encoder, signals "J", "K", "B" & "B90" correspond, respectively, to "X", "Y", "A" & "A90" for the primary encoder.

Each set of signals is derived from an encoder whose design preferably is identical to the other encoder. The periods of the signals coming from the secondary encoder are, in the exemplary embodiment, "257/256" times those for the primary encoder.

The main and quadrature fine track signals are processed by external circuitry, well known to those of ordinary skill in the art. This processing results in a "x4" (four times) frequency multiplication, and a determination of the direction of rotation. For each upward and downward transition on the main and quadrature tracks, an upward going transition occurs in the output of the "x4" multiplication circuitry. The performance of the position transducer is evaluated by examining the fine track signals, as processed by the multiplication circuitry.

Between the upward and downward transitions for each coarse track, there are, for example, two thousand and forty eight plus or minus one transition ($2,048 \pm 1$), in the associated "x4" fine track.

For clockwise rotation of the input shaft, the offset between upward transitions of signals "A" and "A90" will be one thousand and twenty four plus or minus one ($1,024 \pm 1$) "x4" "XY"-track counts. Similarly, the offset between upward transitions of signals "B" and "B90" will be one thousand and twenty four plus or minus one ($1,024 \pm 1$) "x4" "JK"-track counts.

Performance is characterized by a measurement of "x4" (four times) "XY"-track counts between upward transitions of the "A" & "B90" tracks, as the input shaft is rotated clockwise (from the perspective of viewing the instrument's input shaft). For each revolution of the input shaft a new count is developed and two hundred and fifty six (256) distinct counts may be obtained. The pattern of "256" counts repeats as the input shaft is turned.

For a counterclockwise rotation of the input shaft, the "x4" "XY"-track counts preferably are measured between downward transitions of the "B90" and "A" tracks. This procedure assures the use of the same mechanical reference points in the instrument.

The count can go to, for example, four thousand and ninety six (4,096), which is "1000" in hexadecimal form ("HEX"). The last HEX digit is called the "remainder". The scatter of the remainder numbers determines the quality of the position transducer.

It is desirable that the remainder, as defined above, shall remain within a boundary of plus or minus two (± 2). This means that all 256 test numbers must have stable remainders for all specified speeds, in both

directions of rotation, independent of temperature, etc.

The remainder, as defined above, is measured for all rotations of the input shaft using the "A90" and "B" tracks instead of the "A" and "B90" tracks. The remainder thus measured is the quadrature remainder. It should meet the same requirements as the other remainder.

5 To connect the encoders of the "smart" transducer to the SPPT CBA two cables of, for example, the ribbon form, are used. These cables are terminated in appropriate connectors.

The main channel leads the quadrature channel for clockwise rotation of the shaft, as viewed from the shaft end of the units. This applies to (X, Y), (J, K), (A, A90) and (B, B90) and their complements.

10 With the input shaft rotating clockwise, the primary encoder turns clockwise, while the secondary encoder turns counter-clockwise. Thus, "X" leads "Y", "K" leads "J", "A" leads "A90" and "B90" leads "B".

- DETERMINATION OF POSITION & VELOCITY INFO. -

15 As noted above, in the exemplary embodiment the encoders have two sets of direct and quadrature tracks. The fine tracks produce 1024 pulses per revolution, and the coarse tracks are one ppr. When combined with times four (x4) circuitry, the effective resolution of the fine tracks is four thousand and ninety six (4,096) pulses (12 bits) per revolution. The coarse track geometry is very carefully controlled.

20 The primary encoder is directly driven, while the secondary encoder is driven through a gear system (as shown in the Masel et al patent for the preferred embodiment and in Figure 7 for a second embodiment). In the preferred embodiment, position increments are derived from the primary fine tracks. Absolute position at "256" points (8 bit) can be established from the (spatial) phase of one coarse track on the primary encoder with respect to a coarse track on the secondary encoder. To determine coarse track phasing may require as many as two revolutions of the input shaft. The total range of the transducer is defined by "256" revolutions of the input shaft.

25 The absolute position readouts are characterized by (spatially derived) signals that can go to 4096 or "1000" in hexadecimal. The first part of the HEX number is coarse position (zones 0 to 255 decimal). The last digit is the remainder number. The transducer is designed so that the remainder is close to "8" HEX to permit ignoring it using a truncation (shift right) operation.

30 The determination of position for the primary channel requires the finding of coarse position and then adding incrementally derived fine positions to it. Further, for reasons of elevator safety, a redundant secondary position is required. This is accomplished using hardware that is independent of that used for the primary position.

35 Described below are the procedures which can be used to find the primary and secondary position and velocity. The basic signal processing operations and power supply subsystem are shown in the block diagram of Figure 6. Exemplary details of the speed check circuitry of Figure 6 are shown in Figure 4. As can be seen in Figure 4, comparators for the primary velocity signal (PRI. VEL.) and the secondary velocity signal (SEC. VEL.) using a "REFERENCE SIGNAL" are sent to an "AND" gate, which when the signals are appropriately related sends out "SAFE" signals through an "RS-422 DRIVER".

40 A second embodiment of an encoder for use in an SPPT using absolute encoders is depicted in the electromechanical block diagram of Figure 7, in which the "INPUT SHAFT" drives a twelve (12) bit absolutely encoded disk. This same "INPUT SHAFT" drives gearing that turns one or more turns-counting coarse disks through gearing. A pair of exemplary two such coarse disks, "COARSE #1 disk" and "COARSE #2 disk" being illustrated. Each disk has two independent read-heads, namely, "FP" & "FS" for the "FINE DISK", and "C1P" & "C1S" for "COARSE #1 DISK", and "C2P" & "C2S" for "COARSE #2 DISK," respectively, for the primary & secondary signals, respectively. The signals from the primary read-heads are input to the primary processor, while those from the secondary read-heads are input to the secondary processor, shown in Fig. 7. The primary and secondary processors are independent. These processors are connected to speed-check circuitry, which can be of the comparator type shown in Figure 4.

50 The encoders and electronic assemblies are typically housed in a common case.

For the preferred embodiment, using the processing of Figure 6, the fine counts are derived from the fine tracks on each encoder. Times four "x4" multiplication is provided so that every edge of each direct and quadrature track pair is utilized. The track processing hardware and software provides either a separation of pulses resulting from opposite directions of rotation, or assignment of a sign to each pulse based on direction of rotation.

55 The fine track of the primary encoder is "X" and the quadrature track is "Y". The "x4" composite signal is called "XY". 4096 ("1000" HEX) XY pulses are produced per revolution of the input shaft. 256 revolutions of the input shaft produces "100000" HEX (1,048,576) counts.

The fine track of the secondary encoder is "J" and the quadrature track is "K". The "x4" composite signal is called "JK". JK counts may be referenced to XY counts by multiplying the JK counts by $257/256 = 1 + 1/256$. In HEX arithmetic this may be accomplished by adding the JK count to the JK count with the two least significant digits truncated. JK counts referenced to the primary encoder should meet the same specifications as the XY counts.

The primary and secondary coarse positions are defined by measuring the number of fine counts between transitions defined by the coarse tracks. Definitions are given for a transducer having clockwise (viewing the instrument shaft) as a positive direction. The transducer should also be capable of operating with counter-clockwise defined as the positive direction. The technique for realizing a reverse-direction transducer is provided below.

The primary encoder coarse track is called "A" and the associated quadrature track is called "A90". The corresponding terminology applied to the secondary encoder is "B" and "B90".

For clockwise rotation of the input shaft, coarse primary position is found by first determining the number of "XY" counts between an upward transition of A to the immediately following upward transition of B90. The last four (4) bits are then truncated from the XY count to obtain the coarse position. These truncated bits define the remainder number.

For counter-clockwise rotation of the input shaft, XY counts are determined from a downward transition of B90 to the next downward transition of A. The coarse position and remainder number are defined as before.

The measurement procedure assures the use of the same mechanical reference points in the transducer instrument.

Similarly for clockwise rotation of the input shaft, coarse secondary position is found by first determining the number of JK counts between an upward transition of A90 to the immediately following upward transition of B. The JK count is next referenced to the primary fine count by multiplying by $257/256$. The truncated portion is then truncated from the derived XY count to obtain the coarse position. The truncated portion is called the quadrature remainder number.

For counter-clockwise rotation of the input shaft, JK counts are determined from a downward transition of B to the next downward transition of A90. The coarse position and quadrature remainder number are defined as before.

As above, the measurement procedure assures the use of the same mechanical reference points in the instrument.

** Primary Position **

Primary position as a HEX number consists of:

$$\text{PRI_POS} = \text{COARSE_PRI_POS} * 1000 + \text{FINE_PRI_POS}$$

where FINE_PRI_POS is derived from the XY counts and equals "000" at the end of each coarse primary position determination cycle.

Two basic techniques exist for determination of primary position once the transducer system is initialized.

The first technique is to update the coarse position based upon the fine position. When FINE_PRI_POS = 1000, the coarse position is incremented by one count and FINE_PRI_POS is reset to be equal to 000. More, generally, FINE_PRI_POS is divided by 1000 and the result is added to COARSE_PRI_POS, and FINE_PRI_POS is reset to the remainder (local remainder, not the previously defined remainder number).

If FINE_PRI_POS goes negative, COARSE_PRI_POS should be decremented and FINE_PRI_POS reset accordingly. On an interim basis, the fine position must always be characterized by a magnitude and sign. When the reckoning for position is complete, then fine position is always a positive number.

The second technique or method is to update the coarse position directly by measurement. To do this FINE_PRI_POS is set equal to the appropriate value immediately after the completion of the update.

The first technique or method should always be used, while the second technique or method should be used whenever no direction reversals are used during the measurement process.

A disagreement of up to, for example, ten (10) counts may be permitted without the need to reinitialize. If the disagreement is up to, for example, five (5) counts, no correction referenced to the second method is required. A disagreement in the range of, for example, five to ten (5-10) counts for, for example, two consecutive position determinations (for example) requires adjusting the method one position to agree with

the method two position.

** Primary Velocity **

5 The absolute primary velocity (HEX) is computed from the PRIMARY POSITION. Thus:

$$\text{ABS_PRI_VEL}(N) = [\text{PRI_POS}(N-1) - \text{PRI_POS}(N-2)] * (1/1000) * (60/T)_{\text{HEX}}$$

10 where N is the present cycle, N-1 is the previous cycle, etc., T = cycle time, which is measured in decimal seconds.

For T=10ms, (60/T) is HEX number 1770. The above expression should be scaled to a "0.25" rpm/count by multiplying by four (4). To get the PRI_VEL from the absolute value when the velocity is negative, 800 HEX should be added to the ABS_PRI_VEL.

5 For example, at 511.75 rpm the PRI_VEL = 7FF HEX.

15 It is FFF HEX at "-511.75" rpm.

The PRI_VEL should be subjected to a running average over a period of, for example, seventy to ninety milliseconds (70-90ms) prior to transmission.

The above computation should be first or very close to first in a cycle to assure accuracy. It should be noted that the velocity is determined using position data from two previous cycles.

20

**Secondary Position **

The secondary position as a HEX number consists of:

$$\text{SEC_POS} = (\text{COARSE_SEC_POS} * 1000 + \text{SEC_FINE_POS}) * (101/100)_{\text{HEX}}$$

25 where SEC_FINE_POS is derived from JK counts, and SEC_FINE_POS = 000 at the end of each coarse secondary position determination cycle.

30 Two basic techniques or methods exist for the determination of secondary position once the transducer system has been initialized.

The first method is to update the coarse position based upon the fine position. When SEC_FINE_POS = FF0, the coarse position is incremented by one count and SEC_FINE_POS is reset to "000". More generally, SEC_FINE_POS is divided by "FF0" and the result is added to COARSE_SEC_POS, and SEC_FINE_POS is reset to the remainder (local remainder, not the previously defined remainder number).

35 If SEC_FINE_POS goes negative, COARSE_SEC_POS should be decremented, and SEC_FINE_POS reset accordingly. On an interim basis, fine position should always be characterized by a magnitude and sign. When the reckoning for position is complete, then the fine position is always a positive number.

40 The second method is to update the coarse position directly by measurement. SEC_FINE_POS is set to be equal to an appropriate value immediately after completion of the update.

The first method should always be used. The second method should be used whenever there are no direction reversals during the measurement process.

45 A disagreement of up to ten (10) counts may be permitted without the need to re-initialize. If the disagreement is up to, for example, five (5) counts (for example), no correction referenced to the second method is required. A disagreement in the range of five to ten (5-10) counts for two consecutive position determinations (for example) requires adjusting the method one position to agree with the method two position.

50 **Secondary Velocity **

The absolute secondary velocity (HEX) is computed from the SECONDARY POSITION. Thus:

$$\text{ABS_SEC_VEL}(N) = [\text{SEC_POS}(N-1) - \text{SEC_POS}(N-2)] * (1/1000) * (60/T)_{\text{HEX}}$$

55

where T = cycle time, which is measured in decimal seconds.

For T=10ms, (60/T) is HEX number 1770. The above expression should be scaled to a 0.25 rpm/count by multiplying by four (4). To get the SEC_VEL from absolute value when the velocity is negative, 800

HEX should be added to the ABS__SEC__VEL.

For example, at 511.75 rpm the SEC__VEL = 7FF HEX. It is FFF HEX at -511.75 rpm.

The SEC__VEL should be subjected to a running average over a period of, for example, seventy to ninety milliseconds (70-90ms) prior to transmission.

5 ** Initialization **

10 Initialization is the determination of the coarse position after the first power up or after a request to reset the processor system. Primary and secondary position and battery condition are transmitted according to the protocol desired. If the coarse position is unknown, then the transducer signals this by transmitting the position as "00000H". The elevator should respond by slowly moving down unless it is determined to be too close (less than, for example, four meters) to the lowest landing.

15 It is highly desirable that the system includes a speed check. Such a speed check should become active within, for example, one hundred milliseconds (100ms) of power application. Unless the speed check signal is high (safe), initialization should not be allowed to start.

20 The transducer should determine the primary and secondary positions according to the indicated second methods above. Once accomplished, the transducer will be prepared within, for example, one processor cycle to transmit both the primary and secondary positions to the elevator system. The elevator system will continue to run a short distance even if both positions are not established. It will expect that both position signals will be established within, for example, a half meter (0.5m; $\frac{1}{4}$ revolution, nominal) of each other. The half meter distance should be established by the elevator system using both the acquired position signal and the permitted running time.

25 Failure to initialize will cause the elevator system to stop and also send a reset signal to the transducer. Initialization will then be attempted one or more times before the elevator enters the "rescue" mode and finally is closed down for service.

 An exemplary battery backup system should retain all stored information for, for example, an hour after any loss of main power. Within that time period, reinitialization typically should not be necessary.

30 **Polarity Reversal **

 Polarity reversal is necessary as a practical matter to meet different transducer mounting situations. This may be accomplished by the following algorithms expressed in HEX (2's complement):

$$\begin{aligned} \text{PRI_POS} &= 100000 - \text{PRI_POS} \\ \text{SEC_POS} &= 100000 - \text{SEC_POS} \end{aligned}$$

 The primary velocity and the secondary velocity given above in the calculation subsection must be reversed when a polarity reversal is indicated. This can be done by changing the sign bit.

40 ** Independence, Adjustments & Safeguards **

 In the "real world," adjustments to the data are required because of, for example, imperfections in encoders and the basic characteristics of the transducer system.

45 For example, two (2) counts should be added to the un-truncated, primary, coarse position, so that on average the remainder number preferably is, for example, 8. A similar procedure should be followed for the secondary coarse position: two counts should be subtracted from the un-truncated, coarse, secondary position.

 Additionally, the secondary position should be made to register with the primary position within, for example, five (5) counts.

50 In data transmission the secondary position signal may be truncated to the most significant sixteen (16) bits of data prior to transmission.

 Vibratory motion of the transducer input shaft about a reference point could lead to errors, especially in the determination of coarse position. Thus, all coarse position measurements based on the second method above should be carried out in their entirety only when the motion of the elevator car is in one direction.

55 The first method above may be used for all speeds.

 In order to assure independence and the integrity of the primary position information, the signals A and B90 should be monitored every process cycle. The integrity of these signals should be established by checking the "on" and "off" periods in terms of the XY counts. The period for A should be, for example,

2048±35 counts, while the period for B90 should be 2056±35 counts.

Likewise, in order to assure the independence and integrity of the secondary position information, the signals A90 and 13 should be monitored every process cycle. The integrity of these signals should be established by checking the "on" and "off" periods in terms of the JK counts. The period for A90 should be, for example, 2040±35 counts, while the period for B should be 2048±35 counts.

Upon detection of any fault in a processing channel, the "not initialized" signal should be transmitted on that channel. Simultaneously, recovery action should commence.

Although this invention has been shown and described with respect to detailed, exemplary embodiments thereof, it should be understood by those skilled in the art that various changes in form, detail, methodology and/or approach may be made without departing from the scope of this inventions as defined by the claims.

Claims

1. An elevator system, in which there is at least one elevator car (3,4) whose speed is controlled by a motion control subsystem and in which there is included a transducer system (PT) for determining the vertical position of the car (3,4) in the elevator run by providing a binary representation of the number of revolutions made by a rotatable shaft to which a transducer is connected, said transducer system including:
 - a first encoder element having one coarse indicium and a first large number of fine indicia thereon; characterized by
 - a pair of fine sensing means oriented with respect to said fine indicia to provide, for each revolution of said shaft, a series of pairs of fine signals in quadrature relation to each other;
 - a pair of coarse sensing means, one being responsive to said coarse indicium to provide one coarse signal;
 - a second encoder element disposed to said shaft in a manner to rotate one more time than said first encoder element as said first encoder element rotates a second large number of times, of the order of said first large number, across a range of permissible elevator positions, said second encoder element having a coarse indicium thereon related to the other of said coarse pair of sensing means for providing a second coarse signal in quadrature with said one coarse signal for each revolution of said shaft;
 - a first signal processing means responsive to said fine signals and to said coarse signals for providing a first elevator position signal as the summation of (1) coarse positions indicated by the number of said fine indicia sensed between provision of one of said coarse signals and the provision of the other of said coarse signals in each revolution of said shaft, with (2) fine positions indicated by the accumulation within each revolution of said shaft of the number of said fine indicia sensed in such revolution of said shaft;
 - a second signal processing means responsive to said fine signals for providing a second elevator position signal as the summation of said fine signals as said elevator travels within said range of permissible elevator positions; and
 - means for comparing said first elevator position signal with said second elevator position signal and for providing a fault signal indicating a fault in the event the positions indicated by said first and second elevator signals differ by more than a predetermined magnitude.
2. The elevator system of claim 1, wherein said first encoder element includes a single, rotatable encoder disk with at least two encoded tracks and at least two read-heads associated with said tracks producing said signals.
3. The elevator system of claim 1 or 2, wherein said first and second encoder elements each comprise an encoder disk disposed for rotation with said shaft.
4. The elevator system of any of claims 1 to 3, further comprising:
 - means providing a first check signal indicative of the number of said fine signals which should be normally provided during the sensing of said first coarse indicium;
 - means providing a second check signal indicative of the number of said fine signals which should be normally provided during the sensing of said second coarse indicium;
 - means responsive to said fine signals and to said coarse signals for counting the number of fine signals which appear during each of said coarse signals and providing corresponding first and second



2048±35 counts, while the period for B90 should be 2056±35 counts.

Likewise, in order to assure the independence and integrity of the secondary position information, the signals A90 and 13 should be monitored every process cycle. The integrity of these signals should be established by checking the "on" and "off" periods in terms of the JK counts. The period for A90 should be, for example, 2040±35 counts, while the period for B should be 2048±35 counts.

Upon detection of any fault in a processing channel, the "not initialized" signal should be transmitted on that channel. Simultaneously, recovery action should commence.

Although this invention has been shown and described with respect to detailed, exemplary embodiments thereof, it should be understood by those skilled in the art that various changes in form, detail, methodology and/or approach may be made without departing from the scope of this inventions as defined by the claims.

Claims

1. An elevator system, in which there is at least one elevator car (3,4) whose speed is controlled by a motion control subsystem and in which there is included a transducer system (PT) for determining the vertical position of the car (3,4) in the elevator run by providing a binary representation of the number of revolutions made by a rotatable shaft to which a transducer is connected, said transducer system including:
 - a first encoder element having one coarse indicium and a first large number of fine indicia thereon; characterized by
 - a pair of fine sensing means oriented with respect to said fine indicia to provide, for each revolution of said shaft, a series of pairs of fine signals in quadrature relation to each other;
 - a pair of coarse sensing means, one being responsive to said coarse indicium to provide one coarse signal;
 - a second encoder element disposed to said shaft in a manner to rotate one more time than said first encoder element as said first encoder element rotates a second large number of times, of the order of said first large number, across a range of permissible elevator positions, said second encoder element having a coarse indicium thereon related to the other of said coarse pair of sensing means for providing a second coarse signal in quadrature with said one coarse signal for each revolution of said shaft;
 - a first signal processing means responsive to said fine signals and to said coarse signals for providing a first elevator position signal as the summation of (1) coarse positions indicated by the number of said fine indicia sensed between provision of one of said coarse signals and the provision of the other of said coarse signals in each revolution of said shaft, with (2) fine positions indicated by the accumulation within each revolution of said shaft of the number of said fine indicia sensed in such revolution of said shaft;
 - a second signal processing means responsive to said fine signals for providing a second elevator position signal as the summation of said fine signals as said elevator travels within said range of permissible elevator positions; and
 - means for comparing said first elevator position signal with said second elevator position signal and for providing a fault signal indicating a fault in the event the positions indicated by said first and second elevator signals differ by more than a predetermined magnitude.
2. The elevator system of claim 1, wherein said first encoder element includes a single, rotatable encoder disk with at least two encoded tracks and at least two read-heads associated with said tracks producing said signals.
3. The elevator system of claim 1 or 2, wherein said first and second encoder elements each comprise an encoder disk disposed for rotation with said shaft.
4. The elevator system of any of claims 1 to 3, further comprising:
 - means providing a first check signal indicative of the number of said fine signals which should be normally provided during the sensing of said first coarse indicium;
 - means providing a second check signal indicative of the number of said fine signals which should be normally provided during the sensing of said second coarse indicium;
 - means responsive to said fine signals and to said coarse signals for counting the number of fine signals which appear during each of said coarse signals and providing corresponding first and second



count signals indicative thereof; and

means responsive to said first and second check signals and to said first and second count signals for comparing said first check signal with said first count signal, for providing a fault signal in the event that said first count signal indicates a count which differs from the count indicated by said first check signal by more than a first predetermined magnitude, for comparing said second check signal with said second count signal, and for providing said fault signal in the event that said second count signal indicates a count which differs from the count indicated by said second check signal by more than a second predetermined magnitude.

5. The elevator system of any preceding claim, further comprising speed check means, said speed check means comprising:

means related to said first sensing means, for providing, in a series of processing cycles, signal manifestations of successive positions of said elevator in response to indication of said indicia provided thereto by said first sensing means, for providing, in response to the respective signal manifestations in a plurality of cycles, a first elevator velocity signal for a subsequent cycle;

means related to said second sensing means, for providing, in a series of processing cycles, signal manifestations of successive positions of said elevator in response to indications of said indicia provided thereto by said second sensing means, for providing, in response to the respective signal manifestations in a plurality of cycles, a second elevator velocity signal for a subsequent cycle;

means for providing a maximum velocity signal indicative of a predetermined velocity which said elevator is not to exceed; and

means responsive to said first and second elevator velocity signals and to said maximum velocity signal for providing a safe signal indicative of safe elevator operation only when said first elevator velocity signal and said second elevator velocity signal both indicate a velocity less than the velocity indicated by said maximum velocity signal.

6. The elevator system of claim 5, wherein said speed check means derives a door zone speed check signal from a combination of said first and second elevator velocity signal, providing an independent means for checking elevator car speed in the door zone.

7. The elevator system of any preceding claim, further comprising transducer checking means comprising:

means for comparing the number of said fine indicia sensed within the duration of each one of said coarse indicia and providing a fault signal in the event that any said number of said fine indicia differs from a corresponding predetermined number by a related, corresponding threshold magnitude.

8. The elevator system of any preceding claim, wherein said second encoder element is coupled to said first encoder element by gearing, which causes said encoder elements to rotate at different rotational speeds, providing secondary position and velocity signals indicative of the location and velocity of the elevator car; each of said encoder elements including at least one fine track and at least one relatively coarse track each made of sensible indicia, said fine track having many more sensible indicia in its track in comparison to said coarse track; and

position and velocity determination means associated with said encoder elements for generating signals indicative of the position and the velocity of the elevator car using two independent channels, providing with said sensing means effective means for generating at least two independent position and speed signals using a single input shaft.

9. The elevator system of claim 8, wherein

said first and said second encoder elements each include an encoded track utilizing read-heads in association with each encoded track.

10. The elevator system of claim 8 or 9 wherein

said position and velocity determination means generates signals based on the relationship of finding the coarse position and then adding incrementally derived fine positions to it.

11. The elevator system of claim 8 or 9 wherein

said position and velocity determination means generates signals based on two methods, a first method of updating the coarse position based on the fine position, and a second method based on



updating the coarse position directly by measurement.

12. The elevator system of claim 11, wherein
 said position and velocity determination means, when in operation, always generates signals based
 on said first method and generates signals based on said second method whenever the direction of the
 car does not reverse during the cycle of the measurement involved.

13. The elevator system of claim 12, wherein
 said position and velocity determination means follows a "disagreement" algorithm based on the
 comparison of the position signals generated in said first method to the signals generated in said
 second method to maintain the integrity of the data represented by said signals.

14. The elevator system of any of claims 8 to 13, wherein
 said gearing includes mating gear wheels having 256 teeth on the gear wheel of said first encoder
 element and 257 teeth on the gear wheel of said second encoder element.

15. The elevator system of any of claims 8 to 14, wherein said position and velocity determination means
 generates signals indicative of primary position (PRI_POS) based on the relationship expressed as a
 HEX number of:

$$\text{PRI_POS} = \text{COARSE_PRI_POS} * 1000 + \text{FINE_PRI_POS}$$

where FINE_PRI_POS is derived from the XY counts and equals "000" at the end of each coarse
 primary position determination cycle; where the fine track of the first encoder element is "X", the
 quadrature track is "Y", and the times four ("x4") composite signal is "XY".

16. The elevator system of any of claims 8 to 15, wherein said position and velocity determination means
 generates signals indicative of the absolute primary velocity (ABS_PRI_VEL) based on the relation-
 ship expressed as a HEX number of:

$$\text{ABS_PRI_VEL}(N) = [\text{PRI_POS}(N-1) - \text{PRI_POS}(N-2) / 1000] * (60/T)_{\text{HEX}}$$

where T = cycle time.

17. The elevator system of any of claims 8 to 16, wherein said position and velocity determination means
 generates signals indicative of secondary position (SEC_POS) based on the relationship expressed as
 a HEX number of:

$$\text{SEC_POS} = (\text{COARSE_SEC_POS} * 1000 + \text{SEC_FINE_POS}) * (101/100)_{\text{HEX}}$$

where SEC_FINE_POS is derived from JK counts, and SEC_FINE_POS = 000 at the end of each
 coarse secondary position determination cycle; where the fine track of the second encoder element is
 "J", the quadrature track is "K" and the times four ("x4") signal is "JK".

18. The elevator system of any of claims 8 to 17, wherein said position and velocity determination means
 generates signals indicative of absolute secondary velocity (ABS_SEC_VEL) based on the relation-
 ship expressed as a HEX number of:

$$\text{ABS_SEC_VEL}(N) = [\text{SEC_POS}(N-1) - \text{SEC_POS}(N-2) / 1000] * (60/T)_{\text{HEX}}$$

where T = cycle time.

19. The elevator system of any of claims 8 to 18, wherein the transducer includes polarity reversal means
 for reversing the signal polarity by the following algorithm express in HEX (2's complement):

$$\begin{aligned} \text{PRI_POS} &= 100000 - \text{PRI_POS} \\ \text{SEC_POS} &= 100000 - \text{SEC_POS} \end{aligned}$$



with the primary velocity and the secondary velocity being reversed when a polarity reversal is indicated by changing the sign bit of the signal.

5 Patentansprüche

1. Aufzugsystem, mit mindestens einem Aufzugfahrkorb (3, 4), dessen Geschwindigkeit von einem Bewegungssteuersubsystem gesteuert wird, und mit einem Wandlersystem (PT) zum Bestimmen der vertikalen Position des Fahrkorbs (3, 4) in dem Aufzugschacht, indem eine binäre Darstellung der Anzahl von Umdrehungen erzeugt wird, die eine Drehwelle macht, an der ein Wandler angebracht ist, wobei das Wandlersystem enthält:
 - ein erstes Codierelement mit einer auf ihm vorgesehenen Grobmarkierung und einer ersten großen Anzahl von Feinmarkierungen; gekennzeichnet durch
 - ein Paar von Feinfühleinrichtungen, die in Bezug auf die Feinmarkierungen so orientiert sind, daß sie für jede Umdrehung der Welle eine Reihe von Paaren von Feinsignalen liefern, die zueinander in Quadraturbeziehung stehen;
 - ein Paar von Grobfühleinrichtungen, von denen eine auf die Grobmarkierung anspricht, um ein Grobsignal zu liefern;
 - ein zweites Codierelement, welches an der Welle derart angeordnet ist, daß es sich einmal mehr dreht als das erste Codierelement, wenn das erste Codierelement sich eine zweite große Anzahl von Malen, die in der Größenordnung der ersten großen Anzahl liegt, in einem Bereich zulässiger Aufzugpositionen dreht, wobei das zweite Codierelement auf sich eine Grobmarkierung aufweist, die zu der anderen von dem Paar von Grobfühleinrichtungen in Beziehung steht, um ein zweites Grobsignal in Quadratur mit dem einen Grobsignal für jede Umdrehung der Welle zu liefern;
 - eine erste Signalverarbeitungseinrichtung, die auf die Feinsignale und auf die Grobsignale anspricht, um ein erstes Aufzugpositionssignal zu liefern in Form der Summierung von (1) Grobpositionen, die angegeben werden durch die Anzahl von Feinmarkierungen, die zwischen einem der Grobsignale und dem anderen der Grobsignale bei jeder Umdrehung der Welle gefühlt werden, und (2) Feinpositionen, die angegeben werden durch die innerhalb jeder Umdrehung der Welle erfolgende Akkumulation der Anzahl von bei jeder solchen Wellenumdrehung gefühlten Feinmarkierungen;
 - eine zweite Signalverarbeitungseinrichtung, die auf die Feinsignale anspricht, um ein zweites Aufzugpositionssignal bereitzustellen als die Summe der Feinsignale, wenn der Aufzug sich in dem Bereich zulässiger Aufzugpositionen bewegt; und
 - eine Einrichtung zum Vergleichen des ersten Aufzugpositionssignals mit dem zweiten Aufzugpositionssignal, und zum Bereitstellen eines Fehlersignals, welches für den Fall einen Fehler anzeigt, daß die von dem ersten und dem zweiten Aufzugsignal angezeigten Positionen um mehr als einen vorbestimmten Betrag voneinander abweichen.
2. Aufzugsystem nach Anspruch 1, bei dem das erste Codierelement eine einzelne, drehbare Codierscheibe mit mindestens zwei Codierspuren, und mindestens zwei Leseköpfe enthält, die zum Erzeugen der Signale den Spuren zugeordnet sind.
3. Aufzugsystem nach Anspruch 1 oder 2, bei dem das erste oder das zweite Codierelement jeweils eine Codierscheibe aufweisen, die zur Drehung mit der Welle angeordnet ist.
4. Aufzugsystem nach einem der Ansprüche 1 bis 3, weiterhin umfassend:
 - eine Einrichtung zum Bereitstellen eines ersten Prüfsignals, welches die Anzahl von Feinsignalen angibt, die normalerweise während des Fühlens der ersten Grobmarkierung geliefert werden sollten;
 - eine Einrichtung zum Bereitstellen eines zweiten Prüfsignals, welches die Anzahl von Feinsignalen angibt, die normalerweise während des Fühlens der zweiten Grobmarkierung geliefert werden sollten;
 - eine auf die Feinsignale und die Grobsignale ansprechende Einrichtung zum Zählen der Anzahl von Feinsignalen, die während jedes der Grobsignale auftreten, um entsprechende erste und zweite Zähler signale bereitzustellen; und
 - eine auf das erste und das zweite Prüfsignal sowie auf das erste und das zweite Zähler signal ansprechende Einrichtung zum Vergleichen des ersten Prüfsignals mit dem ersten Zähler signal, um ein Fehlersignal zu erzeugen, falls das erste Zähler signal einen Zählerwert angibt, der von dem durch das erste Prüfsignal angegebenen Zählerwert um mehr als einen ersten vorbestimmten Betrag abweicht, um das zweite Prüfsignal mit dem zweiten Zähler signal zu vergleichen und das Fehlersignal für den Fall zu



liefern, daß das zweite Zählsignal einen Zählwert angibt, der von dem durch das zweite Prüfsignal angegebenen Zählwert um mehr als einen zweiten vorbestimmten Wert abweicht.

5. Aufzugssystem nach einem vorhergehenden Anspruch, weiterhin umfassend eine Geschwindigkeitsprüfeinrichtung, welche aufweist:
 - eine zu der ersten Fühleinrichtung in Beziehung stehende Einrichtung, um innerhalb einer Reihe von Verarbeitungszyklen ansprechend auf die von der ersten Fühleinrichtung gelieferte Anzeige der Markierungen Signaldarstellungen aufeinanderfolgender Positionen des Aufzugs zu schaffen, um ansprechend auf die Signaldarstellungen in mehreren Zyklen ein erstes Aufzugsgeschwindigkeitssignal für einen nachfolgenden Zyklus bereitzustellen;
 - eine zu der zweiten Fühleinrichtung in Beziehung stehende Einrichtung, um in einer Reihe von Verarbeitungszyklen Signaldarstellungen aufeinanderfolgender Positionen des Aufzugs in Abhängigkeit von ihm durch die zweite Fühleinrichtung zugeführten Anzeigen der Markierungen bereitzustellen, und um ansprechend auf die jeweiligen Signaldarstellungen in einer Mehrzahl von Zyklen ein zweites Aufzugsgeschwindigkeitssignal für einen nachfolgenden Zyklus bereitzustellen;
 - eine Einrichtung zum Liefern eines Maximalgeschwindigkeitssignals, das kennzeichnend für eine vorbestimmte Geschwindigkeit ist, die der Aufzug nicht überschreiten darf; und
 - eine auf das erste und das zweite Aufzugsgeschwindigkeitssignal und das Maximalgeschwindigkeitssignal ansprechende Einrichtung zur Bereitstellung eines Sigersignals, welches einen sicheren Aufzugsbetrieb bedeutet, nur dann, wenn das erste Aufzugsgeschwindigkeitssignal und das zweite Aufzugsgeschwindigkeitssignal beide eine Geschwindigkeit bedeuten, die geringer ist als die Geschwindigkeit, die durch das Maximalgeschwindigkeitssignal angegeben wird.
6. Aufzugssystem nach Anspruch 5, bei dem die Geschwindigkeitsprüfeinrichtung ein Türzonengeschwindigkeitssprüfsignal ableitet aus einer Kombination des ersten und des zweiten Aufzugsgeschwindigkeitssignals, um eine unabhängige Einrichtung zum Prüfen der Aufzugfahrgeschwindigkeit innerhalb der Türzone zu bilden.
7. Aufzugssystem nach einem vorhergehenden Anspruch, weiterhin umfassend eine Wandlerprüfeinrichtung, gekennzeichnet durch:
 - eine Einrichtung zum Vergleichen der Anzahl von Feinmarkierungen, die innerhalb der Dauer jedes einzelnen der Grobmarkierungen geföhrt werden, und zum Bereitstellen eines Fehlersignals für den Fall, daß irgendeine Anzahl der Feinmarkierungen von einer entsprechenden, vorbestimmten Anzahl um einen dazu in Beziehung stehenden entsprechenden Schwellenwert abweicht.
8. Aufzugssystem nach jedem vorhergehenden Anspruch, bei dem das zweite Codierelement mit dem ersten Codierelement über ein Getriebe gekoppelt ist, welches bewirkt, daß die Codierelemente sich mit unterschiedlichen Drehzahlen drehen, Sekundärpositions- und - Geschwindigkeitssignale liefern, die bezeichnend sind für die Lage und die Geschwindigkeit des Aufzugfahrkorbs; jedes der Codierelemente mindestens eine Feinspur und mindestens eine relativ grobe Spur aus jeweils empfindlichen Markierungen enthält, wobei die Feinspur viel mehr empfindliche Markierungen in ihrem Spurverlauf hat als die grobe Spur; und
 - eine Positions- und Geschwindigkeitsbestimmungseinrichtung in Verbindung mit den Codierelementen, um Signale zu erzeugen, die bezeichnend sind für die Position und die Geschwindigkeit des Aufzugfahrkorbs unter Verwendung zwei unabhängiger Kanäle, um durch die Fühleinrichtung eine effektive Einrichtung zum Generieren mindestens zweier unabhängiger Positions- und Geschwindigkeitssignale unter Verwendung einer einzigen Eingangswelle zu schaffen.
9. Aufzugssystem nach Anspruch 8, bei dem das erste und das zweite Codierelement jeweils eine kodierte Spur aufweisen, wobei Leseköpfe in Verbindung mit jeder kodierten Spur verwendet werden.
10. Aufzugssystem nach Anspruch 8 oder 9, bei dem die Positions- und Geschwindigkeitsbestimmungseinrichtung Signale generiert, basierend auf der Beziehung des Auffindens der Grobposition und des anschließenden inkrementellen Aufaddierens von abgeleiteten Feinpositionen.
11. Aufzugssystem nach Anspruch 8 oder 9, bei dem die Positions- und Geschwindigkeitsbestimmungseinrichtung Signale aufgrund von zwei Verfahren generiert, nämlich aufgrund eines ersten Verfahrens, bei dem die Grobposition basierend auf der Feinposition aktualisiert wird, und eines zweiten Verfahrens, bei



dem die Grobposition direkt durch Messung aktualisiert wird.

- 5 12. Aufzugssystem nach Anspruch 11, bei dem die Positions- und Geschwindigkeitsbestimmungseinrichtung im Betrieb stets Signale generiert auf der Grundlage des ersten Verfahrens, und Signale basierend auf dem zweiten Verfahren dann generiert, wenn die Richtung des Fahrkorbs sich während des betroffenen Meßzyklus nicht umkehrt.
- 10 13. Aufzugssystem nach Anspruch 12, bei dem die Positions- und Geschwindigkeitsbestimmungseinrichtung einem "Widerspruchs"-Algorithmus folgt, basierend auf dem Vergleich der nach dem ersten Verfahren erzeugten Positionssignale mit nach dem zweiten Verfahren erzeugten Signalen, um die Integrität der Daten zu erhalten, die durch die Signale repräsentiert werden.
- 15 14. Aufzugssystem nach irgendeinem der Ansprüche 8 bis 13, bei dem das Getriebe zueinander passende Zahnräder mit 256 Zähnen an dem Zahnrad des ersten Codierelements und 257 Zähnen an dem Zahnrad des zweiten Codierelements aufweist.
- 20 15. Aufzugssystem nach irgendeinem der Ansprüche 8 bis 14, bei dem die Positions- und Geschwindigkeitsbestimmungseinrichtung Signale generiert, die bezeichnend sind für eine Primärposition (PRI_POS) auf der Grundlage der Beziehung, die ausgedrückt wird als eine HEX-Zahl von:

$$\text{PRI_POS} = \text{COARSE_PRI_POS} * 1000 + \text{FINE_PRI_POS}$$

25 wobei FINE_PRI_POS abgeleitet wird von den XY-Zählungen und am Ende jedes Grob-Primärpositionsbestimmungszyklus den Wert "000" hat; und wobei die feine Spur des ersten Codierelements "X", die Quadratur-Spur "Y" und das vierfache ("x4") zusammengesetzte Signal "XY" ist.

- 30 16. Aufzugssystem nach einem der Ansprüche 8 bis 15, bei dem die Positions- und Geschwindigkeitsbestimmungseinrichtung Signale generiert, die bezeichnend sind für die absolute Primärgeschwindigkeit (ABS_PRI_VEL), basierend auf der Beziehung, die als HEX-Zahl ausgedrückt wird durch:

$$\text{ABS_PRI-VEL}(N) = [\text{PRI_POS}(N-1) - \text{PRI_POS}(N-2) / 1000] * (60/T)_{\text{HEX}}$$

wobei T = Zykluszeit.

- 35 17. Aufzugssystem nach einem der Ansprüche 8 bis 16, bei dem die Positions- und Geschwindigkeitsbestimmungseinrichtung für die Sekundärposition (SEC_POS) bezeichnende Signale basierend auf der Beziehung erzeugt, die als HEX-Zahl ausgedrückt wird durch:

$$\text{SEC_POS} = (\text{COARSE_SEC_POS} * 1000 + \text{SEC_FINE_POS}) * (101/100)_{\text{HEX}}$$

40 wobei SEC_FINE_POS abgeleitet wird aus JK Zählungen, und SEC_FINE_POS = 000 am Ende jedes Grob-Sekundärpositionsbestimmungszyklus ist; und wobei die Feinspur des zweiten Codierelements "J", die Quadratur-Spur "K" und das Vierfache ("x4")-Signal "JK" ist.

- 45 18. Aufzugssystem nach einem der Ansprüche 8 bis 17, bei dem die Positions- und Geschwindigkeitsbestimmungseinrichtung Signale erzeugt, die bezeichnend sind für die Absolut-Sekundärgeschwindigkeit (ABS_SEC_VEL), basierend auf der Beziehung, die als HEX-Zahl ausgedrückt wird durch:

$$\text{ABS_SEC-VEL}(N) = [\text{SEC_POS}(N-1) - \text{SEC_POS}(N-2) / 1000] * (60/T)_{\text{HEX}}$$

50 wobei T = Zykluszeit.

- 55 19. Aufzugssystem nach einem der Ansprüche 8 bis 18, bei dem der Wandler Polaritätsumkehrmittel aufweist, um die Signalpolarität mit Hilfe des folgenden Alogrithmus-Ausdrucks in HEX-Schreibweise (Zweierkomplement) umzukehren:

$$\begin{aligned} \text{PRI_POS} &= 100000 - \text{PRI_POS} \\ \text{SEC_POS} &= 100000 - \text{SEC_POS} \end{aligned}$$



wobei die Primärgeschwindigkeit und die Sekundärgeschwindigkeit umgekehrt werden, wenn eine Polaritätsumkehr durch Änderung des Vorzeichenbits des Signals angegeben wird.

5 Revendications

1. Système d'ascenseur, dans lequel il y a au moins une cabine d'ascenseur (3,4) dont la vitesse est contrôlée par un sous-système de contrôle de mouvement et dans lequel est inclus un système de transducteur (PT) pour déterminer la position verticale de la cabine (3,4) dans la course de l'ascenseur en fournissant une représentation binaire du nombre de tours réalisés par un arbre pouvant tourner auquel un transducteur est relié, ledit système de transducteur comprenant :
 - un premier élément formant encodeur ayant une information grossière et un premier grand nombre d'informations fines enregistrées dessus;
 - caractérisé par
 - deux moyens de détection fins orientés par rapport auxdites informations fines pour fournir, pour chaque tour dudit arbre, une série de paires de signaux fins en relation de quadrature les uns par rapport aux autres;
 - deux moyens de détection grossiers, l'un étant sensible à ladite information grossière pour fournir un signal grossier ;
 - un second élément formant encodeur placé sur ledit arbre de manière à tourner une fois de plus que ledit premier élément formant encodeur alors que ledit premier élément formant encodeur tourne un second grand nombre de fois, de l'ordre dudit premier grand nombre, à travers une gamme de positions d'ascenseur permises, ledit second élément formant encodeur ayant une information grossière dessus en relation avec l'autre moyen de ladite paire de moyens de détection grossiers pour fournir un second signal grossier en quadrature avec ledit premier signal grossier à chaque tour dudit arbre ;
 - un premier moyen de traitement de signaux sensible auxdits signaux fins et auxdits signaux grossiers pour fournir un premier signal de position d'ascenseur comme la somme (1) des positions grossières indiquées par le nombre desdites informations fines détectées entre la fourniture d'un desdits signaux grossiers et la fourniture de l'autre desdits signaux grossiers à chaque tour dudit arbre, avec (2) des positions fines indiquées par l'accumulation, pendant chaque tour dudit arbre, du nombre desdites informations fines détectées pendant de tels tours dudit arbre ;
 - un second moyen de traitement de signaux sensible auxdits signaux fins pour fournir un second signal de position d'ascenseur comme la somme desdits signaux fins alors que ledit ascenseur se déplace dans ladite gamme de positions d'ascenseur permises ; et
 - des moyens pour comparer ledit premier signal de position d'ascenseur avec ledit second signal de position d'ascenseur et pour fournir un signal de défaut indiquant un défaut dans le cas où les positions indiquées par lesdits premier et second signaux d'ascenseur diffèrent de plus d'une ampleur prédéterminée.
2. Système d'ascenseur selon la revendication 1, dans lequel ledit premier élément formant encodeur comprend un disque d'encodeur rotatif, unique, avec au moins deux pistes encodées et au moins deux têtes de lecture associées auxdites pistes produisant lesdits signaux.
3. Système d'ascenseur selon la revendication 1 ou 2, dans lequel lesdits premier et second éléments formant encodeurs comprennent, chacun, un disque d'encodeur agencé pour tourner avec ledit arbre.
4. Système d'ascenseur selon l'une quelconque des revendications 1 à 3, comprenant de plus :
 - des moyens fournissant un premier signal de test indicatif du nombre desdits signaux fins qui devraient être fournis normalement pendant la détection de ladite première information grossière ;
 - des moyens fournissant un second signal de test indicatif du nombre desdits signaux fins qui devraient être fournis normalement pendant la détection de la seconde information grossière ;
 - des moyens sensibles auxdits signaux fins et auxdits signaux grossiers pour compter le nombre de signaux fins qui apparaissent pendant chacun desdits signaux grossiers et pour fournir les premier et second signaux de comptage correspondants indicatifs de ceux-ci ; et
 - des moyens sensibles auxdits premier et second signaux de test et auxdits premier et second signaux de comptage pour comparer ledit premier signal de test avec ledit premier signal de comptage, pour fournir un signal de défaut dans le cas où ledit premier signal de comptage indique un comptage qui diffère du comptage indiqué par ledit premier signal de test de plus d'une première



ampleur prédéterminée, pour comparer ledit second signal de test avec ledit second signal de comptage, et pour fournir ledit signal de défaut dans le cas où ledit second signal de comptage indique un comptage qui diffère du comptage indiqué par ledit second signal de test de plus d'une seconde ampleur prédéterminée.

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5. Système d'ascenseur selon l'une quelconque des revendications précédentes, comprenant de plus des moyens de test de vitesse, lesdits moyens de test de vitesse comprenant :

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des moyens en relation avec ledit premier moyen de détection, pour fournir, dans une série de cycles de traitement, les manifestations de signaux des positions successives dudit ascenseur en réponse aux indications desdites informations fournies à celui-ci par ledit premier moyen de détection, pour fournir, en réponse aux manifestations respectives de signaux dans une pluralité de cycles, un premier signal de vitesse d'ascenseur pour un cycle suivant;

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des moyens en relation avec ledit second moyen de détection, pour fournir, dans une série de cycles de traitement, les manifestations de signaux des positions successives dudit ascenseur en réponse aux indications desdites informations fournies à celui-ci par ledit second moyen de détection, pour fournir, en réponse aux manifestations de signaux respectives dans une pluralité de cycles, un second signal de vitesse d'ascenseur pour un cycle suivant ;

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des moyens pour fournir un signal de vitesse maximum indicatif d'une vitesse prédéterminée que ledit ascenseur ne doit pas dépasser ; et

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des moyens sensibles auxdits premier et second signaux de vitesse d'ascenseur et audit signal de vitesse maximum pour fournir un signal de sécurité indicatif d'un fonctionnement d'ascenseur sans danger uniquement lorsque ledit premier signal de vitesse d'ascenseur et ledit second signal de vitesse d'ascenseur indiquent, tous les deux, une vitesse inférieure à la vitesse indiquée par ledit signal de vitesse maximum.

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6. Système d'ascenseur selon la revendication 5, dans lequel lesdits moyens de test de vitesse dérivent un signal de test de vitesse de zone de porte à partir d'une combinaison desdits premier et second signaux de vitesse d'ascenseur, fournissant des moyens indépendants pour vérifier la vitesse de la cabine d'ascenseur dans la zone de porte.

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7. Système d'ascenseur selon l'une quelconque des revendications précédentes, comprenant de plus des moyens de test de transducteur comprenant :

des moyens pour comparer le nombre desdites informations fines détectées dans la durée de chacun desdites informations grossières et pour fournir un signal de défaut dans le cas où l'un quelconque desdits nombres desdites informations fines diffère d'un nombre prédéterminé correspondant d'une ampleur de seuil connexe, correspondante.

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8. Système d'ascenseur selon l'une quelconque des revendications précédentes, dans lequel ledit second élément formant encodeur est couplé audit premier élément formant encodeur par engrenage, qui provoque la rotation desdits éléments formant encodeurs à des vitesses de rotation différentes, fournissant des signaux de position et de vitesse secondaires indicatifs de l'emplacement et de la vitesse de la cabine d'ascenseur ; chacun desdits éléments formant encodeurs comprenant au moins une piste fine et au moins une piste relativement grossière chacune faite d'informations sensibles, ladite piste fine ayant beaucoup plus d'informations sensibles dans sa piste par comparaison avec ladite piste grossière ; et

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des moyens de détermination de position et de vitesse associés auxdits éléments formant encodeurs pour générer des signaux indicatifs de la position et de la vitesse de la cabine d'ascenseur en utilisant deux canaux indépendants, fournissant avec lesdits moyens de détection des moyens efficaces pour générer au moins deux signaux de position et de vitesse indépendants en utilisant un arbre d'entrée unique.

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9. Système d'ascenseur selon la revendication 8, dans lequel ledit premier et ledit second éléments formant encodeurs comprennent chacun une piste encodée utilisant des têtes de lecture en association avec chaque piste encodée.

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10. Système d'ascenseur selon la revendication 8 ou 9 dans lequel lesdits moyens de détermination de position et de vitesse génèrent des signaux en se basant sur la relation consistant à trouver la position grossière et à lui ajouter, ensuite, les positions fines dérivées de manière incrémentale.



11. Système d'ascenseur selon la revendication 8 ou 9 dans lequel lesdits moyens de détermination de position et de vitesse génèrent des signaux en se basant sur deux méthodes, une première méthode de mise à jour de la position grossière en se basant sur la position fine, et une seconde méthode basée sur la mise à jour de la position grossière directement par mesurage.

12. Système d'ascenseur selon la revendication 11, dans lequel lesdits moyens de détermination de position et de vitesse, quand ils sont en fonctionnement, génèrent toujours des signaux en se basant sur ladite première méthode et génèrent des signaux en se basant sur ladite seconde méthode chaque fois que la direction de la cabine ne s'inverse pas pendant le cycle de mesure concerné.

13. Système d'ascenseur selon la revendication 12, dans lequel lesdits moyens de détermination de position et de vitesse suivent un algorithme de "différence" en se basant sur la comparaison des signaux de position générés dans ladite première méthode, avec les signaux générés dans ladite seconde méthode pour maintenir l'intégrité des données représentées par lesdits signaux.

14. Système d'ascenseur selon l'une quelconque des revendications 8 à 13, dans lequel ledit engrenage comprend des roues engrenage accouplées ayant 256 dents sur la roue engrenage dudit premier élément formant encodeur et 257 dents sur la roue engrenage dudit second élément formant encodeur.

15. Système d'ascenseur de l'une quelconque des revendications 8 à 14, dans lequel lesdits moyens de détermination de position et de vitesse génèrent des signaux indicatifs de la position primaire (PRI_POS) en se basant sur la relation exprimée en tant que nombre hexadécimal de :

$$\text{PRI_POS} = \text{COARSE_PRI_POS} * 1000 + \text{FINE_PRI_POS}$$

où FINE_PRI_POS est dérivé des comptages XY et égal à "000" à la fin de chaque cycle de détermination de position primaire grossière ; où la piste fine du premier élément formant encodeur est "X", la piste en quadrature est "Y", et le signal composite fois quatre ("x4") est "XY".

16. Système d'ascenseur selon l'une quelconque des revendications 8 à 15, dans lequel lesdits moyens de détermination de position et de vitesse génèrent des signaux indicatifs de la vitesse primaire absolue (ABS_PRI_VEL) en se basant sur la relation exprimée en tant que nombre hexadécimal de :

$$\text{ABS_PRI_VEL}(N) = [\text{PRI_POS}(N-1) - \text{PRI_POS}(N-2) / 1000] * (60/T)_{\text{HEX}}$$

où T = temps de cycle.

17. Système d'ascenseur selon l'une quelconque des revendications 8 à 16, dans lequel lesdits moyens de détermination de position et de vitesse génèrent des signaux indicatifs de position secondaire (SEC_POS) en se basant sur la relation exprimée en tant que nombre hexadécimal de :

$$\text{SEC_POS} = (\text{COARSE_SEC_POS} * 1000 + \text{SEC_FINE_POS}) * (101/100)_{\text{HEX}}$$

où SEC_FINE_POS est dérivé des comptages JK, et SEC_FINE_POS = 000 à la fin de chaque cycle de détermination de position secondaire grossière ; où la piste fine du second élément formant encodeur est "J", la piste en quadrature est "K" et le signal fois quatre ("x4") est "JK".

18. Système d'ascenseur selon l'une quelconque des revendications 8 à 17, dans lequel lesdits moyens de détermination de position et de vitesse génèrent des signaux indicatifs de vitesse secondaire absolue (ABS_SEC_VEL) en se basant sur la relation exprimée en tant que nombre hexadécimal de :

$$\text{ABS_SEC_VEL}(N) = [\text{SEC_POS}(N-1) - \text{SEC_POS}(N-2) / 1000] * (60/T)_{\text{HEX}}$$

où T = temps de cycle.

19. Système d'ascenseur selon l'une quelconque des revendications 8 à 18, dans lequel le transducteur comprend des moyens d'inversion de polarité pour inverser la polarité du signal par l'algorithme suivant



exprimé en hexadécimal (complément de 2) :

PRI_POS = 100000 - PRI_POS
SEC_POS = 100000 - SEC_POS

avec la vitesse primaire et la vitesse secondaire inversées quand une inversion de polarité est indiquée par le changement du bit de signe du signal.

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