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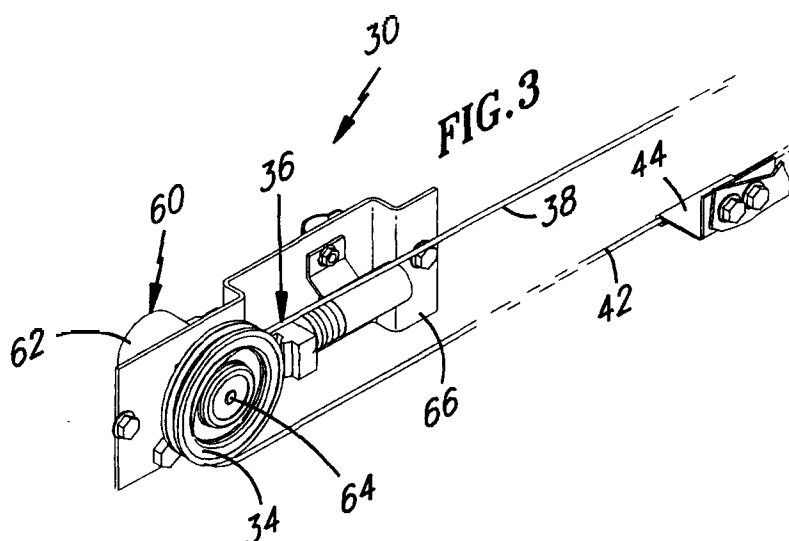
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(54) Positioning and synchronization system for elevator car doors

(57) A positioning and synchronization system for elevator car doors (12, 14) includes an encoder (60) coupled directly to an encoder pulley (34) for interpreting the position and direction of the elevator car doors. Cou-

pling the encoder directly to the encoder pulley eliminates intermediate linkages that introduce inaccuracies and also eliminates the need for translating the linear position of the elevator car doors into the rotary position of the motor.



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Description

The present invention relates to elevator systems and, more particularly, to the movement and positioning of elevator car doors.

In conventional elevator systems, elevator car doors are opened and closed by door operators which are electromechanical assemblies that use a rotary electric motor, mechanical drive linkages, and a control box. The rotary electric motor drives one of the elevator car doors through the mechanical linkage that is attached to that door. The other door is physically pulled by a relating cable extended over two pulleys with one end of the cable attached to one door and the other end attaching onto the other door. The speed and direction of the door movement is usually monitored by cams and switches disposed at the motor, that provide door position and direction data to the elevator door controller.

One disadvantage of the conventional systems is that the linear position and movement of the elevator car door is translated by means of calculations to the rotary position of the motor, since the monitoring of the position and direction of the door movement occurs at the rotary motor. Such translation of the linear position of the door into rotary position of the motor inevitably introduces inefficiencies.

Another disadvantage of the existing scheme is that the accuracy of the position and direction data may become compromised when drive linkages become misaligned or loosened with time. In order to monitor accurately the direction and position data, the switches must be recalibrated periodically and the drive linkages readjusted. The process of recalibration and readjustment is time consuming and expensive. Therefore, a more precise method for monitoring the speed, position, and direction of the elevator car doors is desirable.

Viewed from one aspect the present invention provides a positioning and synchronization system for positioning and timing movement of elevator car doors in an elevator system, said elevator car doors being suspended from first and second door hangers respectively, said door hangers being movably supported by a header, said positioning and synchronization system comprising:

- an idler pulley attached to one side of said header;
- an encoder pulley attached to an opposite side of said header;
- a relating cable extending over said idler pulley and said encoder pulley and forming a closed loop having a first loop portion and a second loop portion;
- and
- a rotary encoder attached to said encoder pulley for measuring position and direction of movement of said elevator car doors.

Direct coupling of the encoder to the encoder pulley eliminates intermediate linkages that potentially intro-

duce inaccuracies. The invention also eliminates the need to translate the linear position of the door into a rotary position, thereby reducing the associated inefficiencies. The synchronization system also ensures that both doors in a two door center opening bi-parting configuration open and close substantially simultaneously.

One advantage of the present invention is that if travel of one of the doors is interrupted, the other door is also stopped. Another advantage is that only one encoder need be used to interpret the positions of both doors. Use of a single encoder represents a significant cost saving.

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawings, in which:-

FIG. 1 is a schematic perspective view of an elevator door system including a positioning and synchronization system according to the present invention;

FIG. 2 is a cut-away schematic perspective view of the elevator door system of FIG. 1; and

FIG. 3 is an enlarged cut-away schematic perspective view of the synchronization link system of FIG. 2.

Referring to FIG. 1, an elevator car door system 10 for selectively opening and closing elevator car doors 12,14 includes a header bracket 16 which supports first and second door hangers 18,20 that have the first and second doors 12,14 suspended therefrom, respectively. A linear motor driving the doors 12,14 includes a motor secondary 22 attached to the header bracket 16 and a pair of motor primaries 24, each attached to one of the door hangers 18,20 respectively.

A positioning and synchronization system 30 includes an idler pulley 32 secured to the header bracket beyond the travel of the door hanger 20, and an encoder pulley 34 also secured to the header bracket and disposed beyond the travel of the door hanger 18. A relating cable 36 extends over both pulleys 32,34 to form a closed loop with a first loop portion 38 and a second loop portion 42, as best seen in FIG. 2. The second loop portion 42 of the relating cable 36 is continuous and is fixedly attached onto the first door hanger 18 by means of a first hitch 44. The first loop portion 38 of the relating cable 36 includes two ends 46,48 of the cable with each end attached to the second door hanger 20 by means of a second hitch 50. The attachment of the ends 46,48 of the cable 36 to the second hitch 50 is adjustable for periodic calibration of tension within the cable.

The pulleys 32,34 include high friction polymer liners that the relating cable 36 comes into contact with. The most effective type of high friction polymer for this embodiment is urethane.

Referring to FIG. 3, the positioning and synchronization system 30 also includes a rotary encoder 60 coupled to the encoder pulley 34. The encoder 60 includes

an encoder body 62 and a shaft 64 which is fixedly attached to the center of the encoder pulley 34 by means of a set screw (not shown). The encoder 60 and the encoder pulley 34 are fixedly secured onto the header bracket 16 by means of a mounting flange 66.

In operation, the linear motor drives the elevator car doors 12, 14 between open and closed positions. As the doors travel in opposite directions, the positioning and synchronization system 30 ensures that both doors travel simultaneously at the same speed. The relating cable 36 pulls both doors simultaneously as the doors are opened or closed. Since there is substantially no slippage between the urethane liners of the pulleys 32, 34 and the relating cable 36, the encoder 60 readings are accurate. The "no slippage" condition is achieved by having urethane liners for the pulleys and by ensuring proper tension in the relating cable. As the doors 12, 14 travel between open and closed positions, the rotary encoder 60 generates incremental pulses which indicate changes in door position and direction. The encoder 60 sends signals to the controller box (not shown) which interprets the position and direction data and also derives the speed of the doors.

A major advantage of the present embodiment over the prior art is that the encoder 60 is directly coupled to the movement of the doors without many intermediate parts, such as mechanical linkages and/or motors. Such a direct connection between the encoder and the movement of the doors minimizes the opportunities for inaccuracies resulting from loosening of the mechanical linkages or misalignment of the mechanical parts. Another major advantage of the present embodiment is that translation of the linear position of the doors into a rotary movement of the rotor is eliminated. Therefore, the present embodiment not only ensures smooth operation of the elevator car doors, but also precisely locates the doors throughout the travel, eliminating inaccuracies and inefficiencies introduced by existing systems.

Another benefit of the present embodiment is that only one encoder is used for both doors, thereby resulting in substantial cost savings.

A further benefit of the present embodiment is that when travel of one of the doors is interrupted, the other door also stops movement as a result of the relating configuration.

The rotary encoder can be a conventional encoder manufactured by various vendors. For example, one type of such product that is suitable for the current application is a rotary encoder fabricated by Danaher Controls of Gurnee, Illinois, USA.

While the present invention has been illustrated and described with respect to a particular embodiment thereof, it will be appreciated that various modifications may be made. For example, although the above described embodiment is an elevator car having a two door configuration, the synchronization and positioning system of the present invention can be used with other door configurations.

Claims

1. A positioning and synchronization system for positioning and timing movement of elevator car doors (12, 14) in an elevator system, said elevator car doors being suspended from first and second door hangers (18, 20) respectively, said door hangers being movably supported by a header (16), said positioning and synchronization system comprising:

an idler pulley (32) attached to one side of said header;
 an encoder pulley (34) attached to an opposite side of said header;
 a relating cable (36) extending over said idler pulley and said encoder pulley and forming a closed loop having a first loop portion (38) and a second loop portion (42); and
 a rotary encoder (60) attached to said encoder pulley for measuring position and direction of movement of said elevator car doors.

2. A system according to claim 1, wherein said idler pulley (32) and said encoder pulley (34) each have a high friction polymer liner for minimizing slippage between said pulleys and said relating cable (36).

3. A system according to claim 2, wherein said high friction polymer is urethane.

4. A system according to any of claims 1 to 3, wherein said first loop portion (38) of said relating cable (36) is attached to said first door hanger (18) and said second loop portion (42) of said relating cable is attached to said second door hanger (20).

5. A system according to any preceding claim, wherein said rotary encoder (60) generates incremental pulses which indicate changes in position and direction of said elevator car doors.

6. An elevator car door operating system for opening and closing a first elevator car door (12) and a second elevator car door (14), said elevator car doors being suspended from first and second door hangers (18, 20) respectively, said door hangers being movably supported by a header (16), said elevator car door operating system comprising:

a positioning and synchronization system for positioning and timing movement of said elevator car doors, said positioning and synchronization system including an idler pulley (32) attached to one side of said header and an encoder pulley (34) attached to an opposite side of said header with a relating cable (36) extending over said idler pulley and said encoder pulley and forming a closed loop having a first loop portion (38) and a second loop portion (42), said positioning and synchronization sys-

tem including a rotary encoder (60) attached to said encoder pulley for measuring the position and direction of movement of said elevator car doors.

7. An elevator car door operating system for opening and closing a first elevator car door (12) and a second elevator car door (14), said elevator car doors being suspended from first and second door hangers (18,20) respectively, said door hangers being movably supported by a header (16), said elevator car door operating system comprising:

a positioning and synchronization system for positioning and timing movement of said elevator car doors, said positioning and synchronization system including an idler pulley (32) attached to one side of said header and an encoder pulley (34) attached to an opposite side of said header with a relating cable (36) extending over said idler pulley and said encoder pulley and forming a closed loop having a first loop portion (38) and a second loop portion (42), said positioning and synchronization system including a rotary encoder (60) attached to said encoder pulley for measuring position and direction data of movement of said elevator car doors; and
a controller for interpreting said position and direction data received from said rotary encoder.

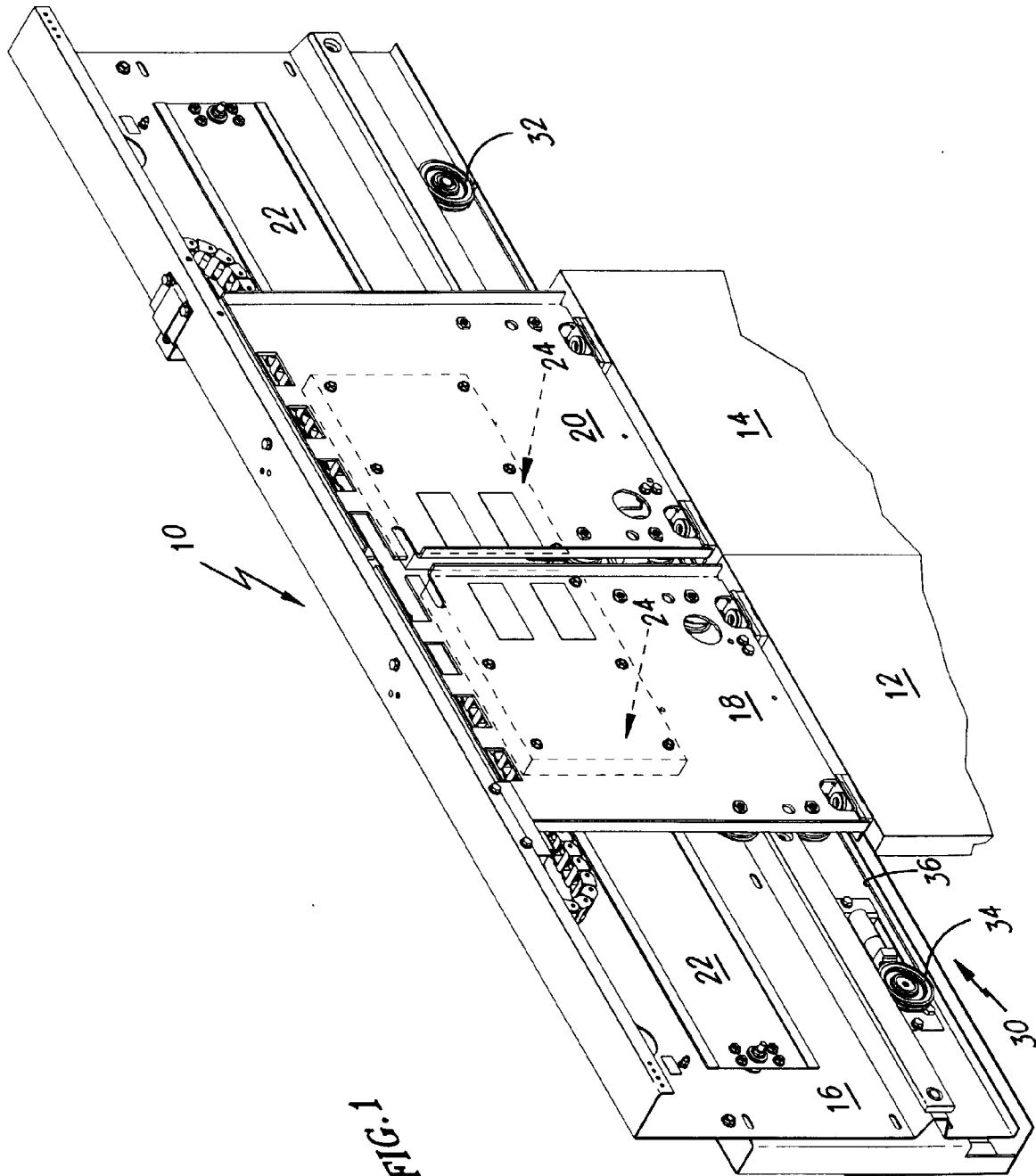
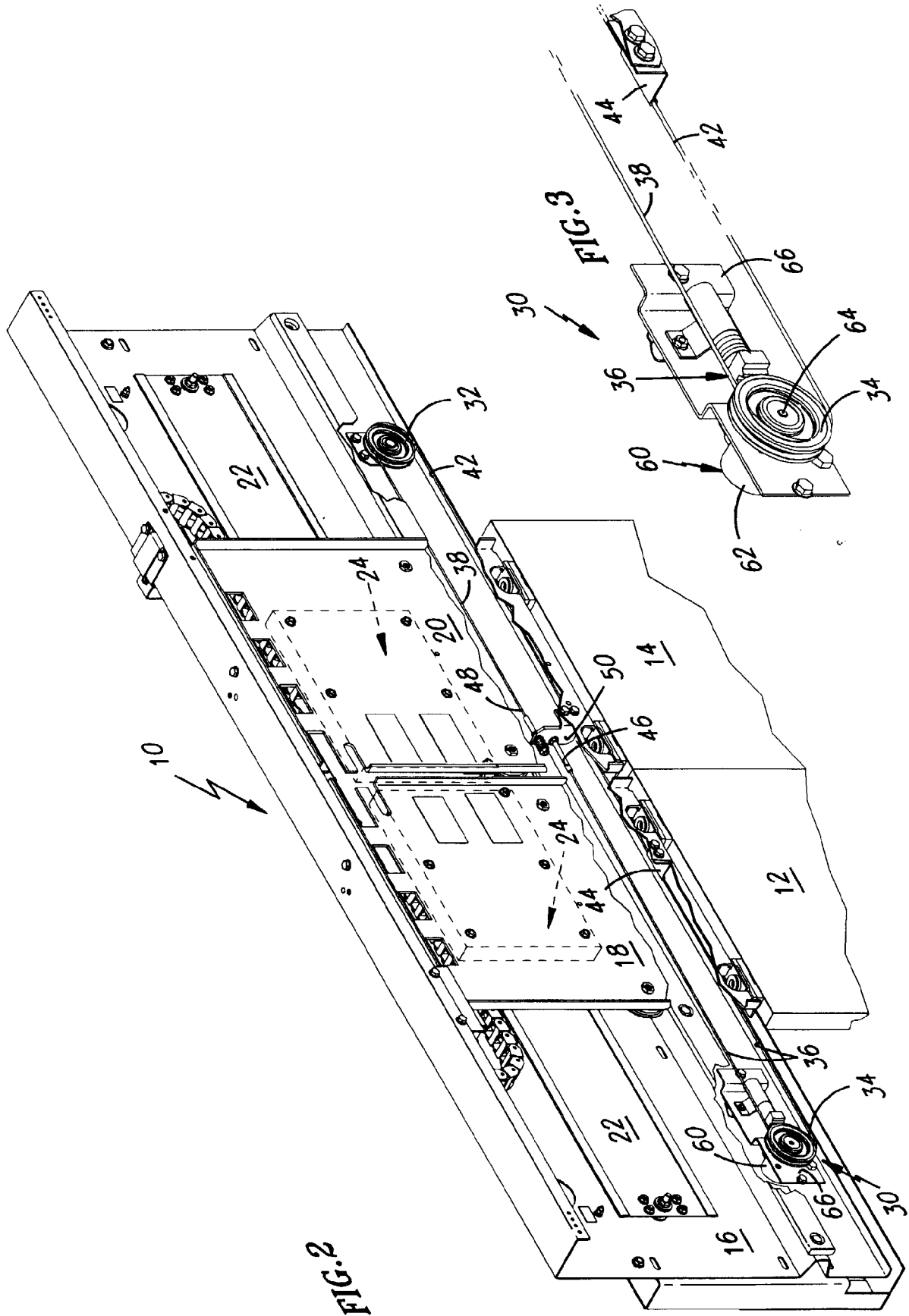


FIG. 1





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EUROPEAN SEARCH REPORT

Application Number
EP 97 30 8737

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	EP 0 677 475 A (OTIS ELEVATOR CO) * column 3, line 11 - column 4, line 34 * ---	1-7	B66B13/14 E05F15/14
Y	FR 2 175 486 A (EATON GMBH) * page 3, line 15 - line 34 * ---	1-7	
A	EP 0 676 527 A (OTIS ELEVATOR CO) ---	1,6,7	
A	PATENT ABSTRACTS OF JAPAN vol. 017, no. 208 (M-1401), 23 April 1993 & JP 04 350086 A (HITACHI LTD;OTHERS: 01), 4 December 1992, * abstract * ---	1,6,7	
A	PATENT ABSTRACTS OF JAPAN vol. 095, no. 007, 31 August 1995 & JP 07 091139 A (SORITSUKU:KK), 4 April 1995, * abstract * ---	1,6,7	
A	PATENT ABSTRACTS OF JAPAN vol. 017, no. 558 (M-1493), 7 October 1993 & JP 05 157155 A (KOBE STEEL LTD), 22 June 1993, * abstract * -----	2,3	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B66B E05F
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 22 January 1998	Examiner Sozzi, R
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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