United States Patent [19]

Johnson

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[45] **Nov. 5, 1974**

[54] **ELEVATOR SYSTEM**

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[21] Appl. No.: **369,513**

[52] **U.S. Cl.** **187/15,** 187/71, 187/73, 187/94, 187/95

[51] **Int. Cl.** **B66b 17/12**

[58] **Field of Search** 187/15, 94, 17, 20, 22, 187/95, 1, 71, 73, 29; 182/178; 52/30, 637, 638

[56] **References Cited**

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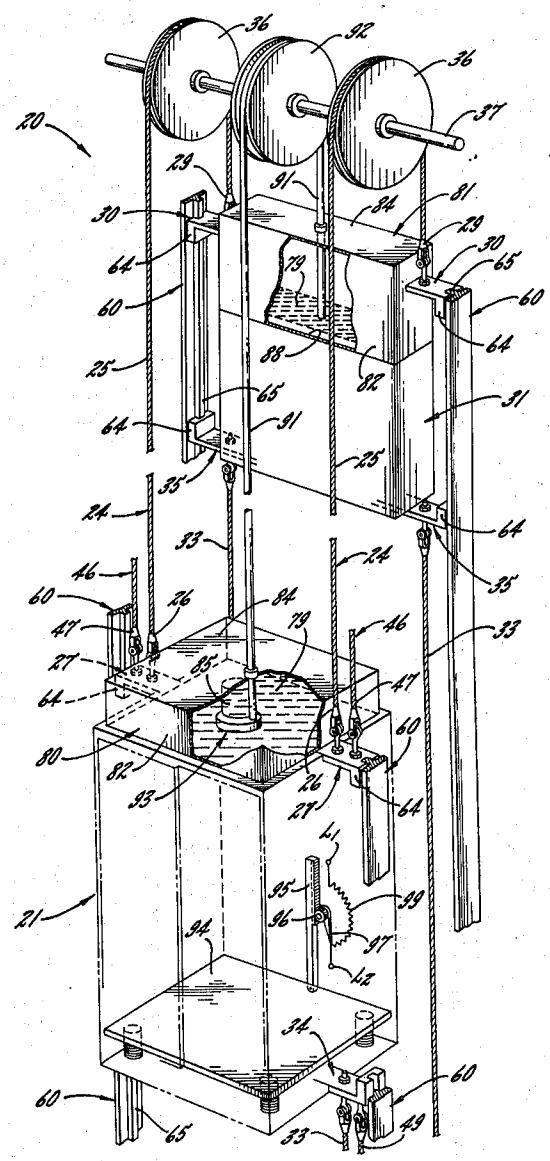
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Primary Examiner—Richard A. Schacher
Assistant Examiner—James L. Rowland
Attorney, Agent, or Firm—Wolfe, Hubbard, Leydig, Voit & Osann, Ltd.

[57] **ABSTRACT**

An elevator system for use within a multiple story building includes a car and a counterweight suspended by cables on opposite sides of pulleys supported within the upper end of an elevator shaft. Upper chambers within the car and the counterweight receive a weight medium operable to be transferred between the chambers to vary the weight of the car and the counterweight in relation to changes in the loaded weight of the car. A motor operable in response to changes in the weight of the load automatically moves the weight medium between the counterweight and the car in an amount equal to half the change in the weight of the load to keep the weight of the car and the counterweight balanced so as to reduce the power required to move the car between floors within the building.

9 Claims, 10 Drawing Figures



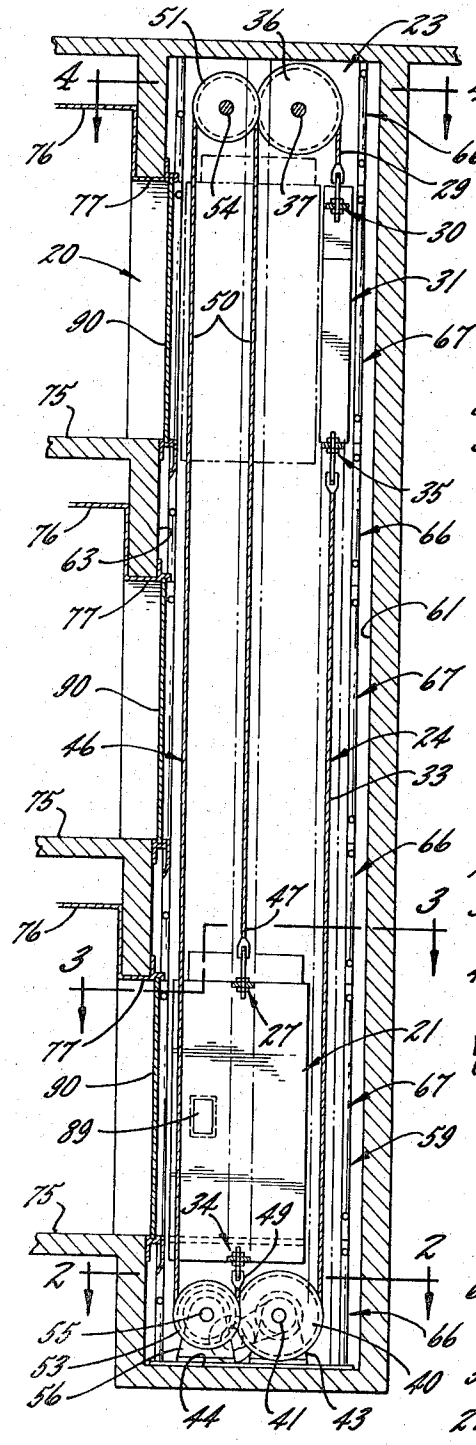


Fig. 1.

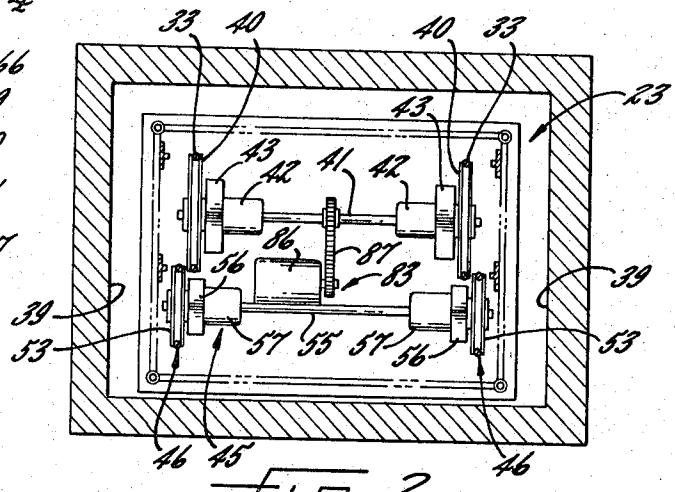


Fig. 2.

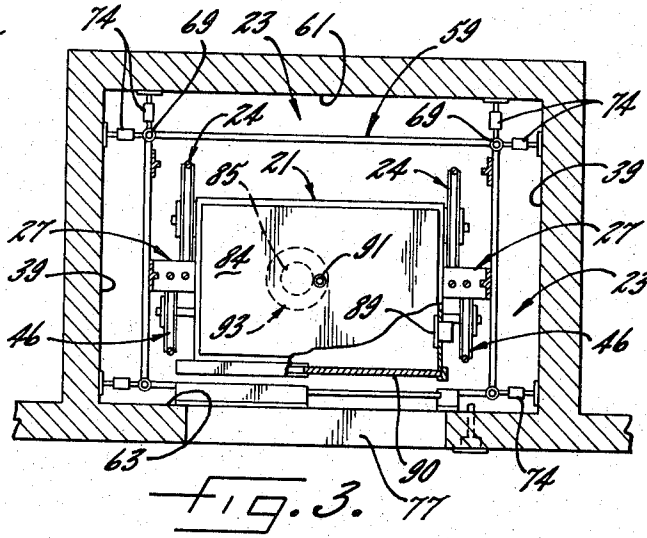


Fig. 3.

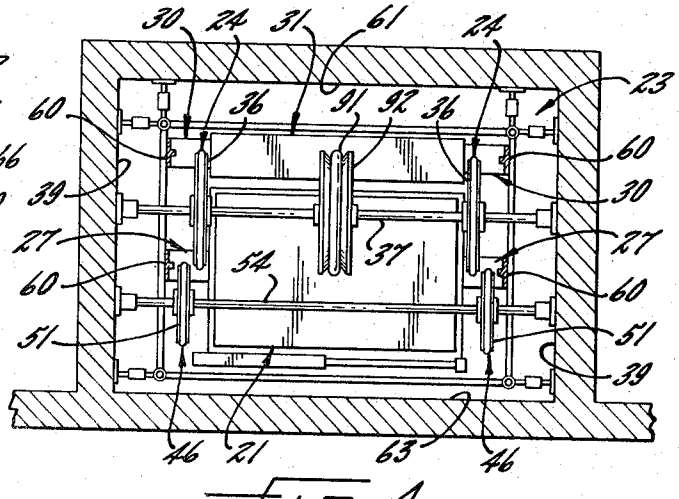


Fig. 4.

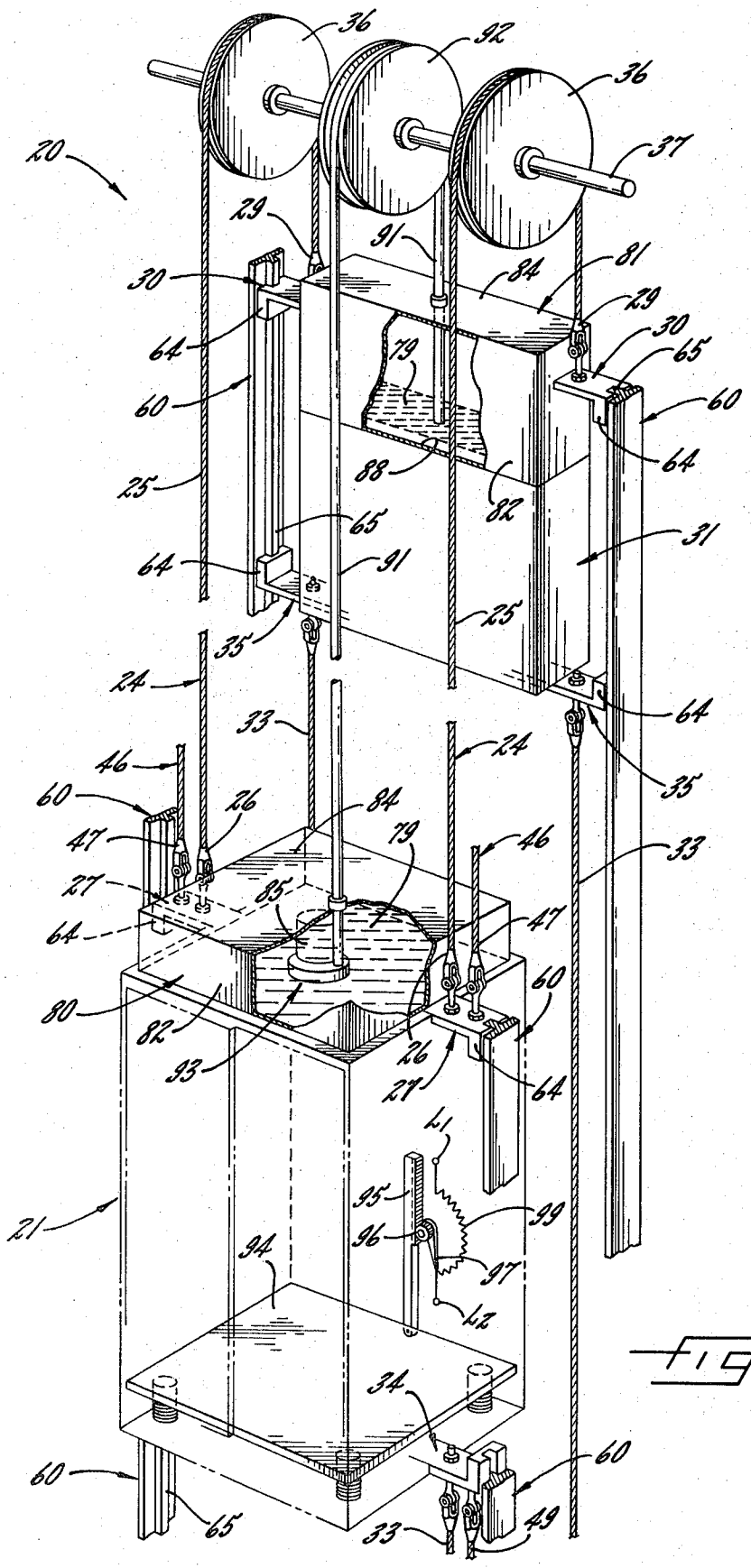

20
36
92
36
37
29
91
81
84
30
64
79
60
25
88
82
65
31
35
24
33
46
26
47
27
85
80
93
95
99
96
97
94
21
34
49

Fig. 5.

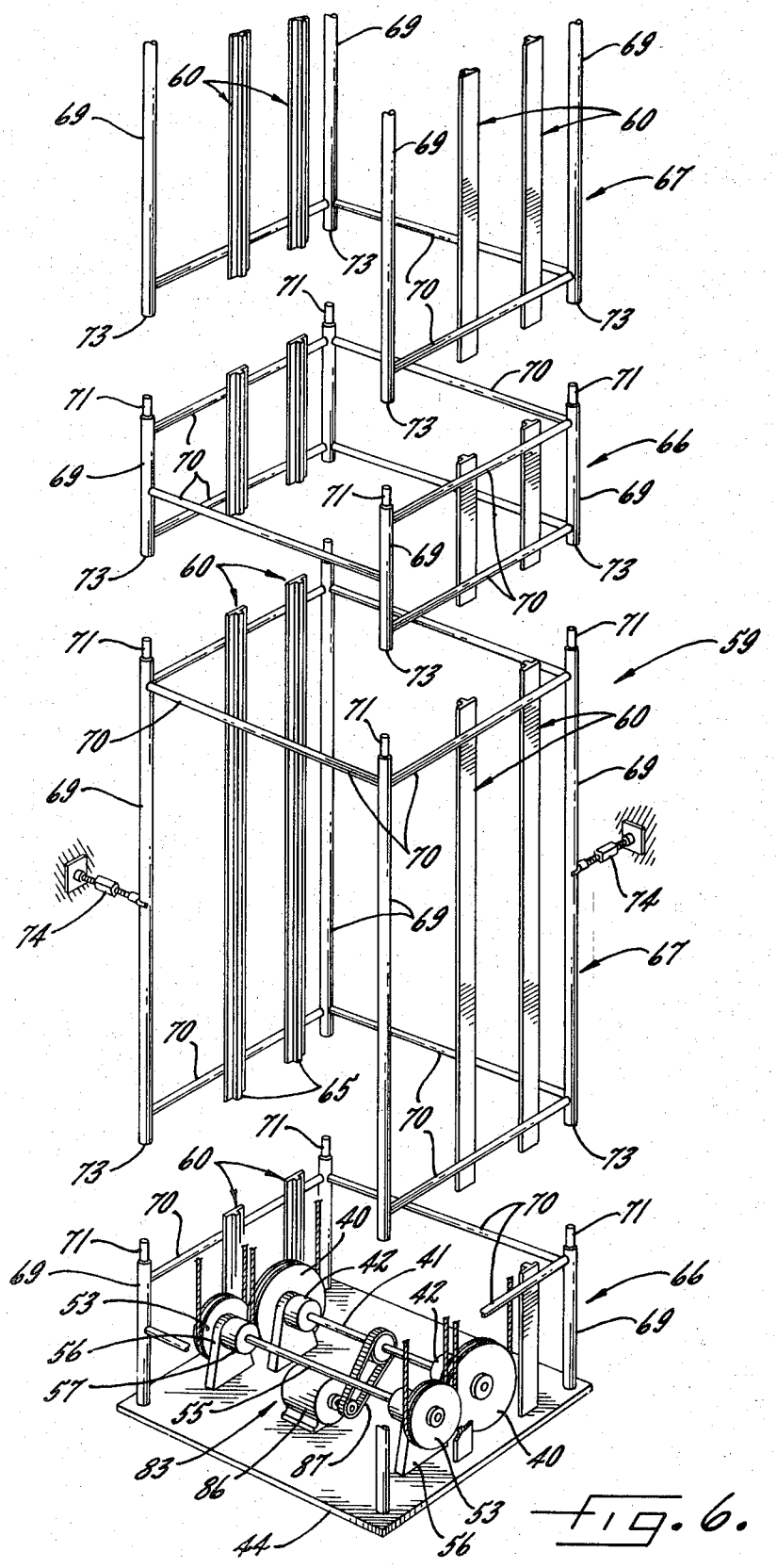


Fig. 6.

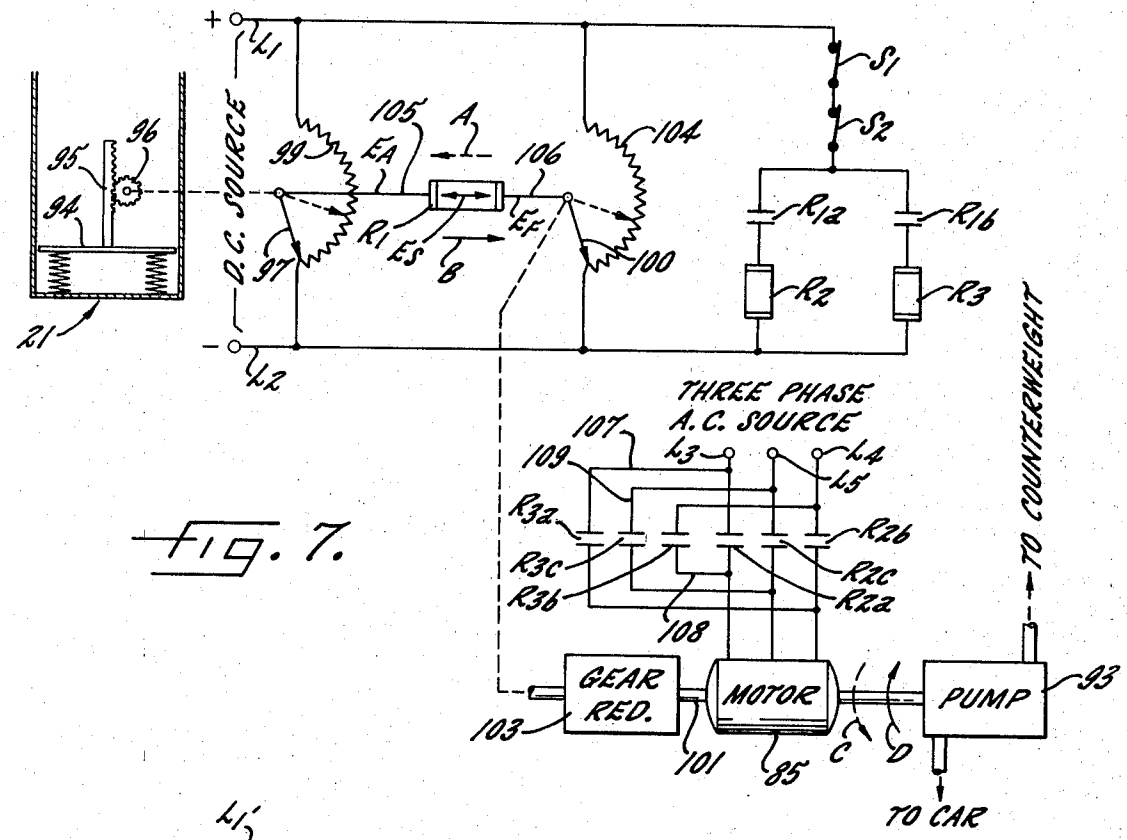

L1
D.C. SOURCE
L2
105
A
EA
99
106
104
S1
S2
95
96
94
97
R1
ES
B
EF
100
R12
R16
R2
R3
21
THREE PHASE
A.C. SOURCE
107
109
L3
L4
L5
R32
R26
R3C
R2C
R36
R22
108
TO COUNTERWEIGHT
GEAR
RED.
MOTOR
PUMP
93
103
101
85
C
D
TO CAR

Fig. 7.

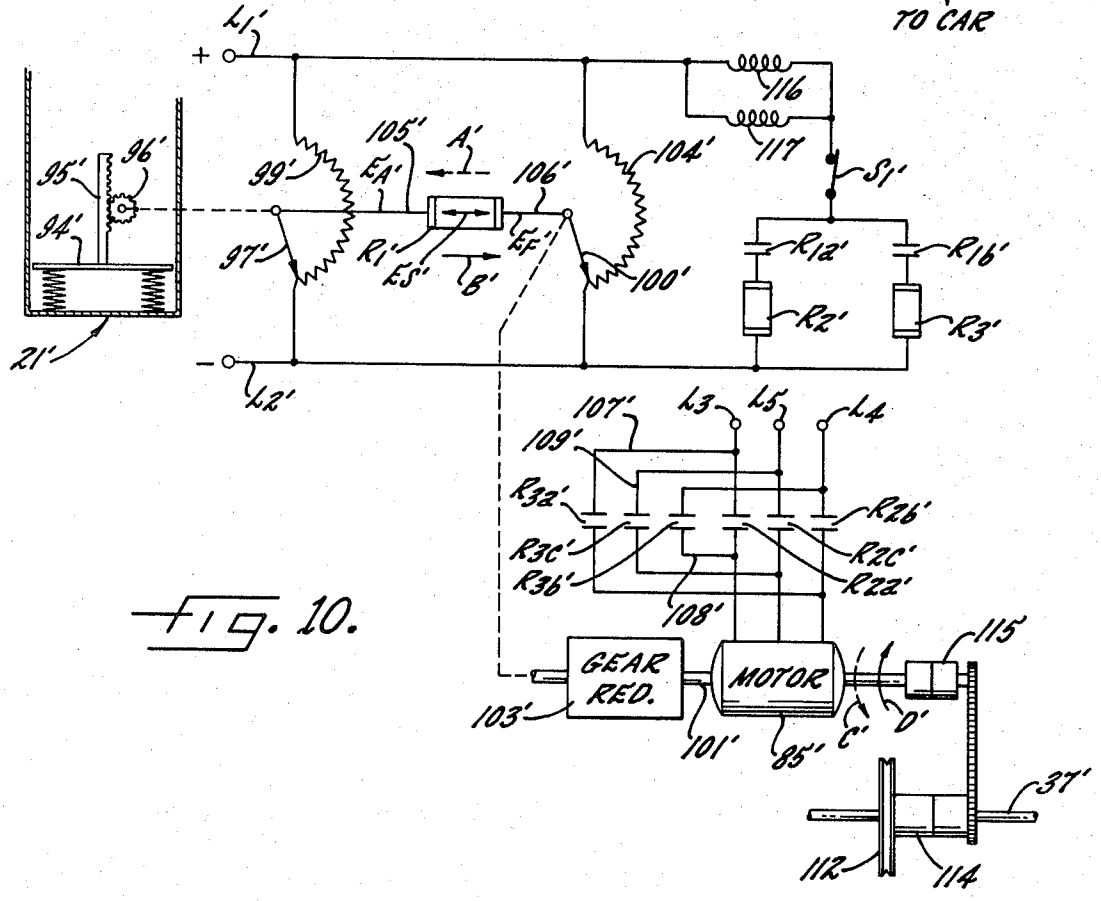

L1'
105'
A'
EA'
99'
106'
104'
116
117
S1'
95'
96'
94'
97'
R1'
ES'
B'
EF'
100'
R12'
R16'
R2'
R3'
21'
L2'
107'
L3
L5
L4
109'
R32'
R26'
R3C'
R2C'
R36'
R22'
108'
115
GEAR
RED.
MOTOR
103'
101'
85'
C'
D'
37'
112
114

Fig. 10.

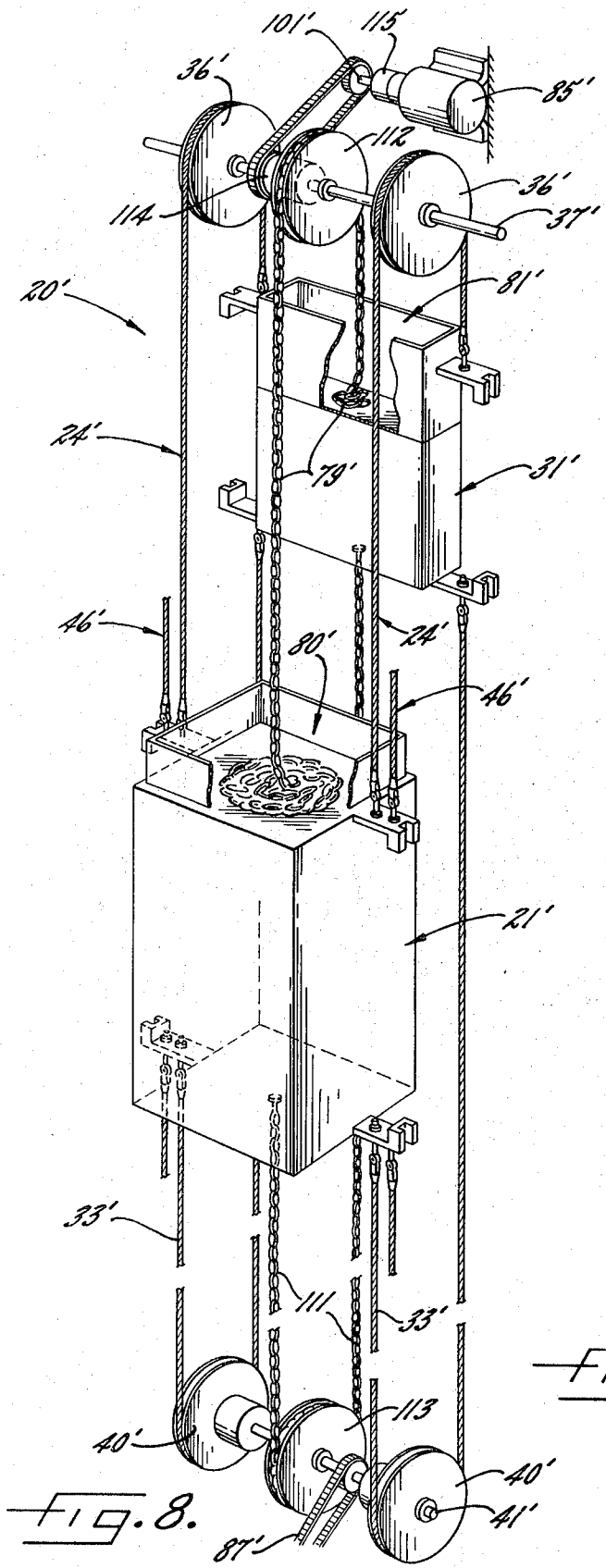

101'
115
36'
85'
112
36'
114
37'
20'
81'
24'
79'
31'
46'
80'
24'
46'
21'
33'
111
33'
113
40'
40'
41'
87'

FIG. 8.

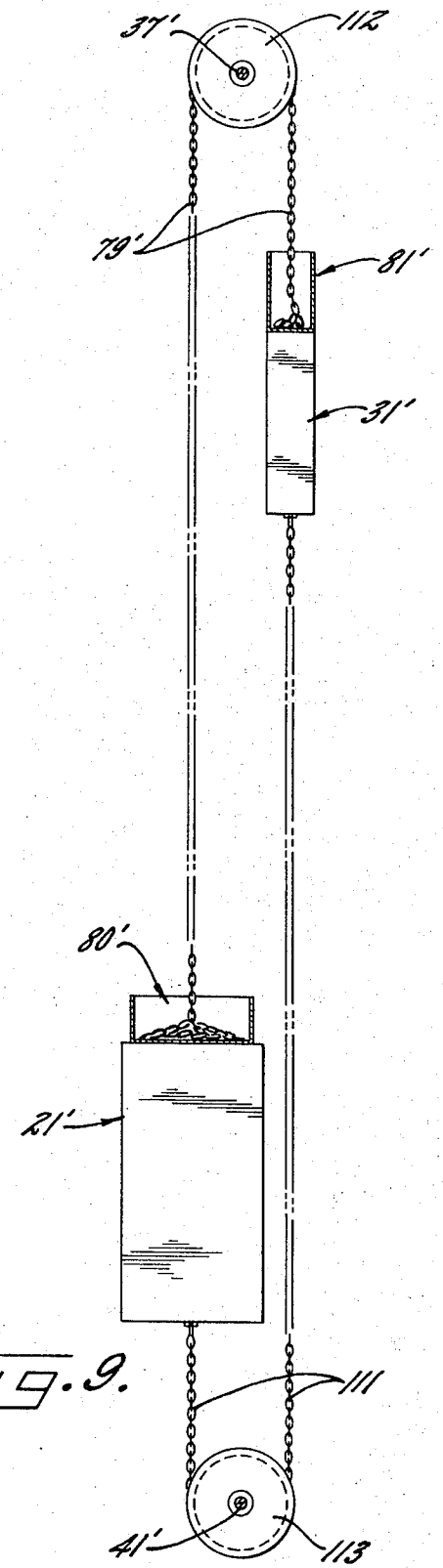

37'
112
79'
81'
31'
80'
21'
111
41'
113

FIG. 9.

ELEVATOR SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to an elevator system including a car and a counterweight both suspended within an elevator shaft from opposite sides of a rotatable pulley by a cable trained over the pulley to move the car vertically within the shaft as the pulley rotates. More particularly, the invention pertains to a system of the type in which a weight medium such as a fluid is transferred between a chamber in the car and a chamber in the counterweight as the car is loaded and unloaded to maintain a weight relationship between the weight of the car and the weight of the counterweight. An elevator system of this general type is disclosed in Marvin U.S. Pat. No. 182,280.

SUMMARY OF THE INVENTION

The general object of the present invention is to provide a unique, inexpensive elevator system which is adapted particularly for use in buildings of moderate height and which requires less space for installation and significantly less power to operate than is required by prior power-operated elevator systems. A further object is to accomplish the foregoing through the provision of an elevator system which is generally of the type disclosed in the aforementioned patent and in which the weight medium is transferred automatically between the chambers in an amount correlated with changes in the weight of the load within the car so the counterweight and loaded car are kept balanced thereby enabling a low power drive unit to be used to move the car vertically within the elevator shaft.

A more detailed object is to achieve the foregoing by sensing changes in the weight of the load on the floor of the elevator car and automatically transferring the weight medium between the chambers in an amount equal to half the weight change in the load so the weight of the counterweight is adjusted to equal the weight of the loaded car.

The invention also resides in the novel arrangement for sensing changes in the weight of the load and transferring the weight medium between the chambers, in the provision of a unique safety system within the elevator system to keep the car from falling in the elevator shaft and in the novel manner in which the elevator system is supported within the shaft.

These and other objects and advantages of the present invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary cross-sectional elevational view of an elevator system embodying the novel features of the present invention.

FIG. 2 is an enlarged cross-sectional view taken substantially along line 2—2 of FIG. 1.

FIG. 3 is an enlarged cross-sectional view taken substantially along line 3—3 of FIG. 1.

FIG. 4 is an enlarged cross-sectional view taken substantially along line 4—4 of FIG. 1.

FIG. 5 is a fragmentary perspective view of the elevator system with parts broken away for clarity of illustration.

FIG. 6 is a fragmentary, exploded perspective view of parts of the elevator system.

FIG. 7 is a diagram schematically showing the electrical circuitry used in conjunction with the transfer of the weight medium in the elevator system.

FIG. 8 is a fragmentary perspective view similar to FIG. 5 but showing an alternative embodiment of the invention.

FIG. 9 is a fragmentary side elevational view of the second embodiment of the invention.

FIG. 10 is a diagram schematically showing the electrical circuitry used in conjunction with the transfer of the weight medium in the alternative embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in the drawings for purposes of illustration, the present invention is embodied in an elevator system **20** particularly adapted for use in a multiple story building of moderate height such as a building containing from two to eight stories. The elevator system includes a car **21** suspended within an elevator shaft **23** located within the building by flexible support lines or main cables **24**. As shown in FIG. **5**, two of the cables **24** are attached to the car adjacent opposite sides thereof and each cable includes an upper section **25** having one end **26** connected to a cross member **27** secured to the top of the car and an opposite end **29** connected to an upper member **30** secured to the top of a counterweight **31** so as to suspend the counterweight laterally of the car and within the elevator shaft. A lower section **33** (FIG. **1**) of each cable is attached similarly between a lower cross member **34** secured to the bottom of the car and a lower member **35** fastened to the bottom of the counterweight.

As shown in FIGS. **1** and **5**, the upper sections **25** of each cable **24** are trained around a set of pulleys **36** mounted rotatably within the upper end of the elevator shaft **23** on a rod **37** extending between the side walls **39** of the shaft (see FIG. **4**). The lower sections **33** of the cables similarly are trained around a set of lower pulleys **40** mounted upon a rotatable rod **41** journaled between two upstanding brackets **43** secured to the bottom **44** of the shaft (see FIGS. **1** and **2**). Two friction brakes **42** mounted opposite each other adjacent the brackets are utilized to keep the car from falling within the elevator shaft.

One of the more detailed features of the present invention contemplates the provision of a supplemental braking system **45** suitable to prevent the car **21** from falling within the elevator shaft **23** in the event of a failure of the main cables **24** of the brakes **42**. To this end, a second set of two cables **46** (see FIGS. **1** and **5**) also supports the car within the elevator shaft. Each of the additional cables includes one end **47** which is attached to the upper cross member **27** and opposite end **49** secured to the lower cross member **34** of the car. The intermediate portions **50** of the cables are trained around a second set of upper and lower pulleys **51** and **53** mounted within the upper and lower ends of the elevator shaft, respectively. At the upper end of the shaft, the upper pulleys **51** (see FIG. **4**) are supported on a rod **54** extending between the side walls **39** of the shaft, and the lower pulleys are mounted on a rod **55** (FIG. **2**) journaled between brackets **56** which are secured to the bottom **44** of the shaft. As shown in FIG. **2**, two friction brakes **57** mounted adjacent the brackets serve

to prevent the car from falling within the shaft should the main cables **24** fail.

Supporting the car **21** and the counterweight **31** within the elevator shaft **23** is scaffolding **59** (FIGS. **1** and **6**) which includes four T-shaped rails **60** serving to guide the car and the counterweight as they move vertically within the shaft. Herein, two of the rails are spaced from each other adjacent each side wall **39** of the elevator shaft, the two rails each being paired with and facing one of the other rails mounted along the opposite side of the elevator shaft (see FIG. **4**). The counterweight is positioned between the two rails located toward the back wall **61** of the elevator shaft while the car is positioned between the two rails located adjacent the front **63** of the shaft. As shown in FIG. **5**, the upper and lower cross members **27, 34, 30** and **35** on both the car and the counterweight, respectively, include notched shoes **64** at their opposite ends and the shoes receive inwardly extending flanges **65** of the rails so the counterweight and the car are guided vertically and held against lateral movement within the elevator shaft by the rails.

Advantageously, the scaffolding **59** of the present elevator system **20** comprises a plurality of selected length units **66** and standard length units **67** so as to enable the scaffolding to be assembled easily within the elevator shaft **23.** In the assembled scaffolding, the shorter selected length units are located at positions spaced from each other from the top to the bottom of the shaft with one of the standard length units being sandwiched between each two selected length units (see FIGS. **1** and **6**). More particularly, each of the scaffolding units **66** and **67** includes tubular vertical members **69** (FIG. **6**) at each corner of the unit and horizontal members **70** which parallel the walls of the elevator shaft and extend between the vertical members to hold the latter together as a unit. Sections of the guide rails **60** are secured to the horizontal members in each unit, the length of the sections of guide rail being such as to abut the ends of the sections of guide rails in the adjacent upper and lower scaffolding units. Preferably, the upper end of each of the vertical members in each scaffolding unit forms a male fitting **71** adapted to fit telescopically within a female fitting **73** in the lower end of each of the vertical members of the next upper scaffolding unit. Turnbuckles **74** braced between the vertical corner members **69** and the side walls **39** and **61** (FIGS. **3** and **6**) hold the scaffolding units **66** and **67** against lateral movement within the elevator shaft.

The standard length scaffolding units **67** extend generally between each floor **75** in the building and the overlying ceiling **76** (see FIG. **1**) and, more particularly, are of a length approximately equal to the height of an elevator door opening **77** on each floor so they may be easily inserted into the elevator shaft **23** when assembling the scaffolding **59.** Each of the selected length scaffolding units **66** are of a height so as to extend upwardly from the upper end of the next adjacent lower standard length unit to a position generally horizontal with the bottom of the next upper door opening. By virtue of this arrangement, the scaffolding may be adapted to fit within any length of elevator shaft regardless of the spacing between the top of the door opening and the overlying floor by simply using different heights of selected length units when assemblying the scaffolding. Moreover, assembly of the scaffolding within the shaft is accomplished in a relatively easy manner by inserting a first selected length unit into the elevator shaft and then mounting a standard length unit on top of the selected length unit, the process being repeated for each floor in the elevator shaft.

For movement of the car **21** vertically within the scaffolding **59** of the elevator system **20,** a weight medium **79** (FIG. **5**) such as a liquid is transferred between a chamber **80** in the car and a corresponding chamber **81** in the counterweight **31** to maintain a predetermined weight relationship between the weight of the car and the weight of the counterweight. In accordance with the primary aspect of the present invention, the elevator system **20** includes means movable automatically in response to changes in the load to move the weight medium between the car and the counterweight so the loaded weight of the car including the weight of the weight medium in the car equals the weight of the counterweight plus the weight of the weight medium in the counterweight thereby enabling use of a low power drive unit **83** (FIG. **6**) to move the car between the floors in the building. For this purpose, the automatically movable means includes a motor **85** (FIG. **5**) which is actuated automatically in response to changes in the weight of the load in the car to move an amount of the weight medium proportional to the change in the weight of the load between the chambers in the car and the counterweight to equalize the weight of the car and the counterweight so that the elevator system is balanced. Advantageously this enables a small motor **86** (FIG. **6**) to be used in the power drive unit to move the car vertically within the elevator shaft.

In the present instance, the motor **86** for moving the car **21** vertically within the elevator shaft **23** is mounted adjacent the bottom **44** of the shaft (see FIG. **6**) and connected by a chain **87** to the rod **41** supporting the lower set of pulleys **40** so as to drive the main cables **24** of the elevator system **20.** A conventional control system (not shown) is used to actuate and deactuate the motor **86** to move the elevator car within the shaft and is operated from within the elevator car on a control panel **86** (see FIG. **1**) mounted on one wall within the car. The motor **85** is actuated automatically to move the weight medium **79** between the chambers **80** and **81** as the change in the weight of the load occurs, the entire transfer of the medium occurring during the time interval provided by the control system for holding the elevator door **90** (FIG. **1**) open as the car rests at a floor. Once the door is closed, the motor **85** is prevented from being actuated to move the weight medium between the chambers. Accordingly, the motor **85** is kept from being actuated as a result of apparent changes in the weight of the load caused by the acceleration or deceleration of the car **21** within the elevator shaft **23.**

In the exemplary form of the invention illustrated in FIGS. **1** through **7,** the chambers **80** and **81** are mounted on the tops of the car **21** and counterweight **31,** respectively, and each is closed liquid-tight, having side walls **82,** a top wall **84** and a bottom wall **88.** A hose **91** (FIG. **5**) communicates between the two chambers through the top walls **84** and is trained around a wheel **92** secured to the rod **37** supporting the main upper pulleys **36.** Herein, the motor **85** provided for moving the weight medium or liquid **79** through the hose between the two chambers is a three phase alternating current induction motor and is mounted within

the chamber **80** on the top of the car. More particularly, the motor is included as part of a constant displacement reversible pump **93** which serves to move the liquid either from the car chamber **80** to the counterweight chamber **81** when the load within the car is increased or to move the liquid from the counterweight chamber to the car chamber when the load in the car is decreased.

To control automatically the amount of the liquid **79** transferred between the chambers **80** and **81**, means are provided for creating a voltage signal E_A (FIG. 7) whose value is proportional to the weight of the load within the car **21**. In response to changes in the value of the signal E_A, the constant displacement pump **93** is actuated to begin transferring a predetermined amount of the liquid between the car and the counterweight **31** with each revolution of the pump. The signal E_A is then algebraically summed with a feedback signal E_F whose value is modified as a function of twice the amount of liquid transferred between the car and the counterweight. If twice the weight of liquid within the counterweight as represented by the feedback signal E_F does not agree with the weight of the load within the car represented by the signal E_A, the pump continues to operate until the total weight of the car equals the total weight of the counterweight.

One arrangement for achieving the foregoing is shown very schematically and in elementary form in FIG. 7, it being understood that this representation is simply for the purpose of explaining the fundamental principles involved. The signal E_A representative of the weight of the load within the car **21** takes the form of a voltage which is produced as a spring-supported false floor **94** (also see FIG. 5) within the car moves vertically when the weight of the load is increased or decreased. Attached to one edge of the false floor is a vertically extending rack **95** which engages a pinion **96** fixed to a wiper arm **97** adapted to move across a potentiometer **99**. As changes in the weight of the load move the false floor vertically within the car, the wiper arm moves across the potentiometer. The latter is connected across power lines L–1 and L–2 which are energized by a source of direct current, the upper and lower ends of the potentiometer being connected to the positive and negative lines L–1 and L–2, respectively. As the weight of the load increases or decreases, the wiper arm moves upwardly or downwardly along the potentiometer so that the voltage E_A between the lines is increased or decreased. When there is no load on the false floor of the car, the magnitude of the voltage E_A is zero.

The feedback signal E_F is produced by second means in the form of a wiper arm **100** (FIG. 7) which is coupled to a drive shaft **101** of the pump motor **85** through reduction gearing **103** to move across a potentiometer **104** connected between the power lines L–1 and L–2. The wiper arm **100** moves toward the upper end of the potentiometer to increase the value of the feedback signal E_F when the liquid **79** is being pumped from the car chamber **80** into the counterweight chamber **79** and moves toward the lower end of the potentiometer **104** to decrease the value of the feedback signal E_F when the liquid is being pumped from the counterweight chamber to the car chamber.

To actuate the motor **85** so that the liquid **79** is pumped in the proper direction between the chambers **79** and **80** as the weight of the load either is increased or decreased, a sensitive polarized relay R1 is connected between the two potentiometers **99** and **104**. The signal E_A is transmitted in one direction by a conductor **105** connected to one end of the polarized relay and the feedback signal E_F is transmitted in the opposite direction to the other end of the relay by a conductor **106**. The polarized relay in effect sums the two opposing signals E_A and E_F and moves in the direction dictated by the greater signal to actuate the motor so the liquid is pumped in the appropriate direction between the two chambers according to whether the load is increased or decreased in weight. When the weight of the load is increased, the voltage of the signal E_A becomes larger than the voltage of the feedback signal E_F and a signal E_S resulting from the sum of the signals E_A and E_F flows through the polarized relay R1 in a direction indicated by the dashed arrow A so as to close a switch R1*a*. This in turn actuates a relay R2 to close switches R2*a*, R2*b* and R2*c* thereby energizing the motor **85** to pump the liquid from the car **21** and to the counterweight **31**.

Herein, the switches R2*a* and R2*b* are located within power lines L–3 and L–4, respectively, which are connected to the motor and are energized by a three phase alternating current voltage source, the switch R2*c* being located within a ground line L–5 leading from the motor. When the current from the A.C. source flows through the power lines L–3 and L–4, the motor shaft **101** turns in the direction indicated by the dashed arrow C so the wiper arm **100** is moved toward the upper end of the potentiometer **104** a predetermined distance in relation to the weight of the liquid being transferred so the voltage of the signal E_F increases, decreasing the value of the signal E_S. The relation between the weight of the liquid being transferred and the resulting movement of the wiper arm **104** is such that the voltage of the feedback signal E_F approaches the voltage of the signal E_A as the twice the weight of the liquid transferred to the counterweight approaches the weight of the load within the car. Once the voltages of the signals E_A and E_F are equal, the voltage of the signal E_S becomes zero causing the relay R1 to center so switch R1*a* opens to drop out relay R2 which in turn causes the switches R2*a*, R2*b* and R2*c* to open thereby de-energizing the motor.

If the weight of the load in the car **21** is decreased, the wiper arm **97** moves back toward the lower end of the potentiometer **99** decreasing the voltage of the signal E_A below the value of the signal E_F so that the signal E_S flows through the relay R1 in a reverse direction indicated by the arrow B so as to cause a switch R1b to close. As a result, a relay R3 is energized to close switches R3*a*, R3*b* and R3*c* which are located in conductors **107**, **108** and **109**, respectively. The latter conductor is connected in the line L–5 around the switch R2*c* and the conductors **107** and **108** by-pass switches R2*a* and R2*b* cross connecting the power lines L–3 and L–4 to effect a reverse connection of the lines L–3 and L–4 with the motor **85** so the latter is energized to turn in a reverse direction as indicated by the arrow D in FIG. 7. Accordingly, the pump **93** draws the liquid **79** through the hose **91** from the counterweight chamber **81** and into the car chamber **80**. With the motor shaft **101** turning in the reverse direction, the wiper arm **100** is swung toward the lower end of the potentiometer **104** until the voltage of signal E_F again equals the voltage of signal E_A. At this point, the relay R1 centers and

the switch R1*b* opens de-energizing the relay R3 which in turn opens the switches R3*a*, R3*b*, and R3*c* to stop the motor, the weight of the car and the weight of the counterweight again being equal so the elevator system is balanced.

To keep the motor **85** from being actuated when the apparent weight of the load increases and decreases from the acceleration and deceleration of the car **21** within the elevator shaft **23,** a switch S1 in the circuit normally is open when the elevator door **90** is closed to keep either relay R2 or R3 from being energized should the signal E_S flow in one direction or the other through the relay R1. In addition, to prevent the motor from being actuated when insufficient liquid **79** is available to be pumped between the chambers **80** and **81** as a result of liquid being lost from the system, a switch S2 is provided in the circuit and normally is closed when sufficient liquid is within the system to be pumped. But, when the liquid in the system, as measured by floats (not shown) in the chambers **80** and **81,** becomes too low to supply the demand of the liquid to be transferred as required by the load change within the car, then the switch S1 is opened to de-energize either the R2 or R3 relays and as a result deactuate the motor.

Another form of the invention is illustrated in FIGS. **8, 9** and **10** in which parts corresponding to the parts of the first embodiment are indicated by the same primed reference numerals. In this form of the invention, the weight medium **79'** is a non-kinking chain which is coated with a sound deadening material (not shown) such as plastic and which is of a predetermined weight per unit of length. An intermediate portion of the chain **79'** is trained over a sprocket **112** at the upper end of the elevator shaft **23'** and extends between the two chambers **80'** and **81'** both of which are open at their upper ends to permit passage of the chain. An excess length of the chain, corresponding in weight to one-half the load capacity of the elevator system **20'** plus each additional length whose weight produces a desired safety factor for overload capacity, normally is stored in the car chamber **80'** under a no load condition in the car **21'**. To balance the weights of the car and the counterweight **31'** when the car is loaded, a portion of the excess length of chain equal to one-half the weight of the load within the car is transferred from the car chamber and is accumulated in the counterweight chamber.

To offset the weight of the length of chain **79'** extending between the two chambers **80'** and **81'**, an added length of chain **111** is suspended within the lower end portion of the elevator shaft **23'** between the car **21'** and the counterweight **31'**. The intermediate portion of this length of chain is trained around a lower sprocket **113** which is fixed on the rod **41'** supporting the main cables **24'** of the elevator system **20'**.

For movement of the chain **79'** between the two chambers **80'** and **81'**, the sprocket **112** is connected to the rod **37'** by way of a clutch **114** which serves to permit the sprocket to rotate freely on the rod as the chain is being transferred between the car **21'** and the counterweight **31'**. Herein, the motor **85'** used to move the chain between the chambers is mounted on the back wall **61'** of the elevator shaft **23** adjacent the upper end thereof. A clutch and pulley **115** connected between the motor shaft **101'** and the sprocket **112** serves to transmit the rotational power of the motor to the sprocket thereby rotating the latter on the rod to move the chain. During movement of the car within the elevator shaft, the clutch and pulley **115** is disengaged while the clutch **114** is engaged to hold the sprocket for movement with the rod. Accordingly, the motor shaft is kept from rotating as the rod rotates during movement of the car. Conversely, when the chain is being transferred between the chambers **80'** and **81'**, the clutch and pulley **115** is engaged and the clutch **114** is disengaged to permit the sprocket to be rotated freely on the rod by the motor.

The circuitry for operating this embodiment of the invention is illustrated schematically in FIG. **10** and is similar to the circuitry of the first described embodiment of the invention and thus need not be described in detail. As in the first circuit, the present circuit includes the sensitive polarized relay R1' and the two potentiometers **99'** and **104'**, the potentiometer **99'** serving to indicate the weight of the load within the car **21'** and the potentiometer **104'** producing the feedback E_F' to center the relay R1' when equal with the signal E_A' so the motor is deactuated when the amount of chain **79'** transferred between the chambers **80'** and **81'** in the car and the counterweight, respectively, equals one-half the change in the weight of the load. Herein, the motor **85'** is connected directly to the chain sprocket **112** through the clutch **115** which is engaged upon energization of a coil **116** in the circuit as either switch R1*a'* or R1*b'* is closed when the polarized relay R1' shifts off center. At the same time, a second clutch coil **117** also is energized to disengage the clutch **114** so the sprocket is free to turn relative to the rod **37'**. The directions of the arrows C' and D' indicate the directions in which the reversible motor **85'** will be driven to either add weight to the chamber **81'** within the counterweight **31'** or to remove weight from the counterweight as current either flows from the potentiometer **104'** to the potentiometer **99'** with a load increase or from the potentiometer **99'** to the potentiometer **104'** with a load decrease.

Thus, it is seen from the foregoing that, the elevator system **20** of the present invention requires less power to operate, is easier to install and, accordingly, is less expensive to own and operate. Primarily, this is because the motor **85** is actuated automatically in response to changes in the weight of the load within the car **21** to transfer the weight medium **79** between the car and the counterweight **31** in order to keep the system balanced so the power required to move the car between floors in the building is provided easily by the small motor **83.**

I claim:

1. An elevator system for use within a vertical shaft in a multiple story building including, a car of predetermined unloaded weight suspended within the shaft to transport a load between floors within the building, a counterweight suspended within the shaft and spaced laterally from said car to offset the unloaded weight of the car, a set of upper and lower wheels rotatably mounted adjacent the upper and lower ends of the shaft, respectively, a flexible support line trained around said upper and lower wheels, said car and said counterweight being fastened to opposite sides of said line between said upper and lower wheels, a small motor operable to power rotate one of said wheels in said set to drive said line around said wheels to move the car and said counterweight vertically within said shaft, a weight medium movable between said counter-

weight and said car to vary the weight of the counterweight in relation to changes in the weight of the load in the car, means mounted within said car and operable to produce a signal in response to changes in the load, and means operable in response to said signal to move said weight medium between said counterweight and said car in an amount equal to half the change in the weight of the load to keep the weight of the medium in the counterweight substantially equal to the weight of the load plus the weight of the medium in the car prior to movement of said car whereby the system is kept balanced to reduce the power required of said small motor to move the car between floors.

2. An elevator system as defined by claim **1** wherein said means operable to move the weight medium includes a motor adapted to be actuated in response to said signal to move said weight medium between said counterweight and said car, second means operable to produce a second signal to deactuate said motor automatically when the amount of weight medium moved equals one-half the weight of the change in the load.

3. An elevator system as defined in claim **2** wherein said weight medium is liquid, said car including a first chamber formed therein to hold said liquid, a second similar chamber formed within said counterweight, a hose connected between said chambers and through which said liquid may be moved from one chamber to the other, a pump mounted within one of said chambers and operable by said signal-responsive motor to move said liquid through said hose.

4. An elevator system as defined by claim **2** wherein said weight medium is a chain, said system further including a sprocket rotatably mounted in the shaft adjacent the upper end thereof, said chain extending between said car and said counterweight and being trained around said sprocket, said signal-responsive motor being connected to said sprocket to power rotate the latter to move said chain between said counterweight and said car, a clutch connected between said sprocket and said motor and operable to permit said sprocket to free wheel as said car is moved vertically within said shaft.

5. An elevator system as defined by claim **4** wherein said chain is coated with a sound deadening material.

6. An elevator system as defined by claim **1** including scaffolding mounted within said shaft to support said car and said counterweight against lateral movement within said shaft, said scaffolding comprising a plurality of first units of selected length spaced from each other within said shaft and extending from the top to the bottom thereof, a plurality of second units of standard length sandwiched between said first units, one of aid second units extending generally between each floor and its overlying ceiling.

7. An elevator system as defined by claim **6** including means for supporting each of said scaffolding units within said shaft against lateral movement, each of said scaffolding units including vertically extending guide rail sections along opposite sides thereof to guide said car and said counterweight vertically within said shaft.

8. An elevator system as defined by claim **1** including a first brake means connected to one of said wheels in said set and operable to prevent free fall of said car within the shaft, a second set of upper and lower wheels rotatably mounted adjacent the upper and lower ends of the shaft, respectively, a second flexible support line having one end connected to the top of said car, an intermediate portion trained around the upper and lower wheels of said second set and an opposite end portion connected to the bottom of said car, a second brake means connected to one of the wheels in said second car and operable to prevent free fall of said car within the shaft.

9. An elevator system for use within a vertical shaft in a multiple story building including, a car of predetermined unloaded weight suspended within the shaft to transport a load between floors within a building, a counterweight suspended within the shaft and spaced laterally from said car to offset the unloaded weight of the car, means connected between said car and said counterweight and supporting said car and said counterweight within the shaft, a first motor for moving said car vertically within the shaft between floors, a first chamber, a second chamber within said counterweight, a weight medium contained within said first chamber, connected with said second chamber and movable between said counterweight and said car to vary the weight of the counterweight in relation to changes in the weight of the load in the car, first means mounted within said car and operable automatically to produce a first signal when the weight of the load in the car is changed, a second motor adapted to be actuated in response to said first signal to move said weight medium between said chambers, and second means operable prior to movement of said car to produce a second signal to deactuate said second motor automatically when the amount of weight medium moved causes the weight of the counterweight to balance with the loaded weight of the car so as to reduce the power required of said first motor to move the car between floors.

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