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ELEVATOR HOISTING MECHANISM

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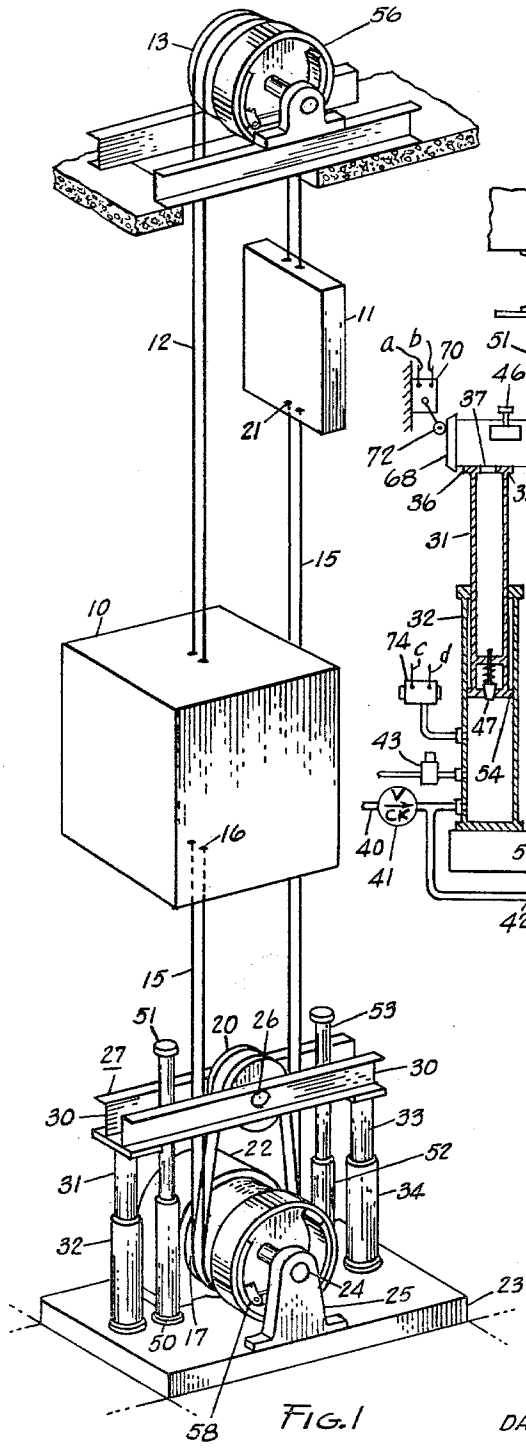


FIG. 1

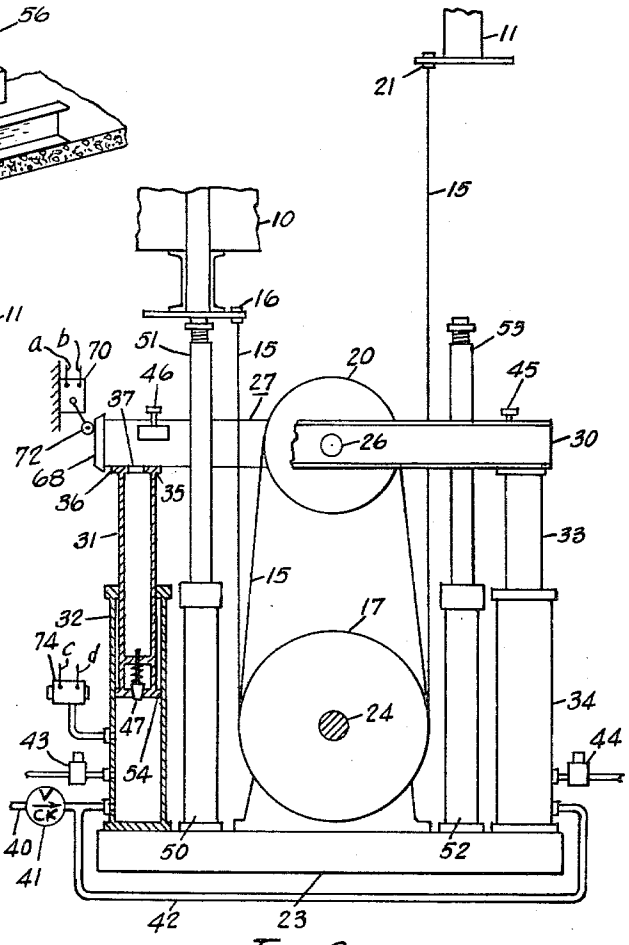


FIG. 2

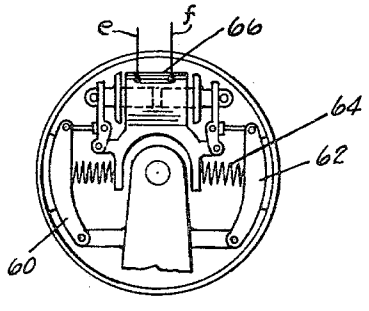


FIG. 3

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ELEVATOR HOISTING MECHANISM

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The invention relates to hoisting mechanism for elevators, especially to hoisting mechanism providing a traction drive for elevators.

In elevator traction drives, the elevator car and its counterweight are raised and lowered by means of the so-called traction machine which may be located at the top or bottom of the elevator hoistway. Where arranged at the bottom of the hoistway, the car and counterweight are suspended by roping which pass over one or more idler sheaves at the top of the hoistway. The car and counterweight are driven by roping which extends from the bottom of the car down and around the hoisting sheave and up to the bottom of the counterweight. Such form of drive has many advantages and the invention is directed to driving mechanism of this character.

With the hoisting mechanism located at the bottom of the hoistway, it is necessary to assure sufficient traction for the safe operation of the elevator. One such arrangement which has been proposed is to extend the hoisting ropes from the bottom of the car around the bottom of the hoisting sheave, thence up and around a secondary sheave, back and around the hoisting sheave and up to the counterweight. Such a roping arrangement is known as double wrap traction. Springs exert force upwardly on the secondary sheave to cause traction between the hoisting sheave and hoisting roping. However, as a result of expansion of the springs to take up rope stretch, traction is decreased, necessitating frequent adjustments. Such an arrangement is disclosed in the patent to Baldwin No. 657,380, granted September 4, 1900. This application describes a related type of system and is a continuation-in-part of my application Serial No. 768,149, filed October 20, 1958, now abandoned.

One object of the invention is to provide an improved multi wrap traction drive at the bottom of the hoistway in which the traction is not decreased with rope stretch.

Another object of the invention is to provide such a drive which also serves to release the traction should either the car or counterweight bottom in the hoistway.

Still another object of the invention is to provide such a drive which also serves to cushion the downward movement of the car or counterweight when its bottoms in the hoistway.

An additional object of the invention is to provide in such a drive system a braking arrangement operating directly on the idler sheave which supports the car and counterweight.

In carrying out the invention according to the preferred arrangement, the hoisting roping extends from the bottom of the car down around a hoisting sheave, up and around a secondary sheave, back around the hoisting sheave and up to the bottom of the counterweight, similar to the above noted prior construction. The secondary sheave is mounted on a crosshead which is supported on fluid actuated mechanism. This mechanism comprises, at each end of the crosshead, a piston upon which that end of the crosshead is mounted and which extends downwardly into a cylinder supported at the bottom of the hoistway. Fluid is supplied to the cylinders under a pressure to move the pistons upwardly tensioning the ropes about sheaves and thus maintaining the desired available traction between the hoisting sheave and hoisting roping. Should bottoming of the car take place, it engages one end of the crosshead to move it downwardly. Thus the secondary sheave is moved downwardly to release the traction. At the same time the piston at that end of the crosshead is moved downwardly into its cylinder, cushioning the downward movement of the car. At the same time a control is actuated to release the pressure in the other cylinder to enable the crosshead to move downwardly without canting. This brings the car to a stop and obivates pulling the counterweight into the overhead. Similarly, should bottoming of the counterweight take place, it engages the other end of the crosshead to move it downwardly. Thus the secondary sheave is moved downwardly to release the traction. At the same time the piston at that end of the crosshead is moved downwardly into its cylinder, cushioning the downward movement of the car. At the same time a control is actuated to release the pressure in the other cylinder to enable the crosshead to move downwardly without canting. This brings the car to a stop and obviates pulling the counterweight into the overhead. Similarly, should bottoming of the counterweight take place, it engages the other end of the crosshead to move it downwardly. Thus the secondary sheave is moved downwardly to release the traction. At the same time the piston at this other end of the crosshead is moved downwardly into its cylinder, cushioning the downward movement of the counterweight. At the same time a control is actuated to release the pressure in the first cylinder to enable the whole crosshead to move downwardly without canting. This brings the counterweight to a stop and obviates pulling the car into the overhead.

A brake is operative directly on the overhead sheave which supports the car and counterweight and is operated automatically should the pressure decrease in either or both the cylinders beneath a predetermined value or if the hoisting ropes break or stretch excessively such that traction might be lost.

Features and advantages will be seen from the above description and appendent claims.

In the drawings:

FIGURE 1 is a trimetric schematic representation of an elevator system with hoisting mechanism embodying the invention; and

FIGURE 2 is a simplified view in elevation, with parts in section, of the hoisting mechanism of FIGURE 1.

FIGURE 3 is a simplified view in elevation of an internal type of brake suitable for use in the described embodiment.

Referring to the drawings, the elevator car **10** and its counterweight **11** are supported by roping **12** passing over an idler sheave **13** at the top of the hoistway. Hoisting roping **15** is secured as at **16** to the bottom of the car and extends downwardly therefrom around the bottom of hoisting sheave **17**. From the hoisting sheave, roping **15** extends upwardly and around the top of secondary sheave **20** and thence downwardly and again around the bottom of the hoisting sheave, double rope grooves being provided on the hoisting sheave for this purpose. From the hoisting sheave the hoisting roping extends upwardly too the bottom of the counterweight where it is secured as at **21**. This provides a double wrap traction drive.

The hoisting sheave **17** is driven by the hoisting motor **22** mounted on bed plate **23**. The sheave shaft **24** is illustrated as supported at the end opposite the motor by a pedestal **25** mounted on bed plate **23**. The shaft **26** of the secondary sheave is mounted on a support in the form of a crosshead **27** extending at right angles to shafts **24** and **26** beyond the hoisting sheave on each side thereof. This crosshead may be in the form of two spaced channel members **30**. The crosshead is supported at the left

end by a plunger 31 operating in a cylinder 32, and at the right end by a plunger 33 operating in a cylinder 34. The upper end 35 of plunger 31 is open and is secured to the under side of a plate 36 in turn secured to the bottom of the crosshead. Plunger 31 may be actuated by any suitable fluid such as air, water or oil and plate 36 has an opening 37 therein to permit escape of this fluid. The same arrangement is provided for the other end of the crosshead.

In this described embodiment air is the preferred medium and air under pressure is supplied to the cylinders by a compressor with accumulator tank (not shown). This enables a constant regulatable pressure to be provided. A pipe 40 leads from the pressure supply and connects through check valve 41 to cylinder 32 and by way of pipe 42 to cylinder 34. Relief valves 43 and 44 may be solenoid actuated subject to the control of switches 45 and 46 respectively, mounted at opposite ends of the crosshead. A pressure relief valve 47 is arranged in the lower end of plunger 31 and a similar valve is provided for plunger 33. A buffer 50 is customarily provided at the bottom of the hoistway. If the car runs into the hoistway pit the plunger 51 of the buffer is engaged by the bottom of the car to cushion downward movement of the car and finally bring it to a stop. A similar buffer 52 is provided for the counterweight and has a plunger 53 adapted to be engaged by the bottom of the counterweight.

As a part of the braking arrangement pressure switch 74 is connected to cylinder 32 and is arranged such that its contacts are actuated when the pressure within the cylinder decreases below a predetermined value. These contacts are connected by the indicated conductors into the circuit of the coil of brake solenoid 66 (FIG. 3).

On the left end of channel members 30 (FIG. 2) which support secondary sheave 20 there is fastened a cam 68 of suitable length and in position to cooperate with cam follower or roller 72 of limit switch 70. The contacts (not shown) of switch 70 are connected over the conductors indicated into the circuit of the coil of brake solenoid 66 (FIG. 3). If perchance hoisting ropes 15 should break or should stretch beyond the expansion capabilities of plunger 31 in cylinder 32 (see plunger stop 54) crosshead 27 will be forced upwardly to a position where roller 70 runs off of cam 68 to actuate the contacts of switch 70.

In FIG. 3 there is shown in simplified form an expanding type, internally mounted brake having brake shoes 60, 62 which upon interruption of current in brake solenoid or magnet 66 are applied by springs 64. Similarly, when the proper amount of current flows in brake magnet 66 its cores are retracted to overcome the pressure of the springs and retract the shoes.

Mounted integral with idler sheave 13 at the top of the hoistway is a brake 56 of the type just described. The contacts of pressure switch 74 and limit switch 70 are connected in the circuit of its brake solenoid coil along with any other contacts appropriate in a conventional control system such that brake 56 is actuated to release its brake shoes 60, 62 against the brake drum whenever a stop is made at a landing or if pressure in cylinder 32 decreases dangerously or ropes break or stretch excessively.

A brake 58 may, optionally, be provided integral with hoisting sheave 17 or be mounted immovably on sheave shaft 24. If so provided, the coil of its brake magnet 66 will be actuated in the same manner and at the same time as has previously been explained for the overhead brake 56.

Although it has not been shown in detail it is to be understood that appropriate control circuits, of which several conventional designs are available, are to be provided for the actuation of the brake mechanism or mechanisms. Thus either or both brakes may be applied at each landing stop (assuming both upper and lower brakes 56, 58 are supplied) by interruption of the circuit for energizing the coil of each brake magnet 66. If only one

brake mechanism is to be supplied it is preferable that it be brake 56 associated with overhead sheave 13—in which case it will be actuated by the conventional control circuit at each landing stop as well as by pressure switch 74 or limit switch 70 when these are actuated. The actuating circuit will, of course, include wires *a* and *b* of limit switch 70 and wires *c* and *d* of pressure switch 74 in series connection with wires *e* and *f* of the coil of brake magnet 66.

In operation, the air supplied to cylinders 32 and 34 forces plungers 31 and 33 respectively upwardly to place tension in the hoisting roping 15. The air pressure is adjusted so as to provide the desired available traction between driving sheave 17 and hoisting roping 15—it being understood this traction increases as the tension in the ropes is increased. As the air pressure falls due to leakage, the check valve 41 allows more air to be supplied to the cylinders to maintain substantially constant pressure. Should the car bottom, that is, run past the lowermost floor into the hoistway pit, it strikes the plunger 51 of buffer 50 which acts to exert a gradually retarding action. As downward movement of the car continues, it engages the left end of crosshead 27 and acts therethrough to force plunger 31 downwardly in cylinder 32 against the air pressure therein. Relief valve 47 acts to let go when the pressure builds up to a certain value to permit some of the entrapped air to escape at the top of the plunger. The ensuing drop in pressure causes switch 74 to open its contacts in the circuit of the coil of brake magnet 66 of the overhead brake 56, and of machine brake 58 if provided. At the same time the car actuates switch 46 to cause actuation of valve 44 to allow the escape of air from cylinder 34, thus enabling plungers 31 and 33 to move downwardly as a unit and thus obviate canting of the crosshead. The downward movement of the crosshead, by decreasing the distance of the secondary sheave from the hoisting sheave, releases the traction of the hoisting ropes, preventing roping 12 pulling the counterweight into the overhead. Also the downward movement of plunger 31 assists buffer 50 in bringing the car to a stop. A similar action takes place in case of bottoming of the counterweight.

While the invention has been illustrated as applied to an installation in which buffers 50 and 52 are provided, it is to be understood that these buffers may be omitted and the retarding action obtained by the plungers 31 and 33 in cylinders 32 and 34. In the latter case the plungers would be arranged to provide a gradually increasing retarding action as is understood in the buffer art. Where used in conjunction with buffers, it has the advantage that it may be applied to existing installations in which buffers are provided.

The invention has been described as utilizing a double wrap traction drive. Other multi wrap traction drives, such for example as triple wrap, may be utilized. The greater number of wraps has the advantage that it enables the desired traction to be obtained with lower pressure in the cylinders. It is preferred to provide a minimum amount of traction which will prevent slip. This further reduces the pressure in the cylinders. Low pressure in the cylinders is of advantage in that it increases rope life. Also, a multi wrap drive utilizing V belts, such as those with steel centers, and V grooves in the driving and secondary sheaves, may be used instead of roping, thereby lowering the pressure in the cylinders required for the desired traction.

As many changes can be made in the above described construction and many apparently different embodiments of this invention can be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown on the accompanying drawing be interpreted as illustrative only and not in a limiting sense.

What is claimed is:

1. In an elevator system in which the elevator car

and its counterweight are suspended by roping passing over an idler sheave at the top of the hoistway, hoisting mechanism for the car and counterweight comprising, a hoisting sheave located at the bottom of the hoistway, a secondary sheave positioned above the hoisting sheave and movable vertically relative thereto, hoisting roping extending from the bottom of the car around the hoisting sheave, thence around the secondary sheave, back around the hoisting sheave and up to the bottom of the counterweight, fluid actuated mechanism including a secondary sheave support supporting the secondary sheave for exerting force thereon to move it upwardly with respect to the hoisting sheave to provide traction between the hoisting roping and hoisting sheave, means for supplying fluid to said fluid actuated mechanism at a pressure to cause sufficient tension in the hoisting roping to insure the desired amount of said traction, notwithstanding stretching of the roping, and means responsive to downward force exerted by the car on the secondary sheave support to actuate the fluid actuated mechanism to reduce the distance between the secondary sheave and hoisting sheave to release the traction.

2. In an elevator system in which the elevator car and its counterweight are suspended by roping passing over an idler sheave at the top of the hoistway, hoisting mechanism for the car and counterweight comprising, a hoisting sheave located at the bottom of the hoistway, a secondary sheave positioned above the hoisting sheave and movable vertically relative thereto, hoisting roping extending from the bottom of the car around the hoisting sheave, thence around the secondary sheave, back around the hoisting sheave and up to the bottom of the counterweight, fluid actuated mechanism including a secondary sheave support supporting the secondary sheave for exerting force thereon to move it upwardly with respect to the hoisting sheave to provide traction between the hoisting roping and hoisting sheave, means for supplying fluid to said fluid actuated mechanism at a pressure to cause sufficient tension in the hoisting roping to insure the desired amount of said traction, notwithstanding stretching of the roping, and means responsive to downward force exerted by the counterweight on the secondary sheave support to actuate the fluid actuated mechanism to reduce the distance between the secondary sheave and hoisting sheave to release the traction.

3. In an elevator system in which the elevator car and its counterweight are suspended by roping passing over an idler sheave at the top of the hoistway, hoisting mechanism for the car and counterweight comprising, a hoisting sheave located at the bottom of the hoistway, a secondary sheave positioned above the hoisting sheave and movable vertically relative thereto, hoisting roping extending from the bottom of the car around the hoisting sheave, thence around the secondary sheave, back around the hoisting sheave and up to the bottom of the counterweight, fluid actuated mechanism including a secondary sheave support supporting the secondary sheave for exerting force thereon to move it upwardly with respect to the hoisting sheave to provide traction between the hoisting roping and hoisting sheave, means for supplying fluid to said fluid actuated mechanism at a pressure to cause sufficient tension in the hoisting roping to insure the desired amount of said traction, notwithstanding stretching of the roping, and means responsive to downward force exerted by the car or counterweight on the secondary sheave support to actuate the fluid actuated mechanism to reduce the distance between the secondary sheave and hoisting sheave, releasing the traction, and to cushion further downward movement of the actuating car or counterweight.

4. In an elevator system in which the elevator car and its counterweight are suspended by roping passing over an idler sheave at the top of the hoistway, hoisting mechanism for the car and counterweight comprising, a hoisting sheave located at the bottom of the hoistway, a secondary sheave positioned above the hoisting sheave and movable vertically relative thereto, hoisting roping extending from the bottom of the car around the hoisting sheave, thence around the secondary sheave, back around the hoisting sheave and up to the bottom of the counterweight, a support for the secondary sheave extending oppositely therefrom, a pair of cylinders, each having a plunger, one of said cylinders and its plunger being positioned under one end of said support and the other cylinder and its plunger being positioned under the other end of said support, said support being mounted on the upper ends of said plungers, and said cylinders being adapted upon the supply of fluid thereto to act through said plungers to exert force on said secondary sheave to move it upwardly with respect to the hoisting sheave and thus provide traction between the hoisting roping and hoisting sheave, and means for supplying fluid to said cylinders at a pressure to cause sufficient tension in the hoisting roping to insure the desired traction, notwithstanding stretching of the roping, said support being positioned in the path of downward movement of both said car and counterweight to be engaged thereby upon the bottoming thereof to move said support downwardly to release the traction.

5. In an elevator system in which the elevator car and its counterweight are suspended by roping passing over an idler sheave at the top of the hoistway, hoisting mechanism for the car and counterweight comprising, a hoisting sheave located at the bottom of the hoistway, a secondary sheave positioned above the hoisting sheave and movable vertically relative thereto, hoisting roping extending from the bottom of the car around the hoisting sheave, thence around the secondary sheave, back around the hoisting sheave and up to the bottom of the counterweight, a support for the secondary sheave extending oppositely therefrom, a pair of cylinders, one at each end of the support, each cylinder having a plunger for supporting said support, said cylinders being adapted upon the supply of fluid thereto to act through said plungers and support to extert force on said secondary sheave to move it upwardly with respect to the hoisting sheave and thus provide traction between the hoisting roping and hoisting sheave, means for supplying fluid to said cylinders at a pressure to cause sufficient tension in the hoisting roping to insure the desired traction, notwithstanding stretching of the roping, one end of said support being positioned in the path of downward movement of said car to be engaged thereby upon the bottoming thereof to move that end of said support downwardly to release the traction and the other end of said support being positioned in the path of downward movement of said counterweight to be engaged thereby upon the bottoming thereof to move that end of said support downwardly to release the traction, and control means on each end of the support adapted upon operation to relieve the fluid pressure in the cylinder under the other end of the support, said control means on said one end being operable by the car upon that end being engaged by the car, and said control means on said other end of said support being operable by the counterweight upon that end being engaged by the the counterweight.

6. In the elevator system in which the elevator car and its counterweight are suspended by roping passing over an idler sheave at the top of the hoistway, hoisting mechanism for the car and counterweight comprising, a hoisting sheave located at the bottom of the hoistway, a secondary sheave positioned above the hoisting sheave and movable vertically relative thereto, hoisting roping extending from the bottom of the car around the hoisting sheave, thence around the secondary sheave back around the hoisting sheave and up to the bottom of the counterweight, a crosshead upon which the secondary sheave is mounted, a pair of cylinders, one at each end of the

crosshead, each cylinder having a plunger for supporting the crosshead, said cylinders being adapated upon the supply of fluid thereto to act through said plungers to exert force on said crosshead to move said secondary sheave upwardly with respect to the hoisting sheave and thus provide traction between the hoisting roping and hoisting sheave, means for supplying fluid to said cylinders at a pressure to cause sufficient tension in the hoisting roping to insure the desired traction, notwithstanding stretching of the roping, one end of said crosshead being positioned in the path of downward movement of said car to be engaged thereby upon the bottoming thereof to move that end of said crosshead downwardly to release the traction and the other end of said crosshead being positioned in the path of downward movement of said counterweight to be engaged thereby upon the bottoming thereof to move that end of said crosshead downwardly to release the traction, control means on each end of the crosshead adapted upon operation to relieve the fluid pressure in the cylinder under the other end of the crosshead, said control means on said one end being operable by that end being engaged by the car, and said control means on said other end of said support being operable by that end being engaged by the counterweight, and a pair of buffers, one for the car and one for the counterweight, for cushioning the downward movement thereof, said crosshead being engaged to bring the corresponding cylinder and plunger into action to assist the acuated buffer as the continued downward movement of the actuating car or counterweight takes place.

7. In an elevator system in which the elevator car and its counterweight are suspended by roping passing over an idler sheave at the top of the hoistway and in which motive power is applied to the car and its counterweight from hoisting mechanism located at the bottom of the hoistway, a powered hoisting sheave and a secondary sheave located at the bottom of the hoistway said secondary sheave being positioned above the hoisting sheave and movable vertically relative thereto, hoisting roping extending from the bottom of the car around the hoisting sheave, thence around the secondary sheave, back around the hoisting sheave and up to the bottom of the counterweight, fluid actuated mechanism including a support for said secondary sheave for exerting force on said support moving the secondary sheave upwardly with respect to said hoisting sheave and tightening said ropes around said sheaves to provide available traction between the hoisting roping and hoisting sheave, means for supplying fluid to said fluid actuated mechanism at a pressure to cause sufficient tension in the hoisting ropes to provide the desired amount of available traction, means responsive to downward force exerted by the car or its counterweight on the secondary sheave support to decrease the pressure of the fluid in said fluid actuated mechanism, a spring applied magnetically released mechanical brake mounted integrally with said idler sheave to control its rotation and pressure responsive means responsive to the decreased pressure in said fluid actuated mechanism and operative to cause said brake to be applied to arrest the rotation of said car supporting idler sheave.

8. In an elevator system in which motive power is applied to the underside of the car and the underside of its counterweight by a hoisting machine located at the bottom level of the hoistway, an idler sheave supported at the top of the hoistway over which the supporting ropes between car and counterweight pass, a mechanical brake operatively connected when actuated to control the rotation of said sheave, the said hoisting mechanism including a hoisting sheave and a secondary sheave positioned thereabove and movable vertically relative thereto, hoisting roping extending from the bottom of the car around the hoisting sheave up and around the secondary sheave and back around the hoisting sheave thence up to the underside of the counterweight, fluid actuated mechanism including a movable support for said secondary sheave exerting force on said support to move said secondary sheave upwardly with respect to the hoisting sheave thereby to increase the tension in the hoisting ropes, a limit switch connected to said sheave support and responsive to upward movement of said support beyond a predetermined position, means for supplying to said fluid actuated mechanism fluid at a pressure to produce the desired rope tension notwithstanding stretching of the roping, means responsive to downward force exerted by the car or its counterweight on the secondary sheave support to actuate the fluid actuated mechanism to reduce the distance between the hoisting and secondary sheaves thereby releasing the traction, and means connecting said limit switch in the actuating control of said brake whereby said brake is applied to check the rotation of said car supporting idler sheave whenever said fluid actuated mechanism forces said secondary sheave support beyond said predetermined position.

9. In an elevator system in which the elevator car and its counterweight are suspended by roping passing over an idler sheave rotatively supported at the top of the hoistway and in which motive power is applied to the underside of said car and the underside of said counterweight by hoisting ropes powered by a hoisting machine located at the lowest level of said hoistway, said hoisting machine including a hoist sheave and a secondary sheave positioned thereabove and movable vertically relative thereto, said hoisting ropes extending under the hoist sheave, up and over the secondary sheave thence back under the hoisting sheave before passing upwardly for connection to said car and counterweight, the improvement which includes a mechanically-applied brake on said overhead idler sheave, a fluid actuated mechanism including a movable support for said secondary sheave for exerting force thereon upwardly to separate said sheave from said hoisting sheave thereby producing tension in said hoisting ropes and available traction for movement of said car and counterweight, means for supplying fluid under controlled pressure to said mechanism, means responsive to downward force exerted by the car or its counterweight on the secondary sheave support to reduce the separation of said hoisting and secondary sheaves to release the traction, and brake control means responsive both to fluid pressure less than a predetermined value within said fluid actuated mechanism or separation of said hoisting and secondary sheaves beyond a predetermined amount and operative to cause said brake to apply and arrest rotation of said car supporting idler sheave upon the pressure decreasing below said value or the sheave separation exceeding said predetermined amount.

10. In an elevator system in which the elevator car and its counterweight are suspended by roping passing over an idler sheave rotatively supported at the top of the hoistway and in which hoisting power is supplied from a hoisting machine located at the lowest level of said hoistway by roping attached to the undersides of said car and counterweight, said hoisting machine including a powered hoisting sheave and a vertically movable secondary sheave positioned thereabove, said hoisting ropes extending from the connection to said car, under said hoisting sheave, up and over said secondary sheave, down and under said hoisting sheave and up to the connection to said counterweight, the arrangement which includes a mechanically applied brake on the overhead idler sheave, fluid actuated mechanism responsive to fluid supplied it under controlled pressure and including a vertically movable support for said secondary sheave operative to exert force thereon upwardly and effect desired vertical separation of said hoisting and secondary sheaves, pressure responsive means operative to its actuated state by insufficient fluid pressure within said fluid actuated mechanism, positional means operative to its actuated state by excessive elevation of said movable secondary sheave sup-

port and an electrical control circuit effective when energized to restrain the application of said mechanically applied brake, said control circuit including said pressure responsive means and said positional responsive means whereby the energization of said circuit and the restraint on said mechanically applied brake is interrupted by the actuation of either of said last mentioned means in response to the decrease in said fluid pressure or the elevation of said sheave support beyond predetermined limits, whichever first occurs.

References Cited in the file of this patent

UNITED STATES PATENTS

657,380	Baldwin et al.	Sept. 4, 1900
1,654,650	Hymans	Jan. 3, 1928
1,861,063	Palm	May 31, 1932
2,270,441	Hymans	Jan. 20, 1942
2,537,075	Margles	Jan. 9, 1951
2,797,075	Wilbur	June 25, 1957
2,924,297	Brandon	Feb. 9, 1960