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(54) Shaft safety system for an elevator

(57) The elevator comprising a car inside an elevator shaft, a landing door to open and close an entrance of the elevator shaft which entrance provides access to a work environment in the elevator shaft. The elevator further comprises a shaft safety system for safeguarding a maintenance worker in the work environment from the car. The shaft safety system comprises a device which is arranged to be automatically activated when said landing door is opened or released to be opened and deactivated by manually reset and a control system for controlling the movement of the car. The device is connected to the control system and the control system is brought in a safely mode wherein the control system prevents the car to move beyond a predetermined position in the shaft in the direction of the work environment if said device is activated.

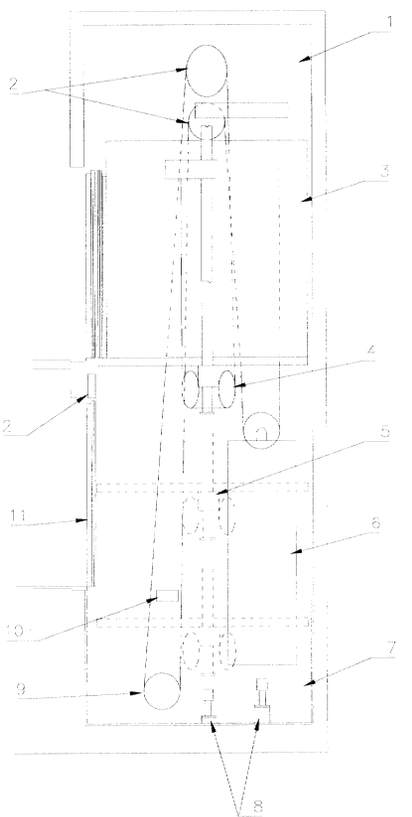

Fig. 1

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Description

[0001] This invention relates to an elevator comprising a car inside an elevator shaft, a landing door to open and close an entrance of the elevator shaft which entrance provides access to a work environment in the elevator shaft and a shaft safety system for safeguarding a maintenance worker in the work environment from the car. The invention also relates to a control system, a shaft safety device and a shaft safety system of the elevator.

[0002] For safe and reliable lift performance regular maintenance and inspection is required. For conventional elevators, the drive and control units are positioned in a separate room. This room has specific dimensions and no direct contact is possible with the moving car or counterweight, so that a safe work environment is guaranteed. For machine-room-less elevators on the other hand, the drive unit and sometimes the control unit as well, are positioned inside the shaft, in most cases in the pit or in the top of the shaft. So maintenance and inspection to these parts shall be performed from inside the shaft as well. To guarantee a safe work environment, additional measures have to be taken.

[0003] Such an elevator is known from US patent 5,727,657.

[0004] Regarding conventional lifts with most equipment in the pit, pit equipment is restricted and only temporary maintenance performance or inspection is necessary. Therefore, the standard shaft safety system is accepted to provide a relatively safe work environment, as is demanded by the relevant regulation (EN81 among others). This standard shaft safety system complying with EN81 incorporates buffers for car and counterweight to limit their lowest elevation in the hoist way and a pit stopping device to prevent car operation when active.

[0005] The buffers, rubber bumpers, spring or hydraulic buffers, safeguard a specified refugee space. The activated pit stopping device safeguards the person present in the pit to be hit by moving parts due to unexpected car operation. Standard procedure is to activate the pit stopping device before entering the pit and deactivating it again after leaving. The operation of the pit stopping device is by manual action, so it can be easily forgotten or even neglected. To reach the parts installed underneath the car after pit entrance, car operation from the pit may be required to lower the car for testing or maintenance performance to these parts. This will lead to unauthorized deactivation of the pit stopping device when present in the pit or climbing on top of something to reach the higher parts which results into an unsafe work environment.

[0006] For an elevator with the drive system and/or the associated equipment positioned in the pit, the pit is regarded as machine room. The relevant regulation (EN81) demands minimal dimensions for machine rooms for easy and safe working on equipment (EN81-6.3.2). In particular there shall be provided at least a clear height of 2 m at working areas. Sales on the other hand require a minimum pit depth to reduce building costs and to be competitive to other suppliers. These two demands are in conflict with each other.

[0007] US patent 5,727,657 shows equipment that automatically provides a safe work environment by limitation of the car travel. One or more travel blocking devices pivot into the travel path of the car whenever the car is moved away from the protected area and the car is stopped. During the movement itself the travel blocking devices are retracted again. Switches check these movements. A key to open the door actuates an unlatching and release device positioned above the shaft door. This will actuate a memory circuit to keep the interruption of the safety circuit and prevents car operation until a key switch resets the memory circuit.

[0008] A disadvantage of this system is that the parts underneath the car are still difficult to reach for maintenance performance. In this circumstance, the car can not be lowered due to the mechanical blocking device. The maintenance person is forced to use a separate ladder or has to climb on top of something else to reach the parts installed underneath the car. This introduces new risks of falling or moving parts crushing left ladders in the pit after maintenance performance. Also dynamic maintenance, that means maintenance performance to parts maintained from the pit that require car movement, cannot be performed in that case. Furthermore, this safety system incorporates a lot of moving parts that can malfunction due to dust or dirt. This system may also be costly due to the amount of parts.

[0009] A similar concept to assure a safe work environment during someone's presence in the pit is described by US patent 5,806,633. Actuators operate two pivotable columns fixed in the pit to extended or retracted position. In extended position, the two stop members fixed to the car will hit the columns when the car reaches a certain lowest level. In this way the refugee space in the pit as demanded by EN81 is safeguarded. Two manually operated devices are mounted to the guide rails or other structure to provide a safe free height for an upright standing person in the pit. A switch mounted under a mat on the pit floor notices if someone is presence in the pit. An electric alarm bell starts ringing as soon as someone steps on this mat. To stop the irritating sound, the person has to install the additional stopping devices.

[0010] Once the actuators have been activated and the safety columns are in the extended position, only upward movement of the car is still allowed. Downward movement is prevented by the control system.

[0011] With this system the car can be moved upward during presence in the pit to perform some of the dynamic maintenance procedures. Maintenance procedures that require a downward car movement cannot be performed. Also for this system the disadvantage is valid that the parts underneath the car are still difficult to reach for maintenance performance due to the mechanical

blocking device that prevents the car from being able to be lowered. The maintenance person is again forced to use a separate ladder or has to climb on top of something else to reach the parts installed underneath the car, which introduces new risks of falling or moving parts crushing left ladders in the pit after maintenance performance.

[0012] Also the safeguarded free height is only just valid as the person stands on the pit floor mat. During the pit entrance, e.g., standing on the ladder, the free height is not yet safeguarded.

[0013] It is an object of the invention to provide a solution to the above-discussed problem.

[0014] The elevator of the invention is characterized in that the shaft safety system comprises a shaft safety device which is arranged to be automatically activated when said landing door is opened or released to be opened and deactivated by manually reset and a control system for controlling the movement of the car wherein the device is connected to the control system and the control system is brought in a safely mode wherein the control system prevents the car to move beyond a predetermined position in the shaft in the direction of the work environment if said device is activated.

[0015] According to the present invention a shaft safety system is provided that is activated automatically as soon as the landing doors near the area in the shaft to safeguard, e.g., the pit or top of the shaft, are opened or are released to be opened. It provides a safe work environment in the shaft that involves a safeguarded free work height as soon as the shaft safety system is active. According to a special embodiment no car operation enabled from another location than the relevant shaft location, e.g., pit or top of the shaft, is possible. More particularly, in case of the pit, the free work height can be overruled from the pit operation panel to reach the lower parts of the car but only by means of a certain conscious action. Preferably, the control system will allow car movement by inspection speed only.

[0016] Even in case of a power failure the shaft safety system will, according to a preferred embodiment, memorize the required condition when the power recovers. An easy check is available for the person if the shaft safety system is active or not.

[0017] The present invention of a shaft safety system comprises according to a special embodiment the following items.

[0018] A car that is able to move up or down inside an elevator shaft. A landing door at the landing floor to close the entrance to the part of the elevator shaft to safeguard. A shaft safety device that notifies that someone enters the shaft. In that case a control system is activated that prevents car operation except from the shaft location near the landing door equipped with the safety device, it makes a temporary limit switch operative and it lightens the work light in the shaft. This temporary limit switch prevents the car to move below or above a certain height to safeguard a free work height as is valid for machine rooms. In case of the pit, an exception can be made by performing a certain conscious action from inside the pit. After leaving the shaft, the device is manually reset from the landing floor and the control system is inactive again.

[0019] Possible embodiment of the shaft safety system will be discussed by means of the following drawings, wherein:

Figure 1 presents a cross-section of an elevator with the machine in the pit including the shaft safety system;

Figure 2 presents an implementation of the shaft safety device for a safeguarded machine location in the shaft with the safety switch positioned on top of the header case and the triangle key lock positioned in the landing door panel;

Figure 3 presents the functioning of a mechanical locking mechanism of a non-stable switch of the shaft safety device; (A) is the default inactive position, (B) is the extreme activated position and (C) is the locked activated position of the switch after that the triangle key lock is being released;

Figure 4 presents another implementation of the shaft safety device with the safety switch positioned on top of the header case and the triangle key lock positioned in the landing door panel;

Figure 5 also presents another implementation of the shaft safety device with the safety switch positioned on top of the header case and the triangle key lock positioned in the landing door panel;

Figure 6 presents the functioning of another mechanical lock mechanism for a non-stable safety switch of the shaft safety device;

Figure 7 presents a side view of the implementation of the shaft safety device as is shown in figure 6.

Figure 8 presents an implementation of the shaft safety device with the safety switch positioned behind the landing door and the triangle key lock positioned in the landing door panel;

Figure 9 presents another implementation of the shaft safety device with the safety switch positioned behind the landing door and the triangle key lock positioned in the landing door panel;

Figure 10 presents another implementation of the shaft safety device with the safety switch positioned behind the landing door, the triangle key lock positioned in the landing door panel and an additional mechanism included to reset the safety switch from the side of the landing door.

Figure 11 presents another implementation of the shaft safety device with the safety switch positioned on top of the header case and the triangle key lock positioned in the top jamb;

Figure 12 presents the mechanism coupled to the triangle key lock of the implementation as is shown in figure 11 in more detail; (A) is a front view, (B) is a top view of the mechanism in default position and

(C) is a top view of the mechanism in the extreme activated position;

Figure 13 presents an implementation of the shaft safety device with the safety switch positioned on top of the header case and the triangle key lock positioned in the top jamb;

Figures 14 and 15 present another implementation of the shaft safety device with the safety switch positioned on top of the header case and which is not coupled to the triangle key lock. The only difference between both figures is the applied reset mechanism of the safety switch;

Figure 16 presents the lock mechanism of the non-stable safety switch of the shaft safety device that can be reset electrically from another location;

Figure 17 presents a schematic presentation of the shaft safety system implementation; and

Figure 18 presents the methodology as applied for the safety circuit regarding the shaft safety system.

[0020] Figure 1 shows the side view of a machine-room-less elevator. The car 3 and counterweight 6 are suspended by a two to one roping system, with the deflection sheaves 2 mounted in the top of the shaft and deflection sheaves below the car, the so called underslung 4. The lower part of the shaft 1 is the pit 7 where the buffers 8 are positioned. In this example the machine 9 is positioned in the pit, but it could also have been installed for example in the top of the shaft. The machine location in the shaft, in this case the pit, is lightened by the work light 10. Landing doors 11 closes entrances to the shaft. The pit is accessible from the lowest landing floor. The elevator is provided with a shaft safety system. This system comprises a shaft safety device 12 which is positioned partly behind and/or above the landing doors near the machine location. The shaft safety system also comprises a temporary operative limit switch 5 positioned in the shaft. In case of a machine in the pit, this limit switch is positioned in the lower part of the shaft. For a machine in the top of the shaft, a temporary operative limit switch can be positioned in the top of the shaft. This limit switch is part of the shaft safety system.

[0021] The function of this invention is as follows regarding the example of a machine-room-less elevator with the machine in the pit. To enter the pit, the landing door has to be opened manually. Coupled to the manual opening of the lowest landing door the shaft safety device will be activated. This will activate a control system of the shaft safety system that lightens the work light in the pit, makes the temporary operative limit switch operative and prevents car operation from any location except for the pit. Besides of lightening the machine workspace, the work light functions as a warning signal that the shaft safety system is active or not as well. The temporary operative limit switch prevents car operation below a certain level of at least the minimum required safety height as is valid for machine rooms from the moment that the shaft safety system is active. Only by a special conscious action on the shaft operation panel the car can be lowered passed the temporary operative limit switch, e.g., to perform maintenance to the lower parts of the car. After leaving the pit the shaft safety device and thereby the shaft safety system has to be reset manually from the landing floor by pulling a pawl or pressing a button inside a key-locked hall panel.

[0022] The effect of this invention is that as soon as a person manually opens the lowest landing door the shaft safety system is active. The person can safely enter the pit and no danger exists that the car goes down unexpectedly by car operation from another location during his presence in the pit. Also dynamic maintenance can be performed safely from the pit without the danger that the car goes down unexpectedly in case of not paying attention to the car movement but to the maintained parts or in case of inaccurate operation. However, it is still possible to lower the car to maintain the lower parts of the car.

[0023] Figures 2 and 3 show an implementation of the shaft safety device including a triangle key lock 19 in the landing door panel 13. This triangle key lock is also part of the conventional door lock system. A lever 18 coupled to the triangle key lock lifts a mechanism when the triangle key lock is manually operated. This will rotate the door latch 14a that is hinged connected to the door hanger 14. When rotated, the door latch no longer locks behind the fixed latch 14b and the door panel, door hanger and everything connected to the door hanger can translate aside. During normal car operation, the door lock is rotated by the vanes 14c fixed to the car door that rotate the door latch when making contact with the rollers of the door latch. Additional to this conventional door lock system, a second lever 20 is fixed to the triangle key lock, to the opposite side as lever 18. A bracket 17 is mounted behind the triangle key lock. A stopper 16 consisting of a bolt nut combination is fixed to this bracket. A second lever 20 is fixed to the triangle key lock to the opposite side as lever 18. The free end of this lever 20 is hinged connected to a strip 21. This strip is connected by bolts to a special bend strip 22 pointing in the same direction as strip 21. Slots are provided in one of these strips to adjust the total strip length. The other end of strip 22 is hinged connected to a plate 24. This plate is also hinged connected to a bracket 23 that is mounted to the door hanger 14. The bent part of this plate 24 can make contact with a lever 25. This lever is fixed to the safety switch lever 28. The safety switch is mounted to and positioned inside a switch frame 29 that is fixed on top of the header case 15. A switch locking lever 26 with trapped cutting is hinged connected to the switch frame and is pushed against the safety switch lever by a spring 27.

[0024] The function of this shaft safety device is as follows. To manually open the doors, the triangle key lock will be rotated by means of the triangle key. The levers fixed to the triangle key lock will be rotated as well. Lever 18 will operate the door latch while lever 20

pulls down the strip 22. Rotation of the triangle key lock and thus the fixed connected levers in the opposite direction is limited by means of the stopper 16. When lever 22 is pulled down, lever 24 will be rotated counter-clockwise and lifts lever 25. This will activate the safety switch and at the same time the lock lever 26 will be rotated one step higher underneath the safety switch lever by the spring force. After lever 24 returned to the default position, the safety switch lever is kept in the active position by this lock lever. To reset the safety switch again, the lock lever has to be rotated manually or electrically against the spring force.

[0025] The effect of this shaft safety device is that the safety switch is activated as soon as the triangle key lock is rotated. That means that the shaft safety system is active even before the landing door is really opened. The safety switch is fixed to a static part, so that no difficulties will occur with the wiring. A safety door lock can be applied because it is made bi-stable by the usage of the lock lever. The installation is simple due to the reduced amount of parts and the adjustable length of the part that connects the parts on the door panel with the parts on the header case.

[0026] Figure 4 shows an implementation of the shaft safety device coupled to the triangle key lock 36 fixed in the door panel 30. A stopper 33 consisting of a bolt-nut combination is fixed to a bracket 34 that is fixed to the door panel. Two plates 35 and 37 are fixed to the triangle key lock. Plate 37 is hinged connected to a strip 38. Plate 38 and plate 39 are fixed connected by bolts. Slots are provided in one of the plates for these bolt connections to adjust the total length of the combined plates. Plate 39 is hinged connected to a flat plate 41 that is hinged connected to bracket 40. This bracket is fixed to the door hanger 31. The safety switch lever 45 is extended by a lever 42. This lever has a bent part at the free end above the plate 41. Lock lever 43 is a plate with a special cutting, trapped over the area that makes contact with the safety switch lever. A spring 44 keeps contact between the lock lever and the safety switch lever. The safety switch is mounted inside a switch frame 46 that is fixed on top of the header case 32.

[0027] The function of this shaft safety device is similar to the function of the shaft safety device as is described for figure 2.

[0028] The effect of this implementation is similar to that of the implementation of figure 2 with that difference that the parts mounted inside the header case have another shape and position regarding the door hanger and the safety switch is positioned more to the center of the landing door. This can be an advantage in case of other parts mounted to the door hanger or header case.

[0029] Figure 5 shows a shaft safety device coupled to the triangle key lock 50 in the door panel 47. A stopper 54 is fixed connected to a bracket 53 that is fixed to the door panel. A lever 51 is fixed to the triangle key lock. One side has a free contact with bar 52, while the other end is hinged connected to a lever 55. The length of this lever is adjustable. This is arranged by the use of two plates that are fixed connected by bolts with slots in one of the plates. Lever 55 is hinged connected to a plate 56 that is hinged connected to the door hanger 49. A torsion spring 57 is applied around this connection point to keep the plate in the default position during normal door operation. A part of plate 56 is bent so that it will make contact with a sliding bar 58 when rotated. This bar is guided by a plate 59 that is mounted to the door hanger. A spring 60 keeps the sliding bar in default position during normal operation. A construction of two plates 61, fixed together by slot-bolts connections, is mounted on top of the sliding bar. The top part of the most upper plate is bent so that it will make contact with lever 61 that is mounted to the switch lever 62 when the sliding bar is lifted. The bi-stable switch itself 63 is mounted to a switch frame 64. This switch frame is mounted on top of the header case 48.

[0030] The function of this implementation of the shaft safety device is similar to the function of. the implementation of the shaft safety device as described for figures 2 and 4.

[0031] The effect of this implementation is also the same as described for figures 2 and 4 with the difference that for this implementation another area of the door hanger can be used for the mounting of some of the device parts. This implementation requires more parts and more adjustments during installation than the formal described implementations.

[0032] Figure 6 shows an implementation of a mechanical lock mechanism for a non bi-stable switch of the shaft safety device. A plate with a special cutting 65 is hinged connected 66 to the switch frame. A torsion spring 67 is applied to keep the plate 65 in contact with the switch lever. A reset lever 68 is hinged connected to plate 65.

[0033] The function of the lock mechanism is to change the non bi-stable switch to a bi-stable switch. The plate 65 hooks around the switch lever when this switch lever is lifted by the operation of the shaft safety device. In that case the switch lever is kept in activated position, even when the pit safety device is no longer operated. The reset lever 68 has to be pulled to release the switch lever again.

[0034] The effect of the lock mechanism is that a non-bi-stable safety switch can be applied for the shaft safety device that is made bi-stable by means of this lock mechanism.

[0035] Figure 8 shows an implementation of the shaft safety device including a triangle key lock 70 in the door panel 69. A compact bi-stable safety switch 76 is mounted behind the door panel. A lever 71 is fixed to the triangle key lock to operate the sliding bar 72 of the door latch mechanism and the safety switch pin 74 at the same time. The special wiring of the safety switch 75 is guided behind the bent sides of the door panel. The safety switch is applied with a reset button 76 to reset the switch.

[0036] The function of this implementation of the shaft safety device is as follows. When the triangle key lock is rotated, the coupled lever lifts the bar of the door latch mechanism and pushes down the operation pin of the safety switch. After leaving the pit the shaft safety device has to be reset by pulling out the reset button on the safety switch behind the door panel.

[0037] The effect of this implementation is a very simple construction to activate and reset the shaft safety system.

[0038] Figure 9 shows a slightly different implementation of the shaft safety device including a triangle key lock 78 fixed in the door panel 77. A special shaped lever 79 is fixed to the triangle key lock. This lever has a free contact with the sliding bar of the door latch mechanism 80 and the special switch operation lever 82 of a compact bi-stable safety switch 81. This switch is mounted to a bracket 83. This bracket is fixed to the bent side of the door panel by bolt connections for which slots are provided in both the bracket and door panel. The special wiring of the switch is guided behind the bent sides of the door panel. The switch is provided with a reset button 85.

[0039] The function of this implementation is as follows. The rotation of the triangle key lock rotates the coupled lever that lifts the sliding bar of the door latch mechanism and the switch operation lever at the same time. The shape of the lever is such that the switch operation lever will be lifted within the specified range. After leaving the pit the shaft safety system has to be reset by pulling out the reset button on the safety switch behind the door panel.

[0040] The effect of this implementation is similar to that as described for figure 8 with the difference that the reset button is more close positioned near the side of the door panel, thus more easy to reach. Due to the special shaped lever fixed to the triangle key lock no danger exists that the switch is damaged by rotation over a too big angle of the triangle key lock.

[0041] Figure 10 shows also a slightly different implementation of the shaft safety device coupled to the triangle key lock 87 fixed in the door panel 86. The lever 88 fixed to the triangle key lock is extended to one side. The free end has a free contact with a compact bi-stable safety switch 90. This switch is mounted to a bracket 91 that is fixed to the upper bent plate of the door panel. The switch is provided with a reset button 92. A lever 93 is coupled to this reset button and somewhere in the center hinged connected 94 to a special shaped bracket 95. This bracket is fixed to the bent side plate of the door panel and guides a sliding bar 97. A spring 96 keeps the sliding bar in the default position during normal operation. The end of the sliding bar to the inner side of the door panel has a free contact with the lever 93 connected to the reset button. In front of the other end of the sliding bar a small hole 98 is provided in the side of the door panel.

[0042] The function of this implementation is as follows. The rotation of the triangle key lock rotates the coupled lever. This rotation lifts the sliding bar of the door latch mechanism and activates the safety switch of the shaft safety device. After leaving the pit the shaft safety system has to be reset by pushing a pencil within the small hole in the side of the door panel. This will translate the sliding bar against the spring force and rotates the lever coupled to the reset button around the pivot point. The reset button will be pulled. After releasing the pencil from the hole, the spring will return the sliding bar to its default position.

[0043] The effect of this implementation is similar to that as described for figure 8 with that difference that the reset can be easily performed from the side of the door panel.

[0044] Figures 11 and 12 show an implementation of the shaft safety device including a triangle key lock 105 positioned in the top jamb 100. The top jamb is the upper beam of the door frame in the shaft wall. A frame 106 made of a special bent plate is mounted underneath the triangle key lock. A bent plate 108 is fixed on top of the triangle key lock. A spring 104 is mounted between this plate and the frame. A screw 107 is fixed to the frame at the other side of the triangle key lock. At the end of the plate 108, near the spring attachment, the inner wire of a cable 110 is mounted. The end of the outer wire near the triangle key lock is mounted to a bracket 103 that is mounted to the top jamb. The other end of cable 110 is mounted to the free end of a lever 112 positioned on top of the header case. The cable is positioned between the shaft wall and the header case. A special bent plate 101 has one free end positioned in the rotation path of plate 108 while the other end is connected to the door latch.

[0045] Lever 112 is a special bent plate with a horizontal bent part there where the cable is mounted and an inclined bent part at the other end. At a certain distance from both ends, it is hinged connected to a bracket 111 that is fixed to the header case 102. Lever 112 has a free contact with the switch operation lever 113. The compact bi-stable safety switch 114 is mounted to a frame 115 that is also mounted on top of the header case. A reset lever 118 is mounted to the reset button 116 of the switch. A spring 117 is applied between the reset lever and the header case to avoid the reset button being pulled by the mass of the reset lever.

[0046] The function of this implementation is as follows. Rotation of the triangle key lock will rotate the coupled plate as well. This will not only rotate plate 101 to open the door latch, but will also pull the inner wire over a certain distance out of the outer wire. Lever 112 will rotate around the pivot point and lifts the switch operation lever. The switch is activated. After release of the triangle key lock the spring will return the coupled plate back to the default position. The stopper prevents the plate to rotate too far. This will release the wire pulling as well and lever 112 will rotate back to the original position. The bi-stable switch however will stay activated.

After leaving the pit the switch has to be reset by pulling the reset lever. This will pull out the reset button of the switch.

[0047] The effect of this implementation is the operation of the shaft safety system for an elevator with the triangle key lock positioned in the top jamb. The position of the safety switch on the header case is flexible within a certain range due to the use of a cable to connect the parts in the top jamb with the parts on the header case. Because the cable is positioned between the header case and the shaft wall, no conflicts will occur with parts positioned within the header case.

[0048] Figure 13 shows a similar but slightly different implementation of the shaft safety device as is described for figure 12 with the triangle key lock 135 positioned in the top jamb 120. A frame made of a bent plate 134 is mounted underneath the triangle key lock. A long screw 133 is fixed to this frame at one side of the triangle key lock. A spring 136 is fixed to this frame at the opposite side of the triangle key lock. The other side of the spring is fixed to a bent plate 132 that is fixed on top of the triangle key lock. A hook-shaped flat plate 131 has a pivot connection at the corner to the top jamb. One free end is positioned within the rotation path of the bent plate 132. The inner wire of the cable 121 is fixed to the other free end. The cable consists of an inner and outer wire and is positioned between the header case 129 and the shaft wall. The cable is guided by a bracket 122) fixed to the header case. The outer wire near the triangle key lock is fixed to header case. The other end of the cable is fixed to a lever 124. This lever is hinged connected at a certain distance from the free end to a bracket 128 that is fixed on top of the header case. A spring 123 is mounted between the lever and header case. The part of this lever at the other side of the pivot connection has free contact with the switch operation lever 126 of the compact bi-stable safety switch 125. This switch is mounted to a frame on top of the header case. A rod 127 is hinged connected to the opposite end of the lever then where the cable was fixed to operate the door latch. The reset is again by means of a reset lever coupled to the reset button of the safety switch.

[0049] The function of this implementation is similar to the function of the implementation as described for figures 11 and 12 with the following differences. The cable goes straight up and is not bent. The inner wire is not directly mounted to the plate fixed on top of the triangle key lock, but an additional part is used. The rotation of the plate fixed on top of the triangle key lock will make contact with this vertical mounted plate. Due to that this plate will be rotated as well which pulls out the inner wire of the cable. The spring applied between the lever on top of the header case and the header case is applied to ensure that the lever will return to its default position after release of the triangle key lock. No parts of the shaft safety device or even the door latch operation device are positioned within the header case.

[0050] The effect of this implementation is similar to that of the implementation as described for figures 11 and 12.

[0051] Figure 14 shows an implementation of a shaft safety device that is operated based on the combination of the landing door opening and the car being present yes or no at the same landing floor. Besides the conventional door latch with roller set 137, a second set of rollers 138 with attached plate 139 are pivot connected to the door hanger 140. A stiff spring is applied to keep the plate in the upward, default position. The conventional door latch will be operated by the conventional vanes 137a on the car door, while an additional set of vanes 138a on the car door will operate the additional set of rollers. A safety switch 147 with extended switch operation lever 141 is fixed to the switch frame 146 that is mounted on top of the header case 150. A special cut plate 144 is hinged connected to the frame at point 145 and is coupled by a spring 143 to the frame side. A wire 148 is fixed to the free end of this plate that is positioned outside the switch frame. This wire is guided over the deflection sheaves 142 and 149 and tensioned by a small mass 151. A pull ring 152 is mounted at the end of the wire that is accessible from the landing floor with the landing door opened over a small area.

[0052] The function of this implementation of the shaft safety device is as follows. On the car frame or door two sets of vanes are mounted parallel to each other. When the car is at the same level as the involved landing floor, these vanes will rotate both sets of rollers against the spring forces. This will open the door latch and at the same time it lowers the attached plate to the second roller set. When the doors open, the plate will translate underneath the extended switch operation lever without making contact. So the switch will not be activated. A different situation arises when the landing door is manual opened and the car is at another floor. In that case only the door latch will be opened but the second roller set with attached plate is not operated and remains in the upward, default position. This plate will make contact with the extended switch operation lever when the doors open. The switch will be activated. The lock mechanism, by means of the special cut plate kept in contact with the switch operation lever by means of a spring, will ensure that the switch stays activated even when the doors close again. After leaving the pit the shaft safety system can be reset by pulling the reset wire. This will rotate the connected special cut plate against the spring force and the switch operation lever is released.

[0053] The effect of this implementation is that the triangle key lock is no longer part of the shaft safety device. So the triangle key lock will not be forced by additional forces to operate the shaft safety device. The landing doors have to be opened only over a small area to reset the shaft safety system. Of course also an electrical reset device can be applied to reset the shaft safety system from another location (see figure 16).

[0054] Figure 15 shows a similar implementation as describes in figure 14 with the difference that instead of

the described lock mechanism for the non-bi-stable safety switch, the lock mechanism as described in figure 6 is applied.

[0055] Figure 16 shows the lock mechanism for a non-bi-stable safety switch as applied in figures 2, 3 and 4 with the extension of an electrical operated plunger.

[0056] The function of this implementation is that the plunger is translated by the manual operation of a switch or button from another location on the landing floor. The plunger pushes the lock lever down against the spring force and the switch operation lever will be released.

[0057] The effect is that the doors do not have to be opened to reset the shaft safety system and the position of the reset button or switch is more flexible.

[0058] Figure 17 shows the schematic implementation of the shaft safety system. The safety switch 168 of the shaft safety device 165 is activated by the operation 167 of manual opening of the doors 166. The safety switch is reset 169 by the activation of the reset button or pawl 170 from the landing floor. The state of the safety switch is transferred 171 to the control system 173. The control system is part of the total elevator control 172. In case of activation of the safety switch, the control system cuts 176 the safety chain, switches on 174 the work light 175, gives a signal 177 to the elevator control and activates 180 the temporary limit switch 184. The cut off of the safety chain also gives a signal 178 to the elevator control to stop the machine. The elevator control controls 181 the elevator car 182 movement and the car operation abilities 190, 191 and 192 via the shaft operation device 187, the car roof operation device 188 and the hall operation device 189. As soon as that the elevator control receives the signal that the shaft safety system is activated, the car operation abilities 190 and 191 via the car roof and hall operation devices are switched off. Only car operation 192 via the shaft operation device is still functioning, but with inspection speed only.

[0059] If the elevator car reaches the level equal to the minimum height as required for machine rooms it operates 183 the temporary limit switch. The temporary limit switch gives a signal 180 to the control system as soon that it is activated. The control system transfers 177 this signal to the elevator control which will stop 181 the car. However in case of the pit, the elevator car can be lowered passed the temporary limit switch in case the shaft operation device and the cancelling of the temporary limit switch 186 are both activated 185. This command is transferred via the control system to the elevator control.

[0060] In an advanced embodiment the control system only resets the safety switch if the landing doors are in closed position.

[0061] When the control system receives the signal that the shaft safety device is reset, it fixes the safety chain, the work light is switched off, the temporary limit switch is deactivated and the elevator control receives a signal to recover normal operation.

Claims

1. An elevator comprising a car inside an elevator shaft, a landing door to open and close an entrance of the elevator shaft which entrance provides access to a work environment in the elevator shaft and a shaft safety system for safeguarding a maintenance worker in the work environment from the car, characterized in that the shaft safety system comprises a shaft safety device which is arranged to be automatically activated when said landing door is opened or released to be opened and deactivated by manually reset and a control system for controlling the movement of the car wherein the device is connected to the control system and the control system is brought in a safely mode wherein the control system prevents the car to move beyond a predetermined position in the shaft in the direction of the work environment if said device is activated.

2. Elevator according to claim 1, characterized in that the control system in the safety mode further prevents control of the car from any place except from the work environment in the shaft.

3. Elevator according to claim 1 or 2, characterized in that, the shaft safety system is further provided with a temporary limit switch located in said elevator shaft and connected with said control system wherein the temporary limit switch is arranged to be operated by the car if the car moves beyond the predetermined position and wherein the safety control system in the safety mode stops the movement of the car if the temporary limit switch is operated by the car.

4. Elevator according to claim 1, 2 or 3, characterized in that, the shaft safety system further comprises a shaft light which is activated to enlighten the work environment if the control system is brought in the safety mode if the device is activated.

5. Elevator according to any of the preceding claims, characterized in that, the said shaft safety device comprises a safety switch which is arranged to be operated from a first position to a second position if the landing door is opened or released to be opened wherein the safety switch is connected with the control system and wherein the control system is brought in the safety-mode if the safety switch is brought in its second position.

6. Elevator according to claim 5, characterized in that the safety switch is mechanically operated from the first position to the second position.

7. Elevator according to claim 5 or 6, characterized in that the shaft safety device further comprises a key-

lock arranged to be operated from outside the shaft near the landing door wherein the key-lock releases the landing doors to be opened and controls the safety switch to be brought from the first position into the second position if the key-lock is operated with a key corresponding to the key-lock.

8. Elevator according to claim 5 or 6, characterized in that the elevator further comprises a key-lock arranged to be operated from outside the shaft near the landing door wherein the key-lock releases the landing doors to be opened if the key-lock is operated with a key corresponding to the key-lock and wherein the landing door controls the safety switch to be brought from the first position into the second position if the landing doors are opened.

9. Elevator according to claim 7, characterized in that, the key-lock mechanically controls the safety switch.

10. Elevator according to claim 9, characterized in that mechanical means are provided to transform a rotational movement of the key-lock into translational movement to control the safety switch.

11. Elevator according to any of the preceding claims 5-10, characterized in that the safety switch is a bistable switch.

12. Elevator according to any of the preceding claims 5-10, characterized in that, a mechanical locking device is provided to make the safety switch bistable.

13. Elevator according to any of the preceding claims 5-12, characterized, in that the safety switch is arranged to be manually reset from the second position into the first position from the working environment.

14. Elevator according to any of the preceding claims 5-12, characterized, in that the safety switch is arranged to be manually reset from the second position into the first position from outside the shaft.

15. Elevator according to claim 13, characterized in that, the reset of the safety switch is arranged by a pawl mechanically linked to the safety switch and that resets the safety switch when pulled or pushed.

16. Elevator according to claim 13, characterized in that, the reset of the safety switch is arranged by an electrical operated plunger and a reset button wherein the plunger resets the safety switch if the reset button is operated.

17. Elevator according to claim 14, characterized in that, the reset of the safety switch is arranged by an electrical operated plunger and a reset button wherein the plunger resets the safety switch if the reset button is operated.

18. Elevator according to claim 17, characterized in that, the reset button is positioned behind a key-locked hall panel or other key-locked cabinet accessible from a hall outside the shaft.

19. Elevator according to any of the preceding claims 13-18, characterized in that the reset of the safety switch can only be effected if the landing doors are in closed position.

20. Elevator according to any of the preceding claims 5-19, characterized in that, means are provided so that the safety switch can only be operated from the first position into the second position if the car is not present behind the landing door.

21. Elevator according to any of the preceding claims 5-19, characterized in that, a first reset button is provided in the shaft and a second reset button is provided outside the shaft wherein the safety switch is only reset from the second position into the first position if the second reset button is operated after that the first reset button is operated.

22. Elevator according to any of the preceding claims, characterized in that the prevention of the car to move beyond the predetermined position in the shaft in the direction of the work environment can be overruled by means of a predetermined action performed by a person in the working environment.

23. A control system of the elevator according to any of the preceding claims 1-4.

24. A shaft safety system of the elevator according to any of the preceding claims 1-22.

25. A shaft safety device of the elevator according to any of the preceding claims 1-22.

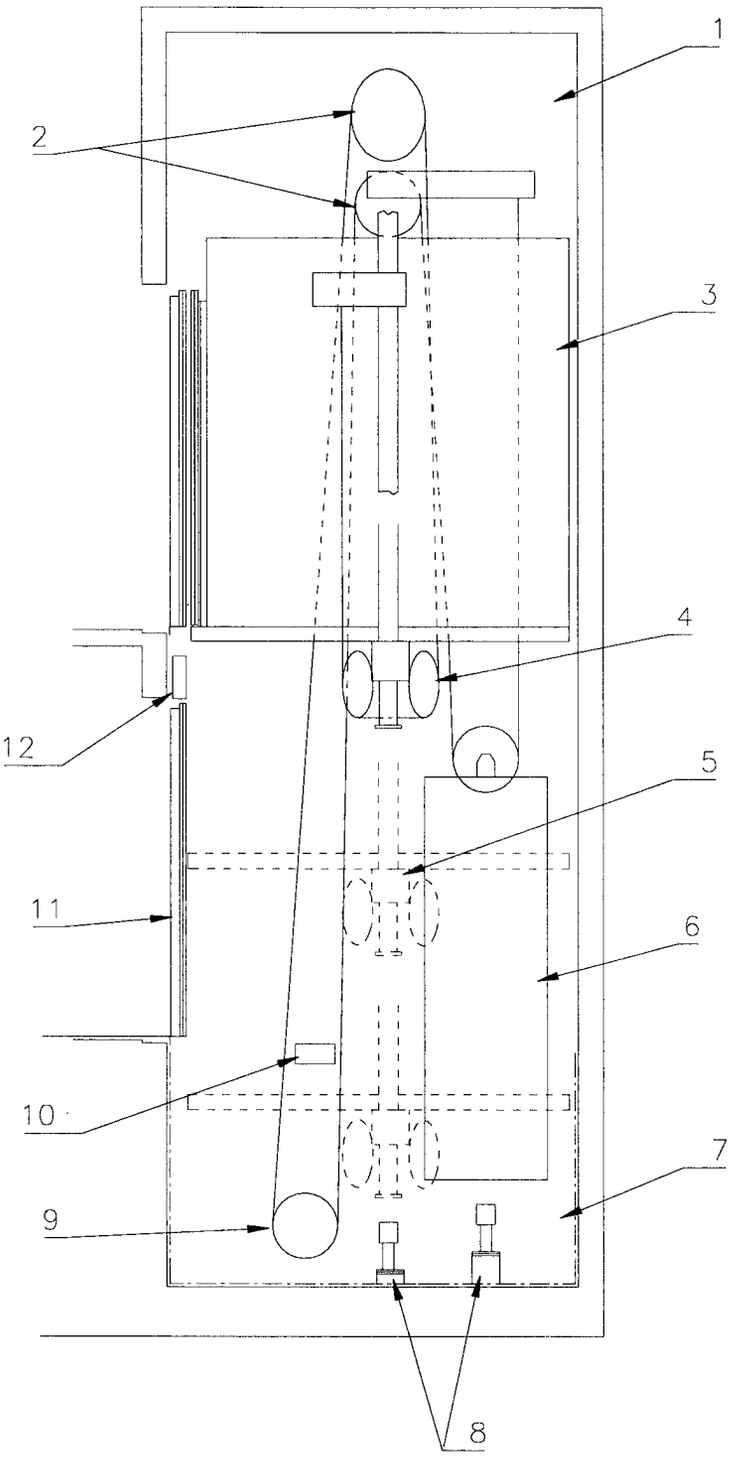

Fig. 1

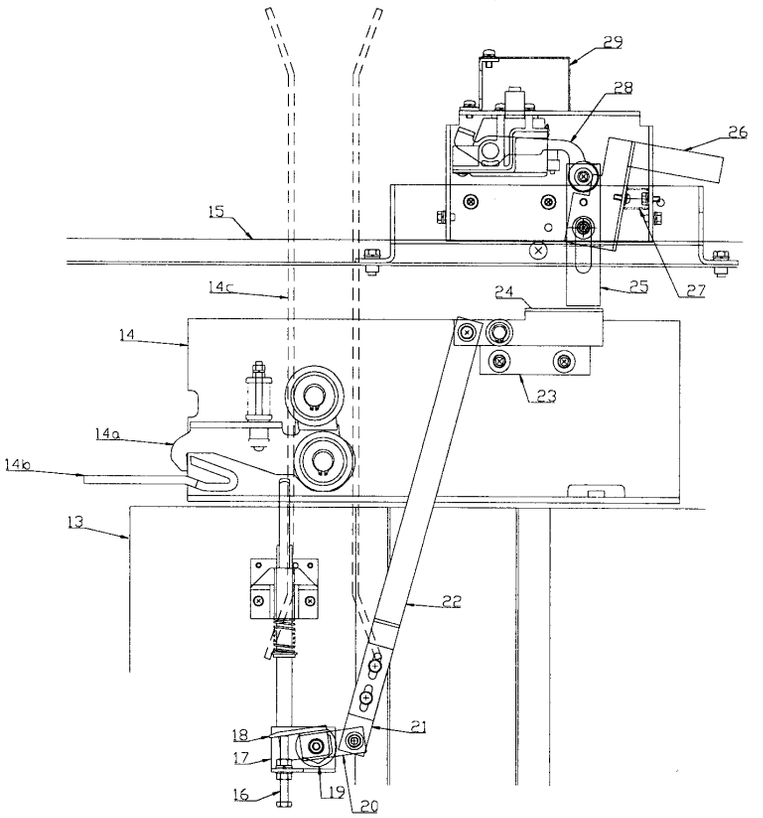

Fig. 2

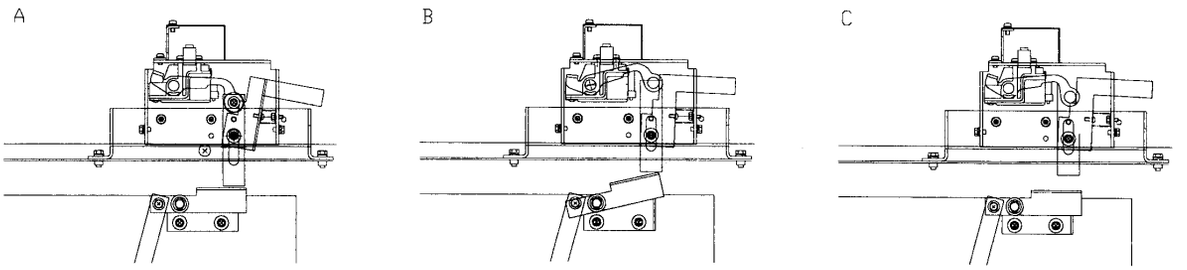

Fig. 3

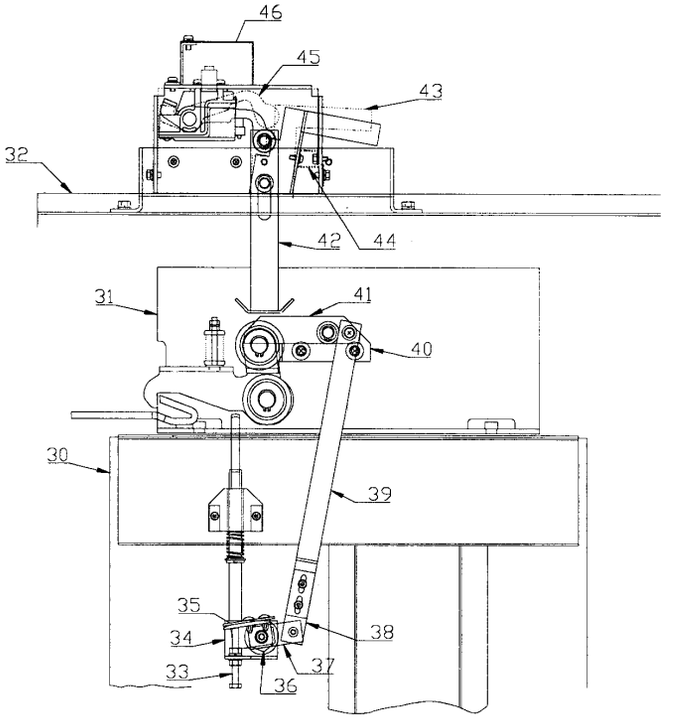
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Fig. 4

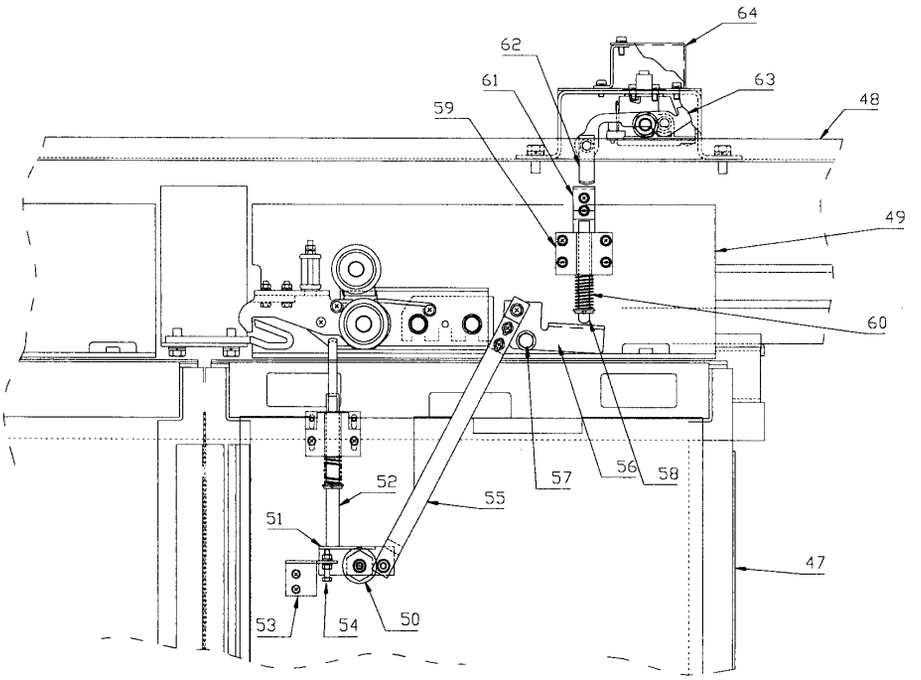
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Fig. 5

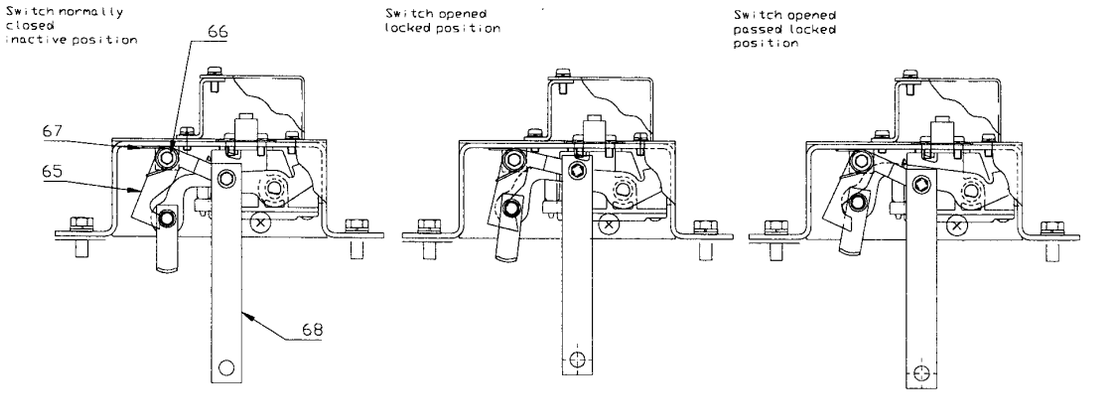
Switch normally closed inactive position
66
67
65
68
Switch opened locked position
Switch opened passed locked position

Fig. 6

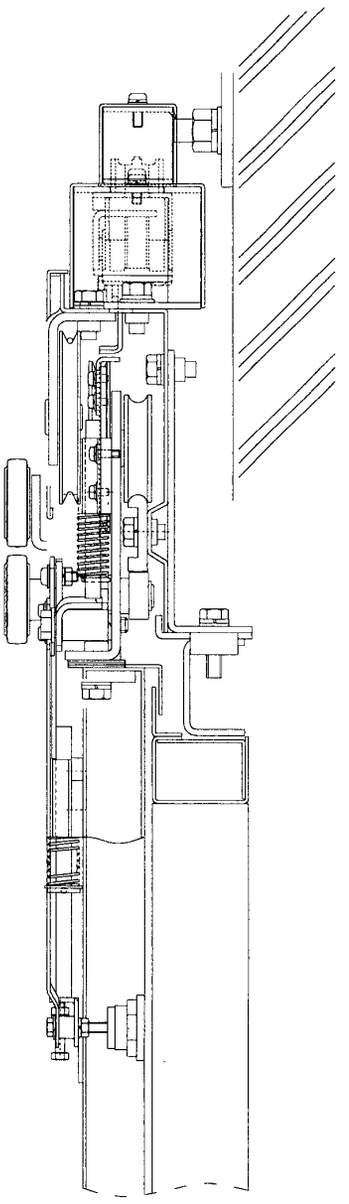

Fig. 7

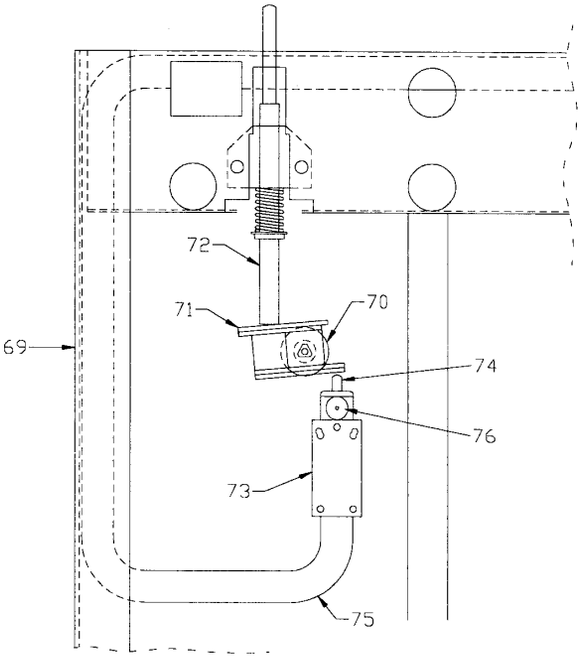

Fig. 8

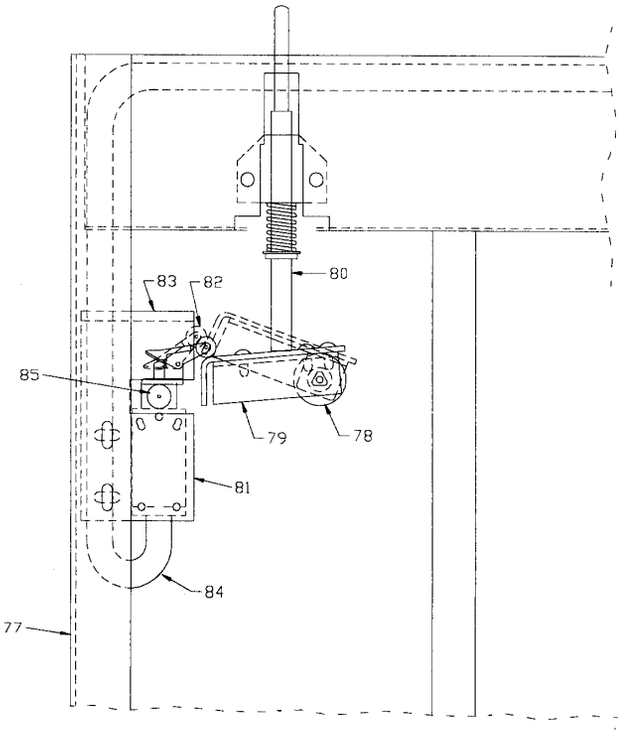

Fig. 9

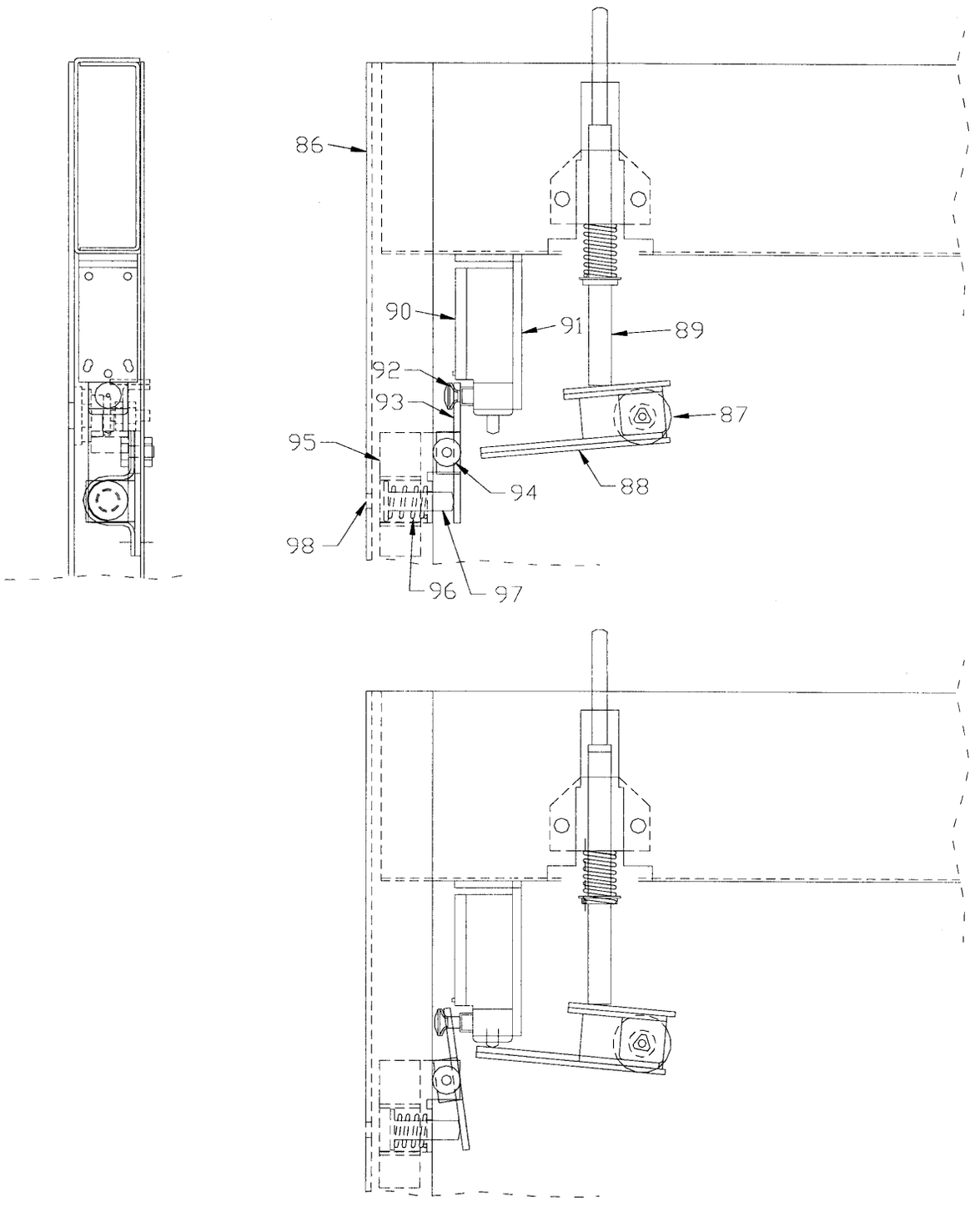

Fig. 10

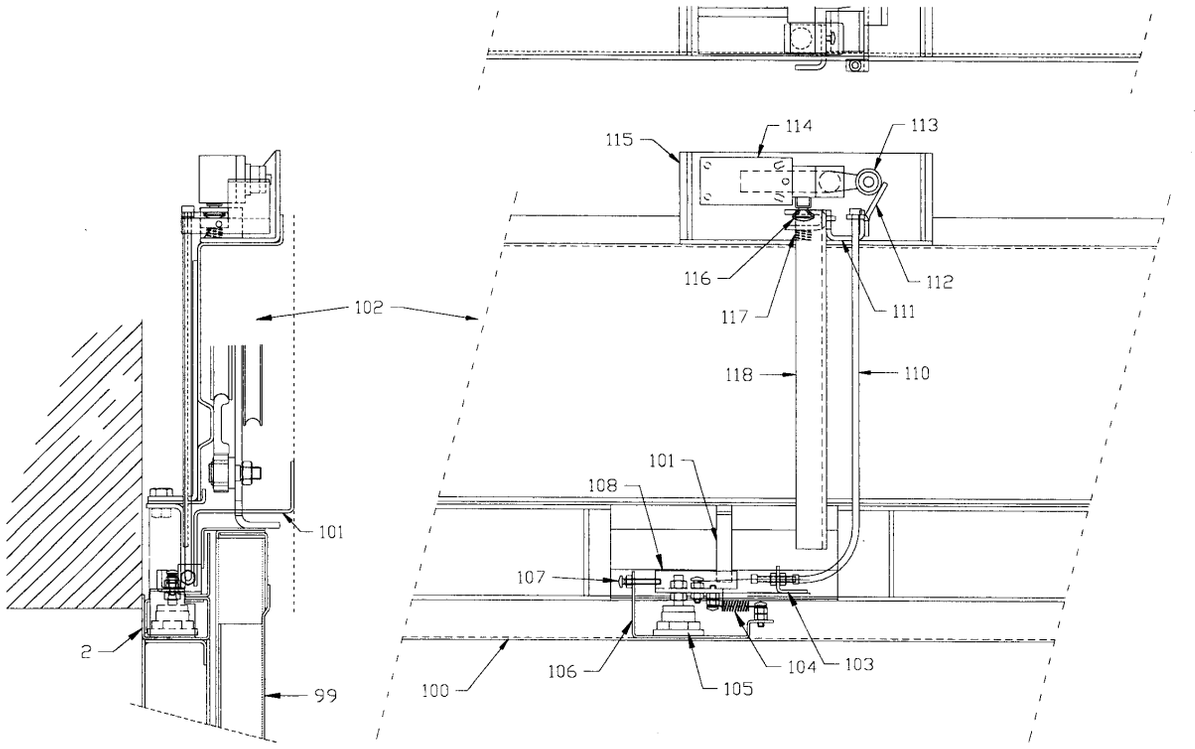
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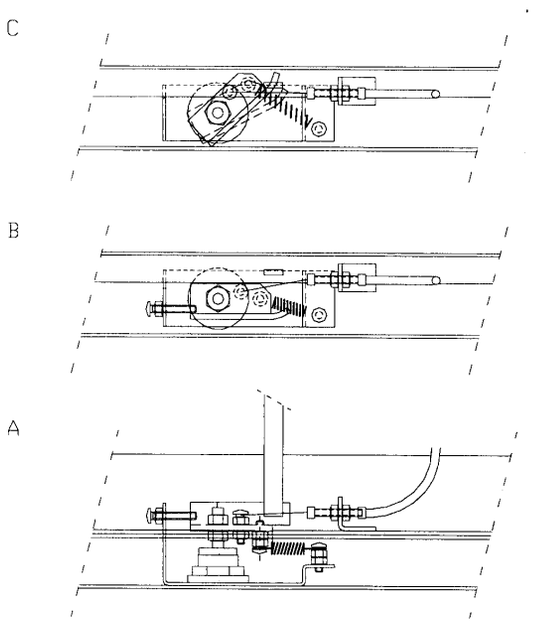
Fig. 11


C
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A

Fig. 12

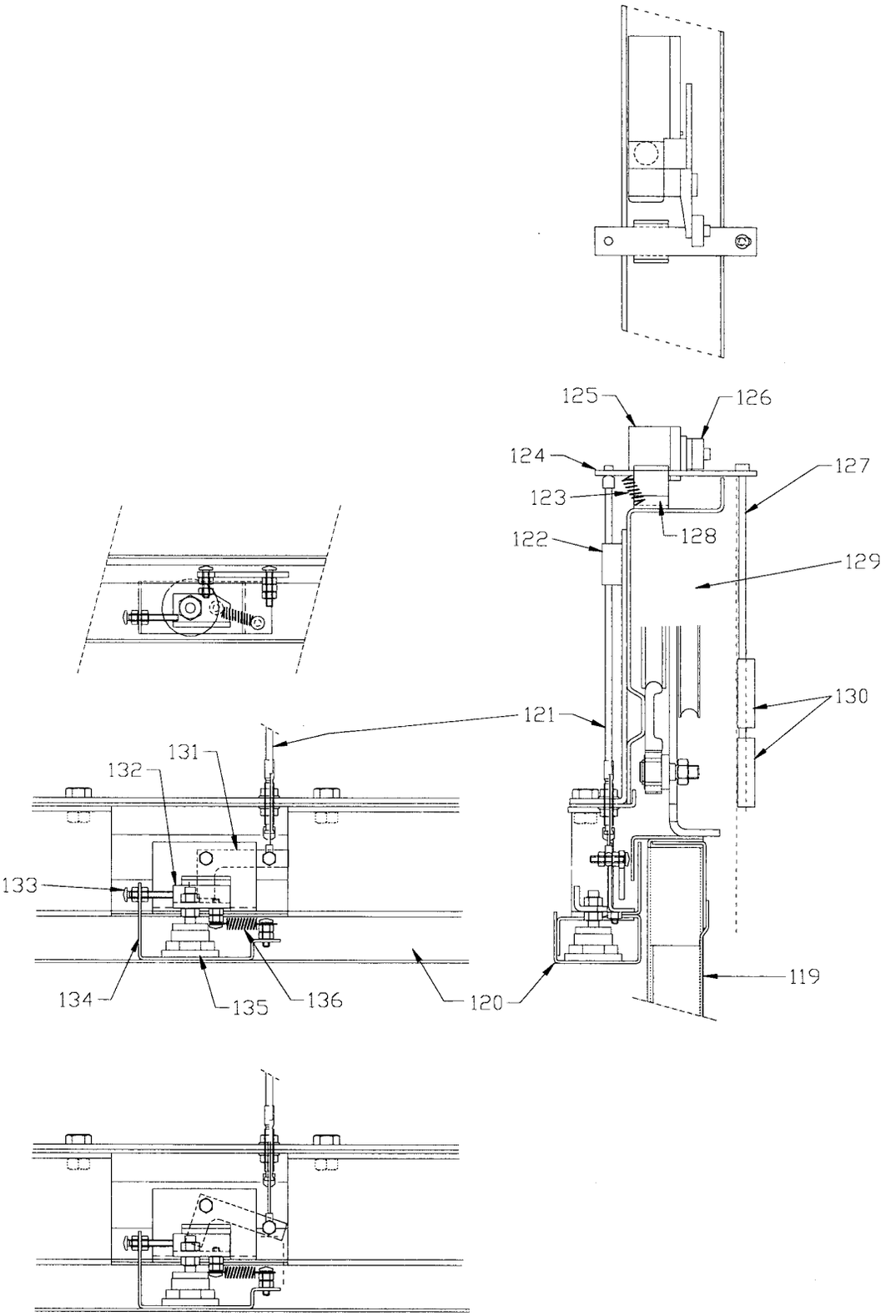
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Fig. 13

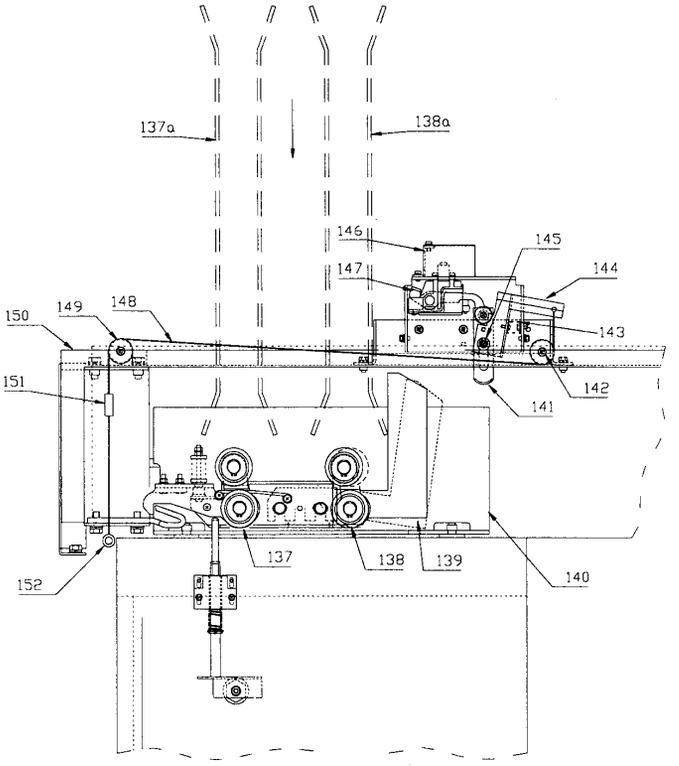
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Fig. 14

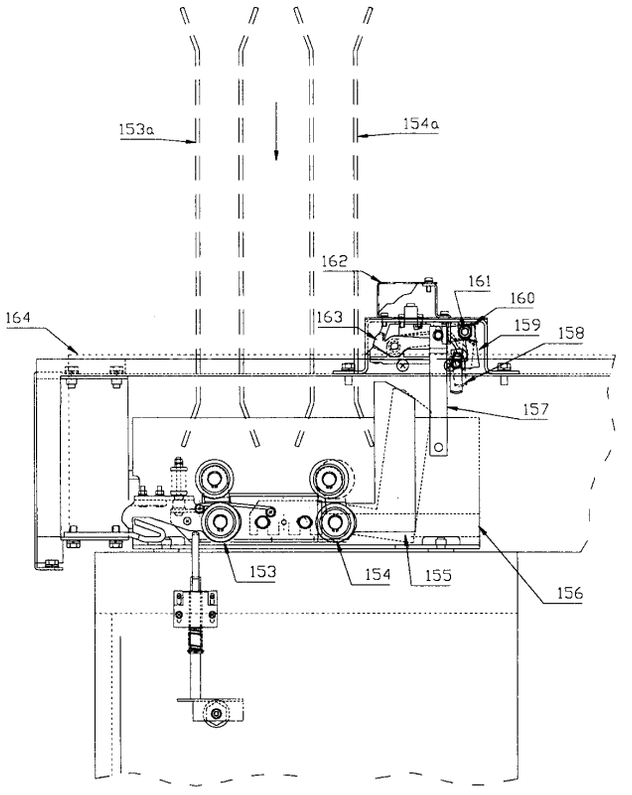
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Fig. 15

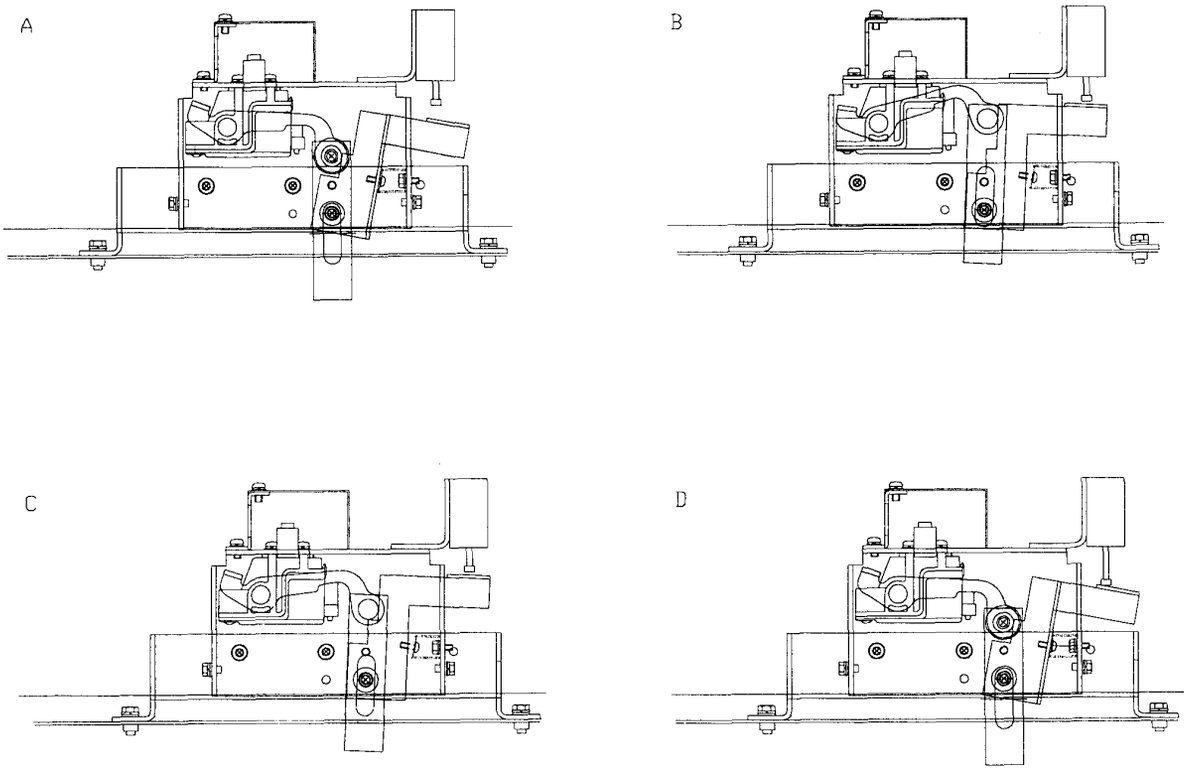

Fig. 16

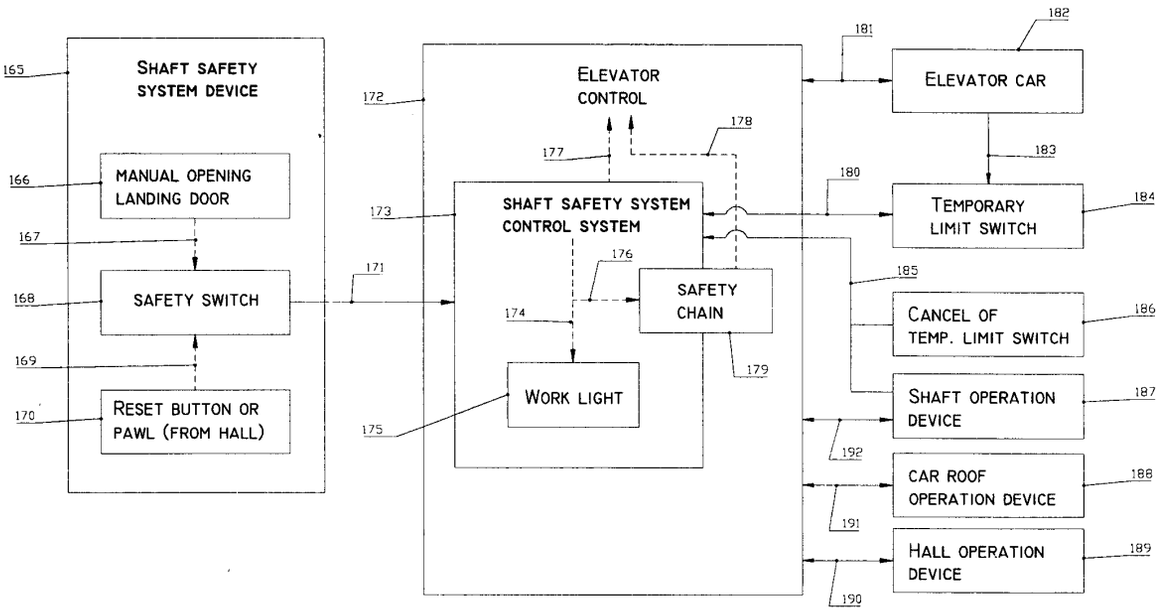
165
SHAFT SAFETY SYSTEM DEVICE
166
MANUAL OPENING LANDING DOOR
167
168
SAFETY SWITCH
169
170
RESET BUTTON OR PAWL (FROM HALL)
171
172
ELEVATOR CONTROL
173
SHAFT SAFETY SYSTEM CONTROL SYSTEM
174
175
WORK LIGHT
176
SAFETY CHAIN
177
178
179
181
182
ELEVATOR CAR
183
180
TEMPORARY LIMIT SWITCH
184
185
CANCEL OF TEMP. LIMIT SWITCH
186
SHAFT OPERATION DEVICE
187
192
CAR ROOF OPERATION DEVICE
188
191
HALL OPERATION DEVICE
189
190

Fig. 17

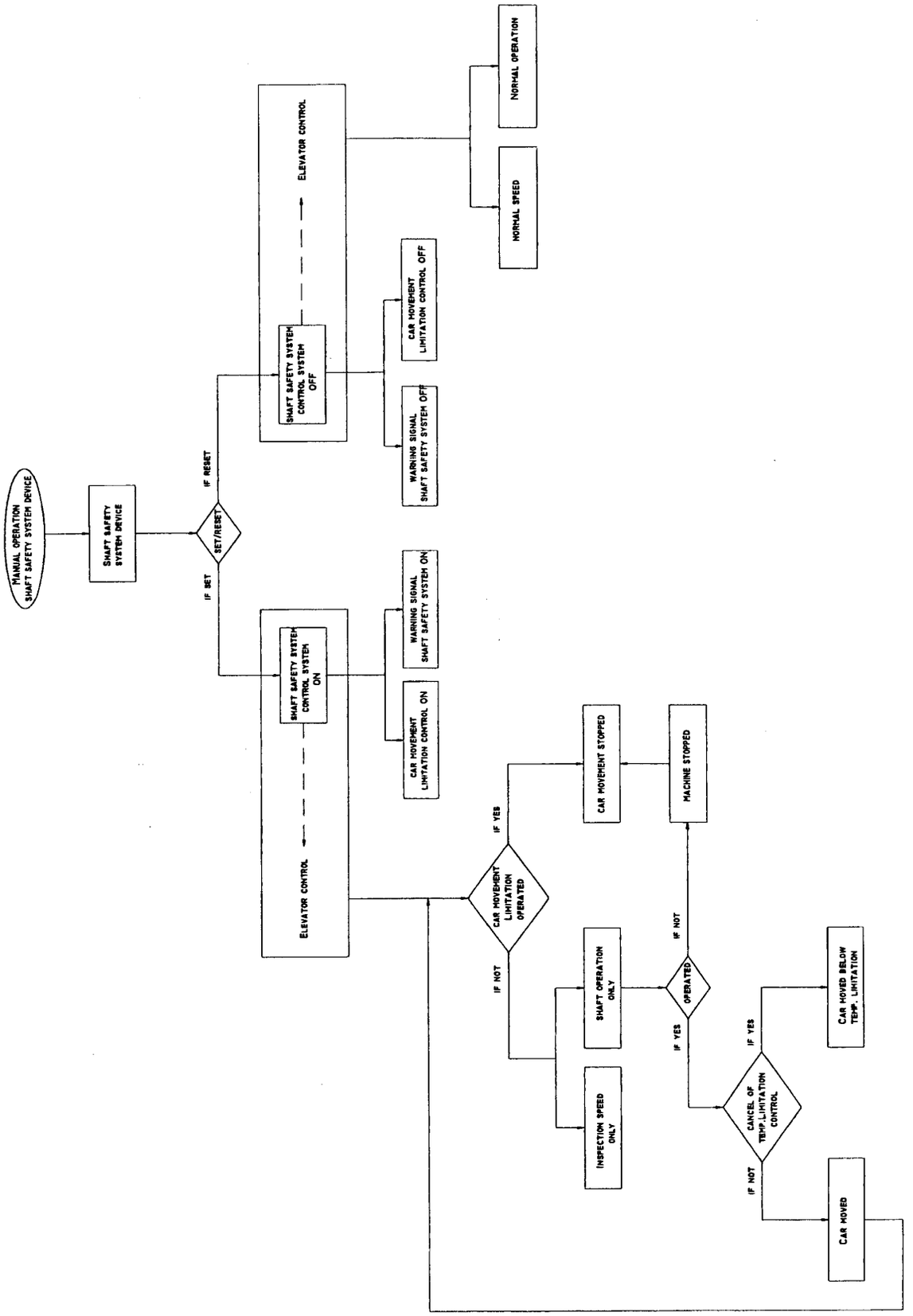
MANUAL OPERATION SHAFT SAFETY SYSTEM DEVICE
SHAFT SAFETY SYSTEM DEVICE
SET/RESET
IF RESET
IF SET
ELEVATOR CONTROL
SHAFT SAFETY SYSTEM CONTROL SYSTEM OFF
NORMAL OPERATION
NORMAL SPEED
CAR MOVEMENT LIMITATION CONTROL OFF
WARNING SIGNAL SHAFT SAFETY SYSTEM OFF
ELEVATOR CONTROL
SHAFT SAFETY SYSTEM CONTROL SYSTEM ON
WARNING SIGNAL SHAFT SAFETY SYSTEM ON
CAR MOVEMENT LIMITATION CONTROL ON
CAR MOVEMENT LIMITATION OPERATED
IF YES
IF NOT
CAR MOVEMENT STOPPED
MACHINE STOPPED
SHAFT OPERATION ONLY
INSPECTION SPEED ONLY
OPERATED
IF NOT
IF YES
CANCEL OF TEMP. LIMITATION CONTROL
IF YES
IF NOT
CAR MOVED BELOW TEMP. LIMITATION
CAR MOVED

Fig. 18

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 20 4429

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	WO 99 47447 A (KONE CORP ;SYRMAN TIMO (FI); HAEGG JORI (FI); KETOVIITA SEPPO (FI)) 23 September 1999 (1999-09-23) * the whole document * ---	1-25	B66B5/00
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A	EP 0 129 678 A (GMV SERVICE SRL) 2 January 1985 (1985-01-02) * the whole document * ---	1-25	
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A,D	US 5 727 657 A (FOELIX HEINRICH) 17 March 1998 (1998-03-17) * the whole document * -----	1-25	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			B66B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 June 2000	Hauser, L

CATEGORY OF CITED DOCUMENTS

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