May 31, 1960 R. F. LOUGHRIDGE 2,938,603

ELEVATOR APPARATUS

Filed Oct. 6, 1958

4 Sheets-Sheet 1

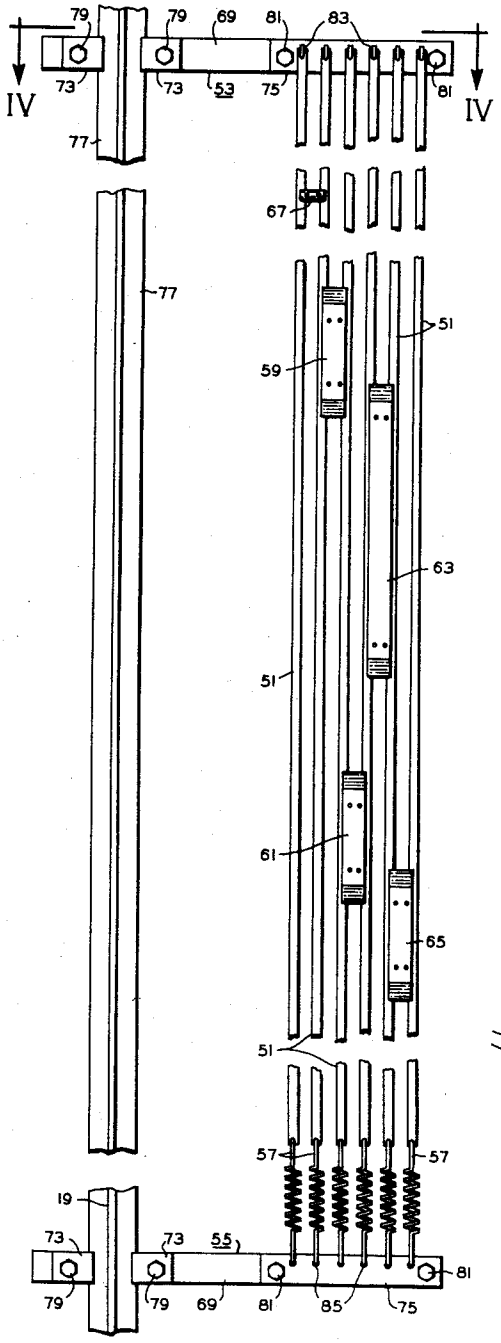


FIG. 2

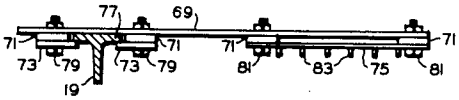


FIG. 4

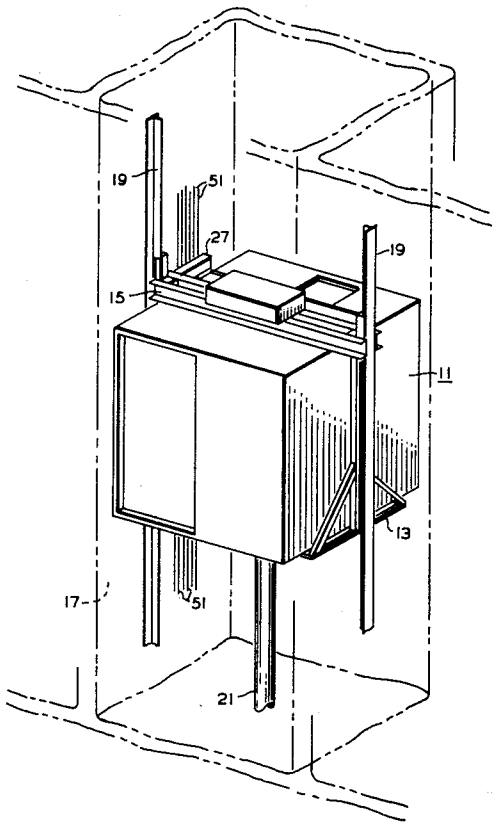


FIG. 1

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4 Sheets-Sheet 2

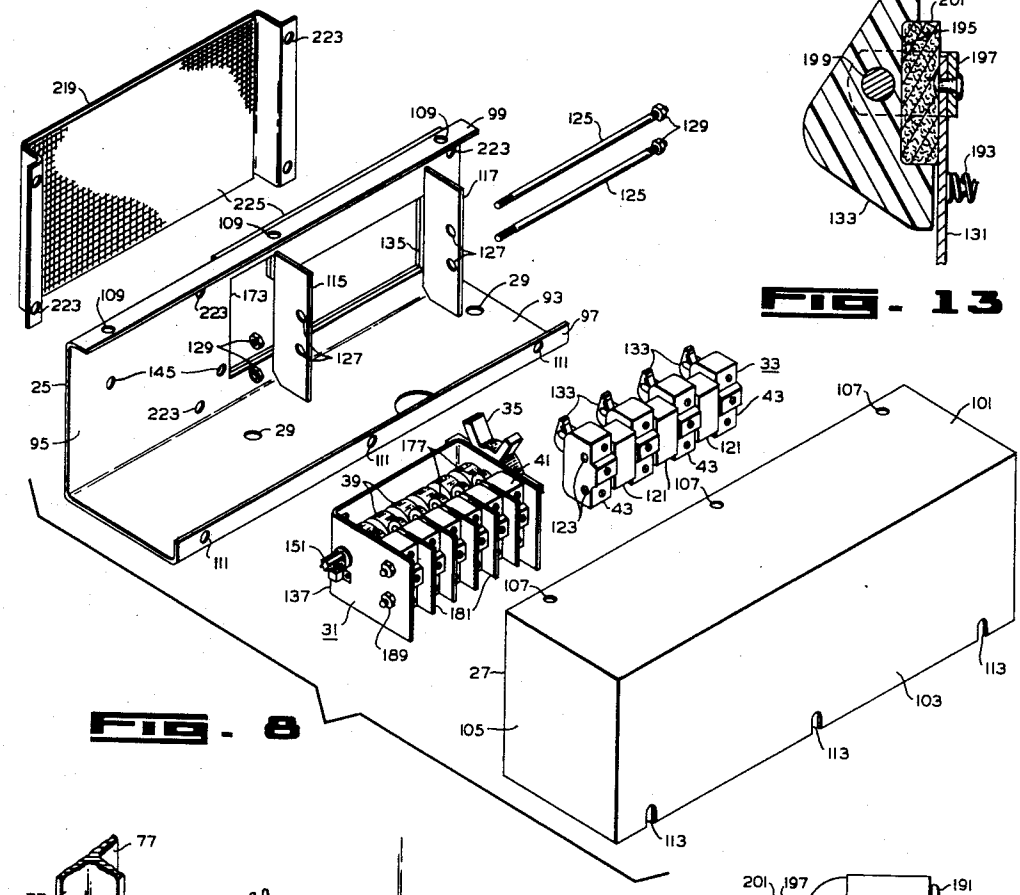


FIG. 8

FIG. 13

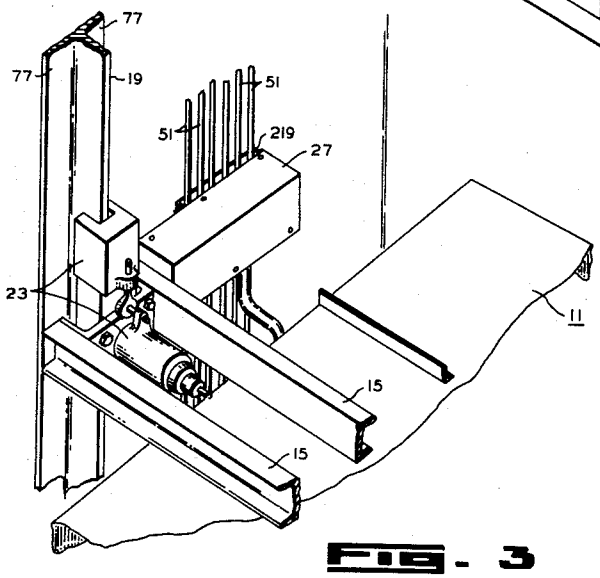


FIG. 3

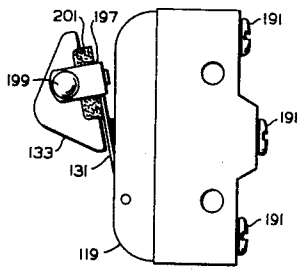


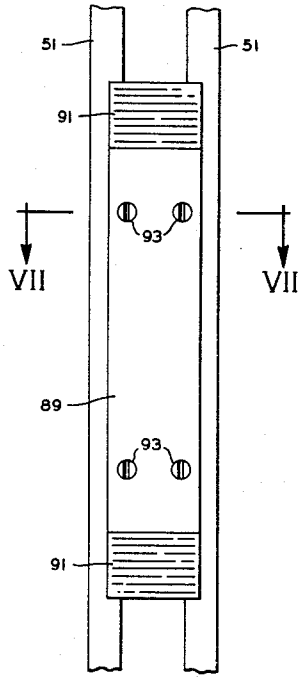
FIG. 12

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ELEVATOR APPARATUS

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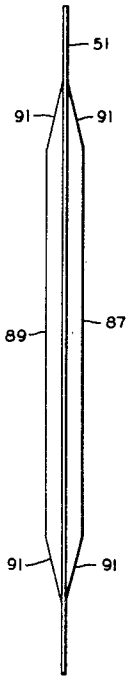


Fig. 5 Fig. 6

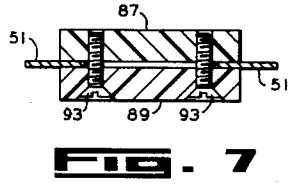


Fig. 7

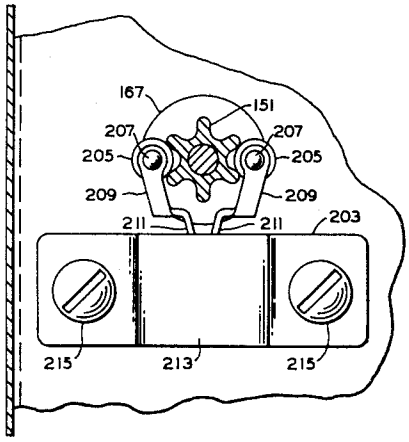


Fig. 11

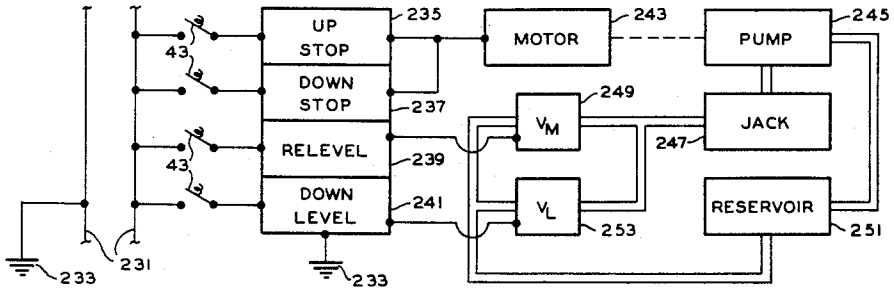


Fig. 14

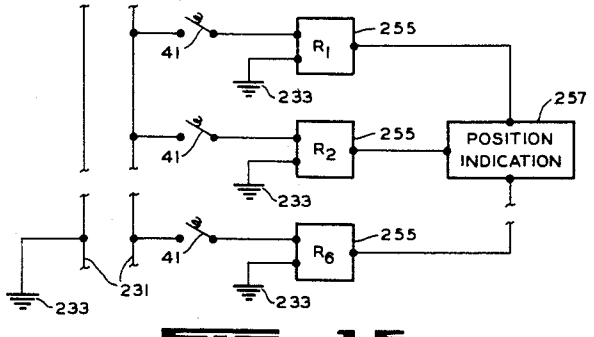


Fig. 15

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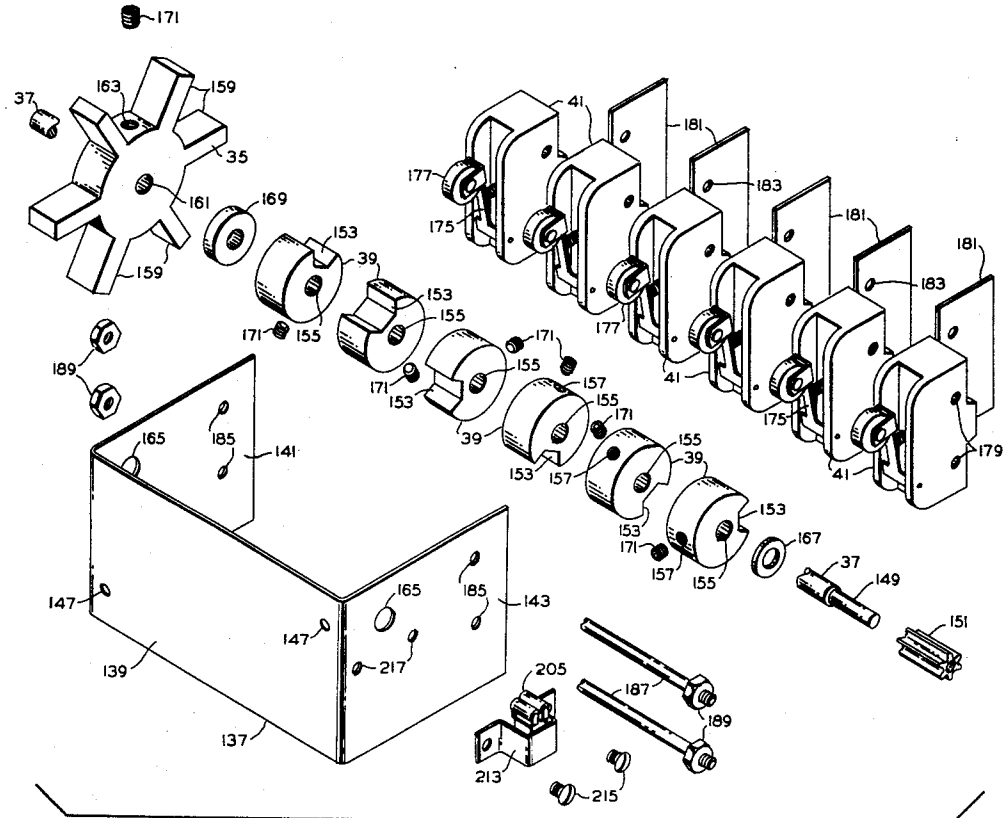


Fig. 9

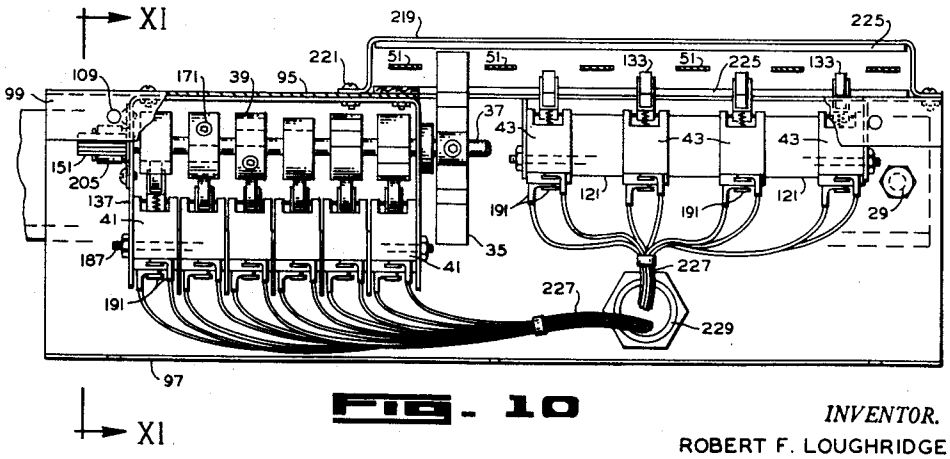


Fig. 10

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2,938,603

ELEVATOR APPARATUS

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Filed Oct. 6, 1958, Ser. No. 765,537

15 Claims. (Cl. 187—29)

My invention relates to elevator apparatus and particularly to apparatus, equipment, arrangements and mechanism especially adapted for controlling elevators of the hydraulic lift type.

The general object of my invention is to provide improved apparatus and arrangements for controlling hydraulic elevators. More specifically, it is an object of my invention to provide elevator selector apparatus which is simple, reliable, easy to maintan, effective, and economical to manufacture and install.

Another object of my invention is to provide elevator selector cam and cam mounting apparatus which is simple, reliable, effective, easy to maintain, and economical to manufacture and install.

Another object of my invention is to provide improved, simple, and effective elevator selector cams and selector cam adjusting arrangement.

Another object of my invention is to provide an improved elevator cam striker and switch actuator structure and arrangement.

These and other objects are effected by my invention as will be apparent from the following description taken in accordance with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a perspective orientation view showing an elevator utilizing the various features of my invention in accordance with a preferred embodiment thereof;

Fig. 2 is a front elevational view, partially fragmented, showing the cam and cam mounting apparatus and arrangement in accordance with a preferred embodiment of my invention;

Fig. 3 is an enlarged fragmentary perspective view showing the selector mounted to the upper left back side of the elevator car sling;

Fig. 4 is a section view taken at line IV—IV of Fig. 2;

Fig. 5 is an enlarged front elevational view of a cam mounted between a pair of cam support tapes;

Fig. 6 is a side elevational view of the apparatus of Fig. 5;

Fig. 7 is an enlarged section view taken at line VII—VII of Fig. 5;

Fig. 8 is a partially exploded perspective view of the selector apparatus in accordance with a preferred embodiment of my invention;

Fig. 9 is a partially exploded perspective view of the stepping wheel portion of the selector and its associated mechanism;

Fig. 10 is a plan view of the assembled selector, partially in section and with the cover removed;

Fig. 11 is a fragmentary section view taken at line XI—XI of Fig. 10;

Fig. 12 is an enlarged side elevational view of a selector switch and switch actuator;

Fig. 13 is an enlarged longitudinal section view of the switch actuator of Fig. 12;

Fig. 14 is a schematic circuit diagram showing a portion of a basic control system; and,

Fig. 15 is a schematic circuit diagram showing another portion of a basic control system.

Referring now to the drawings, there is shown in Fig. 1 a typical elevator car **11** fitted and fixed within a conventional sling **13** made up of structural metal members including a pair of parallel spaced channel members extending transversely across the top of the car and usually referred to as the cross-head **15**. The elevator is, of course, within a hatchway **17**, which is fitted with the usual guide rails **19** centered on opposite sides thereof. The elevator is powered by a hydraulic jack having a plunger **21** the upper end of which is centered on and fixed to the underside of the sling **13**. The plunger is extensible out of the jack cylinder (not shown) which is located and extends downward below first floor level. The car sling **13** is held against lateral movement by the guide shoe assemblies **23**, one of which is fixed between the cross-head members **15** adjacent each end thereof. The guide shoe assemblies may be of a convention type, forming no part of the present invention, and therefore will not be described in detail herein. The guide shoe assemblies of course are adapted for cooperation with the guide rails **19**.

The primary features of the present invention involve the selector assembly and the selector cam and tape assembly. The selector assembly is contained within a housing which may be about 4½ inches square and 14½ inches long. The housing may be made longer if required by the number of floors to be served. The selector housing includes a chassis portion **25** and a cover **27** (see Fig. 3). A bracket (not shown) is adjustably fixed to the lower side of one cross-head member **15** adjacent its end, and the selector assembly chassis **25** is fixed to the bracket by means of bolts (not shown) in holes **29**. The selector assembly includes two sub-assemblies, namely, a stepping wheel sub-assembly **31** and a control switch sub-assembly **33**. The stepping wheel sub-assembly includes a stepping wheel **35** which rotates a cam shaft **37** on which there is mounted a cam **39** for each floor to be served by the elevator, and a switch **41** associated with each cam **39**. The control switch sub-assembly **33** includes four control switches **43**, which are herein termed the down-stop switch, the up-stop switch, the down-level switch, and the re-level switch.

Cooperating with the selector assembly, is the selector cam and cam support assembly, which includes a plurality of tapes **51**, upper and lower tape support brackets **53**, **55**, a tension spring **57** for each tape, down-stop cams, up-stop cams **61**, down-level cams **63**, re-level cams **65**, and stepping wheel cams **67**. The tape support brackets **53**, **55** each comprise a main member **69** (see Fig. 4), four spacers **71**, a pair of clamp plates **73**, and a hanger member **75**. The parts of the tape support brackets are made of flat steel bar material. The main member **69** in each case lies flat against the back side of the guide rail **19** at one end portion, and extends outwardly from the guide rail and perpendicular to it. The clamp plates **73** each contact the front side of the guide rail flanges **77**. A bolt **79** through each clamp plate **73**, spacer **71**, and main member **69** causes the main member in each case to be clamped securely and rigidly to the guide rail **19**. The hanger **75** in each case is held in spaced relation to the free end portion and on the front side of the main member by means of a bolt **81** at each end, which bolt passes through the hanger, a spacer **71**, and the main member **69**. The upper hanger is provided with upturned hooks **83** spaced longitudinally of the hanger at intervals which will provide the desired tape spacing. The lower hanger is provided with holes **85** which are spaced longitudinally at the same intervals as the hooks **83**. The upper tape

support bracket 53 should be mounted on the rail 19 at a point about three feet below the crosshead 15 when the car 11 is at the lowest landing. In the usual installation, there are six tapes required, as will be hereinafter more fully explained. The tapes 51 may be ordinary commercial banding tape of the type commonly used in packaging heavy items for shipment. A commercial type banding tape about one half inch wide by about 1/48 inch thick, having a corrosion resistant coating, has proved satisfactory for the purposes of my invention. The tapes 51 are each precut to the length required for a particular installation and have a hole punched adjacent each end. Each tape is packaged in a roll for shipment to the installation site. At installation the free end of the tape of each roll is hooked to a corresponding hook 83 on the upper tape support bracket hanger, and the tapes are unrolled down the elevator hatchway. A tension spring 57 is provided for each tape 51. Each tension spring 57 is simply a helical coil spring having a hook on each end. Springs having an overall length of about 6 inches at rest with a tension of approximately five pounds per inch have been found to be satisfactory in practice. Each spring 57 is hooked at its lower end in a hole 85 of the lower hanger and at its upper end in the hole in the lower end of a respective tape 51. The lower tape support bracket 55 is readily adjusted on the rail 19 to accomplish the desired degree of spring tensioning. The degree of spring tension is not critical; however, it is desirable that the springs be tensioned just sufficiently to positively space the lower ends of the tapes 51 and prevent any of them from swinging loosely. The spring tensioning arrangement compensates for minor differences in tape lengths, making it unnecessary that the set of tapes for a particular installation be cut to precisely the same length.

There is provided a set of cams for each floor level. Each set will normally consist of a stepping wheel cam 67, down-stop cam 59, up-stop cam 61, down-level cam 63, and re-level cam 65. The down-stop, up-stop, down-level and re-level cams are all identical, except for length. The down-stop, up-stop, and re-level cams may have a length of about 8 inches overall. The overall length of the down-level cam 63 will depend upon maximum down car speed; for a down car speed of 150 feet per minute, this overall length should be about 26 inches. These cams are preferably made of material known to the trade as "Formica," which is a tough hard laminar structure of paper or cloth and a phenolic resin. The "Formica" used is about 1/4 inch thick and is cut in strips about 1½ inches wide. Each cam is made up of a pair of identical "Formica" pieces 87, 89 (see Figs. 5, 6 and 7) placed back to back. Each cam piece has a one to four flat taper 91 at each end (see Fig. 6), or in other words, the cam surface is tapered from a line beginning one inch from the end on one side to a line containing the end on the other side. One cam piece 89 is provided with four holes which are drilled and countersunk, while the other cam piece 87 has four corresponding holes which are drilled and tapped. These holes are arranged in pairs, with each pair on a line perpendicular to the cam length and located about two inches from the end of the cam piece. Each hole is located so that its outer edge is substantially 1/4 inch from the side edge of the cam piece. Each pair of cam pieces 87, 89 is clamped together by means of screws 94 in the holes. It is apparent that the provision of and the location of clamping screws 94 makes it easy to give the tapes proper spacing and alignment in assembly. Also, the sets of cams clamped to the tapes greatly enhances the lateral stability of the tape and cam assembly. A representative set of cams is shown in place on the tapes 51 in Fig. 6. If the tapes are considered as being numbered one to six from right to left in Fig. 6, then the cam between tapes 1 and 2 is the re-level cam 65; between tapes 2 and 3 is the down-level cam 63; between tapes 3 and 4 is the up-stop cam 61; and between tapes 4 and 5 is the down-stop cam 59. The various cams are clamped onto the tapes 51 in the approximate proper position after the tapes are installed, and then finally adjusted when the elevator is in actual running condition, as will be hereinafter more fully explained. It is apparent that the cams may be easily and readily adjusted up or down on the tapes, and that they also serve to hold the tapes in proper spacing alignment. It should be noted also that there is a simple one to one ratio between cam linear adjustment and elevator movement. The stepping wheel cams 67 are each made up of a pair of "Formica" half-round bars about one half inch in diameter and clamped between tapes 5 and 6 by means of screws.

Turning now to the selector assembly and referring particularly to Figures 8, 9 and 10, it will be seen that the selector chassis 25 is a single piece of sheet metal having a bottom 93, and a back 95, with a front flange 97 extending upwardly from the bottom front edge, and with a top flange 99 extending forwardly from the back top edge. The selector assembly cover 27, also made of sheet metal, has a top 101, a side 103, and ends 105. The cover 27 fits onto the chassis 25 forming a closed rectangular box housing, the cover being removably fixed to the chassis by means of sheet metal screws (not shown) which pass through aligned holes 107, 109 in the cover top and the chassis top flange, and through holes 111, 113 in the chassis front flange which match slots in the lower edge of the cover side 103. A pair of identical substantially rectangular control switch assembly support plates 115, 117 are fixed in spaced parallel relation to the back 95 and bottom 93 of the chassis 25. One plate 117 is in a plane which passes through the chassis back and bottom and perpendicular thereto and adjacent the right end thereof (as seen in Fig. 6), while the other plate 115 is in a plane spaced from the first a distance by a distance substantially equal to the width of the control switch subassembly 33.

The control switch sub-assembly as hereinbefore mentioned includes four switches 43 arranged side by side with each pair of adjacent switches held apart by a rectangular spacer block 121. The spacer blocks are preferably made of "Formica" and the same width as the switches. A pair of spaced parallel holes 123 extend through assembly of switches and spacer blocks, the assembly being mounted between the support plates 115, 117 with a pair of rods 125 passing through aligned holes 127 in the plates and through the said spaced parallel holes 123 in the assembly 33. The rods 125 are threaded at their end portions and nuts 129 are threaded onto the rods to hold the control switch sub-assembly firmly in position. Each control switch 43 is provided with an actuator arm 131 to the end portion of which there is mounted an actuator piece 133. The chassis back 95 is provided with a first rectangular opening 135 which extends the distance between the support plates 115, 117 in width and is just higher than the length of a switch 43. When the control switch sub-assembly 33 is mounted in position on the chassis 25, the switch actuator arms 131 and actuator pieces 133 extend through the opening 135. The details and functions of the control switches 43 will hereinafter be more fully explained.

As hereinbefore mentioned, the stepping wheel assembly 31 includes the stepping wheel 35, a plurality of cams 39, a cam shaft 37, and a plurality of switches 41. There is a cam and a switch for each floor to be served by the elevator, the assembly shown being for a six-floor installation. The assembly is supported on the chassis by stepping wheel assembly support member 137 in the form of a wide sheet metal strip formed in U shape and having a back 139, a right side 141 and a left side 143, the right

side being adjacent the stepping wheel as shown in the drawings. The support member **137** is fixed at its back **139** to the left side of the chassis back **95** by means of bolts (not shown) passed through holes **145** in the chassis back matching holes **147** in the support member back **139**, so the support member sides **141**, **143** extend forwardly of the chassis back **95**. The cam shaft **37** is simply a rod, having a turned down portion **149** at one end, which portion receives a positioning gear **151**. The positioning gear is a short length of six tooth gear rod which makes a pressed fit on the turned down portion **149** of the cam shaft **37**. The stepping wheel **35** and the cams **39** are made of "Formica," preferably a cloth base type. The cams **39** are identical, each being in the form of a short cylinder which may be about ½ inch long and one inch in diameter, and each having a transverse notch **153** cut into its peripheral surface. Each cam **39** is further provided with an axial opening **155** to fit the cam shaft **37**, as well as a threaded radial opening **157** communicating with the axial opening and with the cam peripheral surface. The stepping wheel **35** is in the form of short cylinder having integral rectangular projections **159** extending radially outward from its peripheral surface, the projections being 60° apart and six in number. The width of the projections and length of the cylinder may be about ½ inch, with the cylinder diameter being about 1½ inches, the length of the projections being about ¾ inch, and their thickness about ¼ inch. The stepping wheel **35** is provided with an axial opening **161** to fit the cam shaft, and a threaded radial opening **163** communicating between the axial opening and the peripheral surface of the cylinder. A pair of aligned holes **165** are provided, one in each side of the support member **139**, which holes are sized to receive and provide bearing support for the cam shaft **37**. The cam shaft is journalled on nylon bearings which are supported in the holes **165**. These holes **165** are located at the upper rear region of each side **141**, **143**, so that the cam shaft **37** will be parallel to the chassis back **95**, and the cams **39** and stepping wheel **35** will be properly located, as will be hereinafter more fully described.

In assembly, a spacer washer **167** is placed on the cam shaft **37** adjacent the positioning gear **151**, then the shaft **37** is inserted in the bearing (not shown) through the bearing hole **165** in the left side **143**, then the cams **39** are placed on the shaft, then the shaft is inserted in the bearing (not shown) through the bearing hole **165** in the right side **141**, then a second spacer washer **169** is placed on the shaft, followed by the stepping wheel. The cams **39** and the stepping wheel **35** are fixed in desired position on the shaft by means of set screws **171** inserted in the radial threaded openings **157**, **163**. The chassis back **95** is provided with a rectangular opening **173** of sufficient width and height to allow the stepping wheel **35** to protrude through the chassis back **95**. Each switch **41** of the stepping wheel sub-assembly **33** is provided with an actuator arm **175** which mounts an actuator roller **177** at its end. Each switch **41** is also provided with transversely extending parallel mounting holes **179** adjacent its rear side. A rectangular "Formica" spacer **181** is provided between each switch. Each spacer has mounting holes **183** aligned with the switch mounting holes **179** and located so that the spacer **181** will extend about ½ inch rearwardly of the switch **41**. The support member **137** is also provided with holes **185** in each side which align with the switch and spacer holes **179**, **183** so that the switch assembly **33** will be held in proper relation to the cams **39**. In assembly, a pair of rods **187**, threaded at their end portions, are passed through the respective aligned holes of the support member **137**, switches **41**, and spacers **181**, and the switch assembly **33** is clamped between the support sides **141**, **143** by nuts **189** on the rod ends, drawn up against the respective support member sides.

All of the switches **41**, **43** in the selector assembly are of a conventional commercially available type and known to the trade as "Micro"-switches. Such switches are characterized by the fact that the switch contacts will snap from open to closed position and vice versa within a very small range of actuator arm movement. The switches used in the selector are of the single pole, double throw variety having a lead from each fixed contact and one from the moveable contact brought out to respective terminals **191** at the back of the switch. The actuator arm **131** is pivoted on a fulcrum at the lower front of the switch, so that its free end, and the actuator roller **177** or actuator piece **133** are at the upper front portion of the switch. The actuator arm **131** is biased outwardly from the switch front by a helical compression spring **193**. For the case of the stepping wheel sub-assembly switches **41**, the normally closed contact is used, while for the case of the control switches **43**, the normally open contact is used. The actuator rollers **177** of the stepping wheel sub-assembly switches **41**, of course ride on the periphery of the associated cams **39**. This means that at all times except when a roller is within a cam notch **153**, the switch actuator arm **131** is held so that the contact being used is in the open position, and closes when the actuator arm is released into the cam notch. The sides of the cam notches **153** extend radially, with the included angle being 60°, and the base of the notch extends tangentially and is about ¼ inch long. The switch actuator rollers are about ¼ inch in diameter.

For the case of the control switches **43**, the contacts used are open except when cammed to the closed position. The actuator piece **133** for the control switches **43** is made of "Formica," designated by the manufacturer as type CH–93, which has a cloth or fabric base and is graphite impregnated. The actuator piece has a generally triangular shape, with a notch **195** at the base and with the apex rounded. The actuator piece **133** is mounted at the end of the actuator arm **131** by means of a U shaped bracket **197**, with the bracket base being bradded to the arm, and the piece being clamped between the bracket sides by a brad **199** extending through the bracket sides and the piece. A small block or pad of felt material **201** is interposed and clamped between the notch **195** in the actuator piece base and the actuator arm **131**, so that the piece **133** is not in contact with the arm. The felt pad **201** serves a double function as a sound deadener and as a lubricant reservoir. The combination of the pad **201** and piece **133** makes the camming action of the piece and its associated cam essentially noiseless.

The cams **39** of the stepping wheel assembly **31** are positively and accurately positioned at each step by coaction of the positioning gear **151** and a spring biased roller device **203**. This device (see Fig. 11) includes a pair of spaced parallel rollers **205** journalled on shafts **207** carried by fork members **209** which are fixed to respective arms **211** which are pivoted on a strap mounting bracket **213** and which are biased toward each other by a spring (not shown). The mounting bracket **213** is fixed to the left end **143** of the stepping wheel assembly support member **137** by means of screws **215** in holes **217** beneath the cam shaft **37**. The rollers **205** of the positioning device **203** seat themselves between pairs of adjacent teeth on opposite sides of the positioning gear **151** each time the stepping wheel **35** moves to a different step, thus providing the cam shaft **37** with six discrete and precise positions, so that the stepping wheel **35** will always cause the proper switch **41** to be actuated at the proper time.

As hereinbefore mentioned, the selector assembly is mounted to a bracket (not shown), which is adjustably fixed to the lower side of one cross-head member **15** adjacent the end thereof. The position of the selector chassis **25** is adjusted so that the actuator arms **131** of the control switches **43**, and the stepping wheel **35**, are substantially centered between the respective pairs of tapes **51**,

and so that the control switch actuator pieces **133** and the stepping wheel projections **159** have the desired degree of spacing from their associated cams. A back-up member **219** in the form of a flanged sheet metal channel is fixed to the back **95** of the selector chassis **25** by means of bolts **221** through holes **223** in the member flanges and in the chassis back **95**, after the selector assembly has been positioned. The back-up member **219** together with a portion of the chassis back **95**, forms a guideway for the tapes **51** and cams. The opposing surfaces of the guideway are padded with belting material **225**. Three-ply cotton belting material has been found to be satisfactory for the purpose. The space between the opposing pad surfaces may be about 5/8 inch, and the length of the guideway may be about 8½ inches. When a cam enters the guideway it will be backed up by the back-up member **219** so that it cannot move away from the actuator piece **133** or stepping wheel **35** beyond a desirable distance. The guideway also acts to damp any tendency of the tapes **51** to develop excessive swaying motion and keeps the tape assembly laterally centered. Wiring conductors **227** are brought from the terminals **191** of the selector switches into a conduit **229** which is attached to the selector chassis bottom **93** and extends to an appropriate terminal box.

The relation of the control switches **43** and the stepping wheel switches **41** to the elevator control system is shown in simplified schematic form by Figures 14 and 15. In Fig. 14 there is shown a power bus **231** (which may be connected to a conventional 220 volt source, not shown) having one side common and grounded at **233**. The control switches are connected in series with the operating coils of respective relays across the bus. These relays, represented by blocks **235, 237, 239, 241**, may be termed the up-stop, down-stop, re-level, and down-level relays, being actuated by a respective control switch of the corresponding designation. Each relay may have a number of contacts depending upon the relative complexity of the specific elevator system. The up-stop and down-stop relays each have one set of contacts connected in the stop-start circuit of an electric motor **243** which is mechanically coupled to drive a hydraulic pump **245**. The contacts are arranged so that the motor circuit will be opened when either the up-stop switch or the down-stop switch is actuated to the closed position. The pump hydraulic output is connected via a conduit to the elevator jack **247**. The output hydraulic line of the jack is connected through a main valve **249**, designated as *Vm* to a reservoir **251**. the output line of which is connected to the pump input. The main valve is bypassed by a levelling valve **253**, designated *Vl*.

In Fig. 15 there is shown a power bus **231** (which may be connected to a conventional 220 volt source, not shown) having one side common and grounded at **233**. The stepping wheel switches **41** (some of which are not shown, for simplicity) are each connected in series with the operating coil of a respective stepping switch relay **255** across the bus. There is one relay for each floor to be served by the elevator system. These relays are represented by blocks designated R1 through R6. Each stepping wheel relay **255** may have a number of contacts depending upon the specific system with which they are used. The relays are shown connected to a block **257** labelled "position indication," since that is their primary function. For example, they may among other things operate lights behind the flow indicator strip in the elevator car. A stepping wheel relay **255** is energized when the corresponding stepping wheel switch **41** is cammed to the closed position.

For preliminary settings the cams which are fixed to the tapes **51** should be set so that (with the elevator car at floor level) the lower ends of the down-stop and down-level cams **59, 63** should be about 18 inches and 2 inches, respectively, above the selector control switch actuator pieces **133**, while the upper ends of the up-stop and re-level cams **61, 65** should be about 2 inches and 8 inches, respectively, below the selector control switch actuator pieces. The stepping wheel cams **67** should be located about halfway between adjacent landings and need not be further adjusted, since their exact location is not critical. Final adjustments of the tape-mounted cams are made with the elevator in actual operation. As hereinbefore stated, these cams are readily adjustable up or down the tapes, and there is a simple one-to-one ratio between cam linear adjustment and elevator movement.

In operation in a typical elevator system utilizing my invention, first assume that the car **11** is moving up toward a pre-selected floor level, in which case the pump motor **243** is running and both the main valve *Vm* **249** and the levelling valve *Vl* **253** are closed. As the car moves up the hatchway the stepping wheel **35** will be actuated by the stepping wheel cam **67** for each floor level passed, thus in each case actuating the appropriate stepping wheel switch **41** which in turn energizes the corresponding relay **255**, the contacts of which set up various car position indication functions. As the car approaches the preselected floor the re-level cam **65** will actuate the re-level control switch, but nothing will happen since the motor circuit is already closed. Next, the up-stop cam **61** will actuate the up-stop control switch, which will set up a time delay circuit (not shown) to lock out the re-level circuits for a short time (usually about five seconds) and also open the motor circuit, causing the car to coast upward. Next, the down-level cam **63** will actuate the down-level control switch to open the levelling valve **253**. The momentum of the car will cause it to continue its upward travel sufficiently far for actuation of the down-level control switch and slightly beyond, then the car will drift downward at a slow speed until the down-level control switch actuator piece goes sufficiently off its associated cam **63** to actuate the switch to the open position, causing the levelling valve **253** to close, stopping the car smoothly at the pre-selected floor level. If for any reason the car should drift downward below the floor level, then the re-level cam **65** will actuate the re-level switch, which will start the motor **243**, moving the car upward again, and the stopping and down-levelling operation will be repeated.

Now, asume that the car is traveling downward toward a pre-selected floor, Under these conditions, the motor circuit would be open and both the main valve *Vm* and the levelling valve *Vl* would be open. Then as the car approaches the pre-selected floor, the down-stop cam **59** will actuate the down-stop switch to close the main valve **249**, unlock the levelling valve circuit, and set up a locking circuit to keep the main valve closed until the car is ready to start a descent to a lower floor level. Next, the down-level cam **63** will actuate the down-level switch, but nothing happens, since the levelling valve **253** is already open. The car decelerates and drifts at reduced speed until the actuator piece of the down-level switch moves off the lower end of the down-level cam **63**, causing the levelling valve *Vl* to close, stopping the car at the pre-selected floor level. If for any reason the car should drift past the pre-selected floor level, then the re-level cycle will occur as hereinbefore described. Of course the stepping wheel **35** will be periodically actuated in elevator descent to accomplish position indication as hereinbefore described.

It will be apparent from the foregoing that the elevator selector cam and cam mounting apparatus and the elevator selector apparatus of my invention is simple, reliable, effective, easy to install and maintain, and economical to manufacture. It is to be understood that dimensions given, and the materials named, in the foregoing description of a specific embodiment of the invention, are for illustrative purposes only. It is further to be understood that specific elevator control system described in elementary form herein is by way of ex-

ample only, and that various control systems already well known to those skilled in the art could be used with the apparatus of my invention. It is apparent that the apparatus of my invention may be used with electric as well as hydraulic elevators.

While I have shown my invention in only one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof.

I claim:

1. Apparatus for mounting cams in an elevator hatchway which cams are to actuate selector mechanism fixed to the elevator car, said apparatus comprising a plurality of tapes which are relatively stiff in directions laterally of their width and relatively flexible in directions laterally of their thickness, each tape being of length greater than maximum elevator car travel, means for suspending said tapes in spaced parallel relation within said elevator hatchway, spring means for individually tensioning said tapes, a plurality of cams mounted between adjacent tapes and fixed thereto in operative relationship relative to said selector mechanism.

2. Apparatus for mounting cams in an elevator hatchway which cams are to actuate selector mechanism fixed to the elevator car, said apparatus comprising a plurality of tapes made of flat metal banding material, an upper tape mounting bracket, a lower tape mounting bracket means holding one end of said tapes on one of said brackets, a tensioning spring held at one end to the other end of each respective tape, with the free ends of said springs being held on said other bracket, said tapes being held in spaced parallel relation with their flat sides lying substantially in a common plane, and a plurality of cams mounted between adjacent tapes and clamped thereto.

3. Apparatus for mounting cams in an elevator hatchway which cams are to actuate selector mechanism fixed to the elevator car, said apparatus comprising a plurality of tapes made of flat metal banding material, upper and lower brackets each adjustably mounted to a hatchway guide rail and extending outwardly therefrom, means holding the upper ends of respective tapes at spaced intervals on said upper bracket, a tension spring fixed to the lower end of each said tape, means holding the lower end of respective springs at spaced intervals on said lower bracket, said tapes being held in spaced parallel relation with their flat sides lying substantially in a common plane which is parallel to the adjacent car side, and a plurality of cams mounted between adjacent tapes and clamped thereto.

4. Elevator selector cam and cam mounting apparatus comprising upper and lower brackets adjustably mounted on an elevator guide rail adjacent upper and lower ends of the rail and extending outwardly therefrom, a plurality of tapes made of flat metal banding material, means holding one end of said respective tapes at spaced intervals on one of said brackets, a respective tensioning spring fixed at one end to the other end of each said tape, means holding the other ends of said springs at spaced intervals on said other bracket, said tapes being held in spaced parallel relation with their flat sides lying substantially in a common plane, and a plurality of cams, each said cam comprising a pair of symmetrical elements placed in back-to-back relation and clamped between a pair of adjacent tapes.

5. Elevator selector cam and cam mounting apparatus comprising a pair of tapes in the form of flat metal banding material, means holding said tapes in spaced parallel relation longitudinally of an elevator hatchway with the flat sides of said tapes lying substantially in a common plane, a plurality of cams, each said cam comprising a pair of substantially identical pieces of rectangular material slightly wider than the spacing between said tapes, each said piece having smooth flat front and back faces, each said piece being tapered from its front face to its back face at each end, and means for clamping said pieces back-to-back between said tapes.

6. Elevator cam and cam mounting apparatus comprising a plurality of tapes in the form of flat metal banding material, means holding said tapes at each end thereof in spaced parallel relation with the flat sides of said tapes lying substantially in a common plane, a plurality of cams clamped between each adjacent pair of tapes and located at spaced longitudinal intervals thereon, each said cam comprising a pair of substantially identical pieces of flat strip material having a smooth front face and a rear face parallel thereto, each said piece being tapered from the front face to the rear face at each end of the piece, each piece having width substantially equal to the spacing between said tapes plus the width of a tape, clamping means longitudinally spaced and aligned on each side of each said piece, said clamping means having transverse spacing equal to desired spacing between adjacent tapes, each pair of pieces being placed back-to-back and clamped between adjacent tapes with said clamping means passing through each piece and contacting a respective tape, whereby the desired tape spacing and alignment is obtained at each cam location.

7. An elevator selector assembly comprising a chassis having a back and a bottom, a control switch sub-assembly comprising a plurality of switches juxtaposed with a spacer block between adjacent switches, with each said switch having an actuator arm and a cam actuator piece fixed to the end portion of said arm, spaced support means fixed to said back and extending forwardly therefrom, a pair of rods extending through said switches and spacer blocks and fixed at their end portions to said support means, said actuator arms and cam actuator pieces extending through an opening in said back, a stepping wheel sub-assembly comprising mounting means fixed to said back and having end pieces extending forwardly therefrom, a cam shaft journalled on said mounting means and extending parallel to and adjacent said back, a plurality of stepping wheel cams mounted on said shaft between said end pieces, a stepping wheel mounted on said shaft on the outside of one of said end pieces and extending through an opening in the back of said chassis adjacent said first mentioned opening, a shaft positioning device mounted on said shaft outside the other of said end pieces, a plurality of stepping wheel switches juxtaposed and each having an actuator arm mounting a roller, a pair of rods passing through said switches and said end pieces and fixed to said end pieces so that respective stepping wheel switch rollers cooperate with respective stepping wheel cams.

8. A stepping wheel sub-assembly for an elevator selector comprising support means including spaced end pieces, a cam shaft journalled on said end pieces, a plurality of cams mounted on said shaft, one for each floor to be served by the elevator, a plurality of juxtaposed switches, one for each cam, each said switch having an actuator arm spring biased away from said switch mounting a roller at its end portion, means mounting said switches between said end pieces so that each roller engages a respective cam, each said cam being in the form of a short cylinder having a notch in its roller engaging surface allowing said roller to move radially inwardly toward said cam shaft to actuate its respective switch, means for adjustably fixing each said cam to said cam shaft with the notches distributed at substantially equal angles about said shaft, a stepping wheel mounted on one end of said cam shaft on the outside of one said end piece, said stepping wheel having a radial projection for each said cam, said projections spaced at equal radial angles about said shaft, a cam shaft positioning device comprising a gear fixed on said cam shaft at the end opposite said stepping wheel, said gear having a tooth for each said cam, a spring biased roller mounted to the end piece adjacent said gear and riding on the periphery of said gear, whereby said cam shaft will be

stopped at a predetermined discrete position each time after said stepping wheel is actuated.

9. Elevator selector and selector cam apparatus comprising a plurality of tapes in the form of flat metal banding material, means mounting said tapes in an elevator hatchway and holding said tapes at each end thereof in spaced parallel relation with the flat sides of said tapes lying substantially in a common plane, a plurality of cams clamped between each adjacent pair of tapes and located at spaced longitudinal intervals thereon, each said cam having smooth flat front and rear faces which are tapered at each end to the plane of the tapes, a selector chassis mounting a plurality of devices to be actuated by said cams, said devices including actuators protruding through an opening in the back of said chassis, means mounting said chassis in fixed relation to the elevator car and with said protruding actuators in predetermined spaced relation with respect to the normal plane of said tapes, and a tape and cam assembly guideway and back-up piece fixed to the back of said chassis and presenting a plane surface parallel to and spaced from said chassis back a distance such that when the rear face of a cam passing through the guideway is in contact with said surface, the front face of said cam is properly positioned with respect to the corresponding selector actuator.

10. An elevator selector control switch actuator and actuator piece of a type wherein said actuator piece is adapted for sliding movement on a cam surface, comprising an actuator arm pivoted adjacent one end on a switch body, means spring biasing said actuator arm in the direction away from said body, an actuator piece made of laminated sheets in a phenolic resin base and impregnated with graphite, said actuator piece having a base side adjacent said actuator arm and a cam surface opposite said base, a notch in said base side, a felt pad in said notch, and means fixing said actuator piece to the free end portion of said actuator arm with said pad interposed between said base and said arm.

11. An elevator selector control switch actuator and actuator piece of a type wherein said actuator piece is adapted for periodic sliding movement on a cam surface, comprising an actuator arm fixed to a switch body and spring biased in the direction away from the switch body, an actuator piece made of graphite impregnated material, said actuator piece having a base side adjacent said actuator arm and a cam surface opposite said base side, means fixing said actuator piece to said actuator arm, and a pad of oil-absorbent material clamped between the base of said actuator piece and said actuator arm.

12. Apparatus for mounting cams in an elevator hatchway which cams are to actuate selector mechanism fixed to the elevator car, said apparatus comprising a plurality of tapes which are relatively stiff in directions laterally of their width and relatively flexible in directions laterally of their thickness, each tape being of length greater than maximum elevator car travel, means for suspending said tapes in spaced parallel relation within said elevator hatchway, means for tensioning said tapes, and a plurality of cams mounted between adjacent tapes and fixed thereto in operative relationship relative to said selector mechanism.

13. Apparatus for mounting cams in an elevator hatchway which cams are to actuate selector mechanism fixed to the elevator car, said apparatus comprising a plurality of tapes which are relatively stiff in directions laterally of their width and relatively flexible in directions laterally of their thickness, each tape being of length greater than maximum elevator car travel, means for suspending said tapes in spaced parallel relation within said elevator hatchway, spring means for individually tensioning said tapes, a plurality of cams mounted between adjacent tapes, each said cam comprising a pair of symmetrical elements placed in back-to-back relation and fixed between a pair of adjacent tapes.

14. Apparatus for mounting cams in an elevator hatchway which cams are to actuate selector mechanism fixed to the elevator car, said apparatus comprising a plurality of tapes which are relatively stiff in directions laterally of their width and relatively flexible in directions laterally of their thickness, each tape being of length greater than maximum elevator car travel, means for suspending said tapes in spaced parallel relation within said elevator hatchway, means for tensioning said tapes, a plurality of cams mounted between adjacent tapes, each said cam comprising a pair of elements placed in back-to-back relation and fixed between a pair of adjacent tapes.

15. Apparatus for mounting cams in an elevator hatchway which cams are to actuate selector mechanism fixed to the elevator car, said apparatus comprising a plurality of tapes which are relatively stiff in directions laterally of their width and relatively flexible in directions laterally of their thickness, each tape being of length greater than maximum elevator car travel, means for suspending said tapes in spaced parallel relation within said elevator hatchway, spring means for individually tensioning said tapes, a plurality of cams, each said cam comprising a pair of substantially identical pieces of rectangular material slightly wider than the spacing between said tapes, each said piece having smooth flat front and back faces, each said piece being tapered from its front face to its back face at each end, and means for fixing said pieces back-to-back between said tapes.

No references cited.