

Dec. 7, 1965

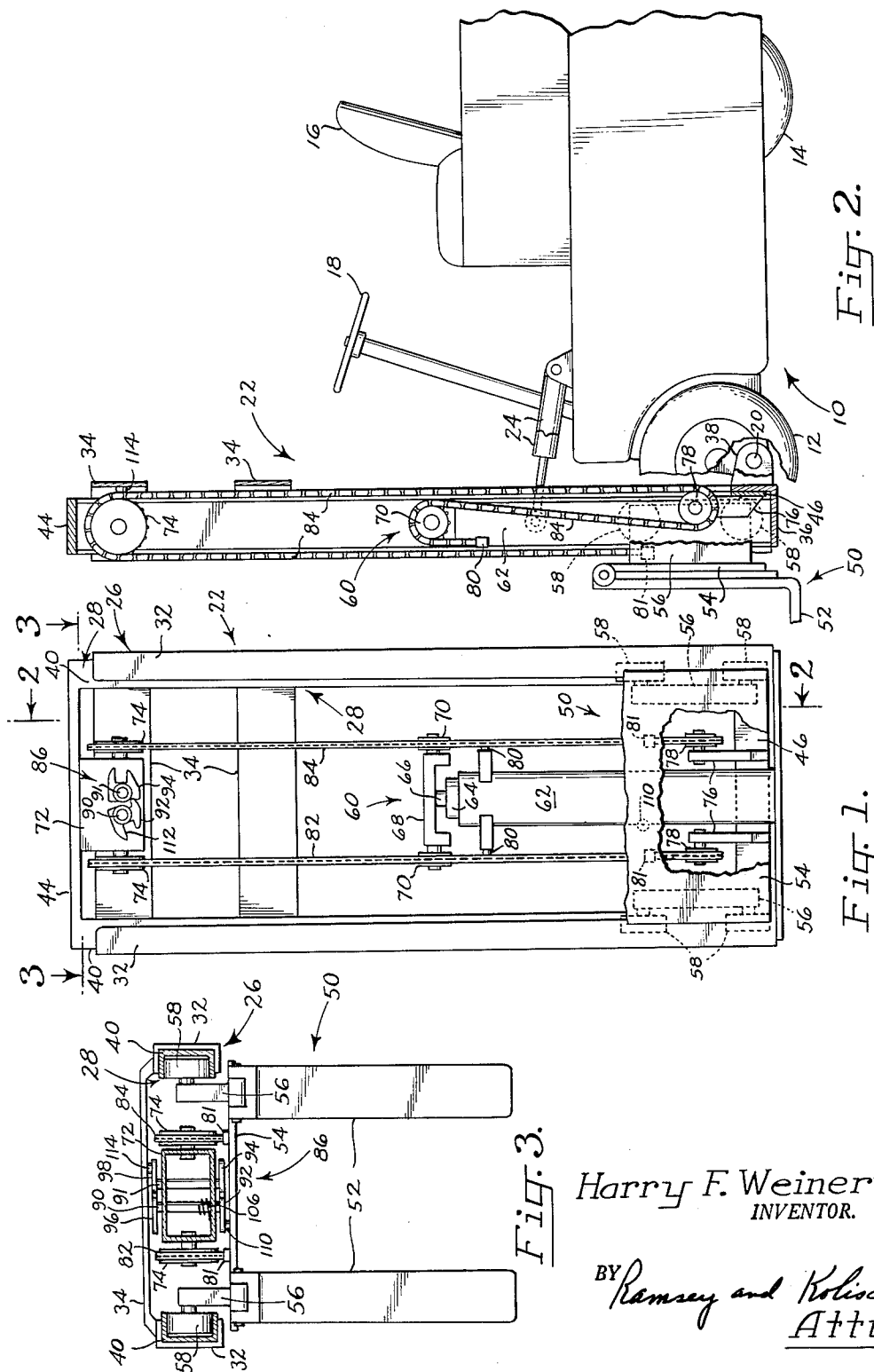
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3,221,840

LOAD-LIFTING STRUCTURE WITH LATCH MECHANISM

Filed March 18, 1963

4 Sheets-Sheet 1



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LOAD-LIFTING STRUCTURE WITH LATCH MECHANISM

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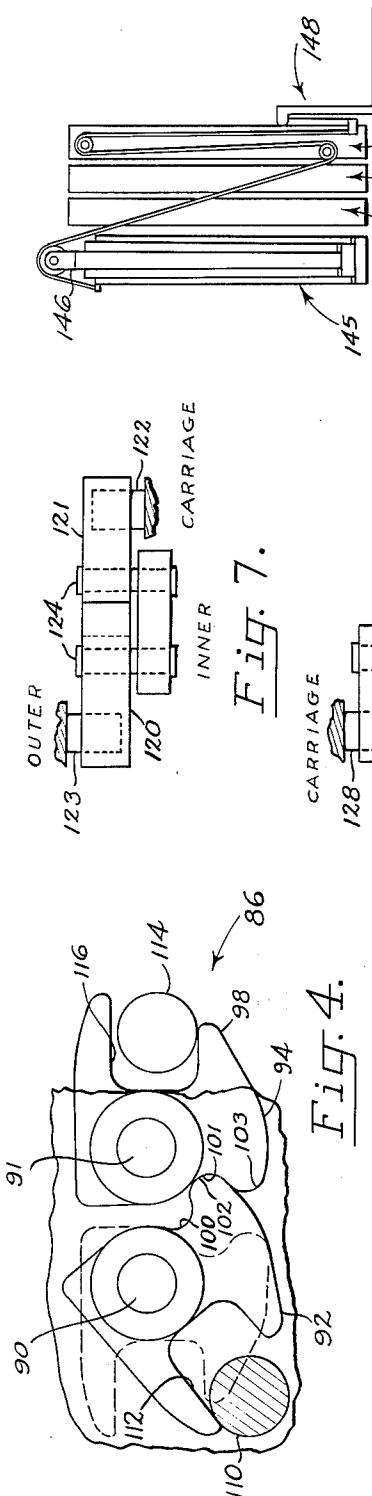


Fig. 4.

Fig. 5.

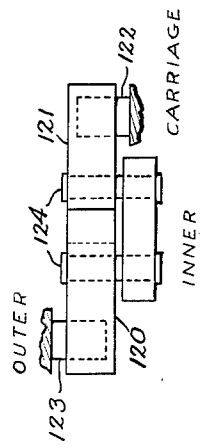


Fig. 7.

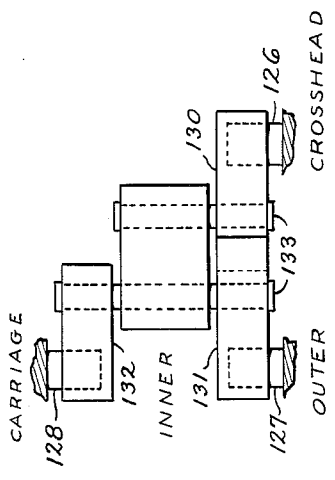


Fig. 8.

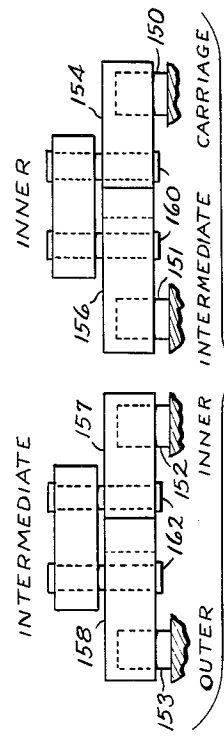


Fig. 9.

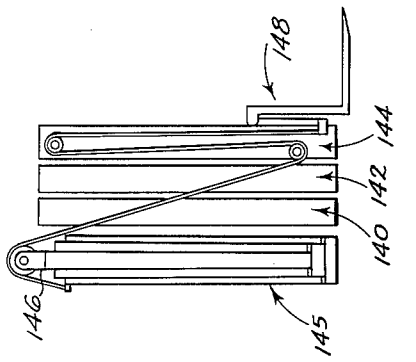


Fig. 6.

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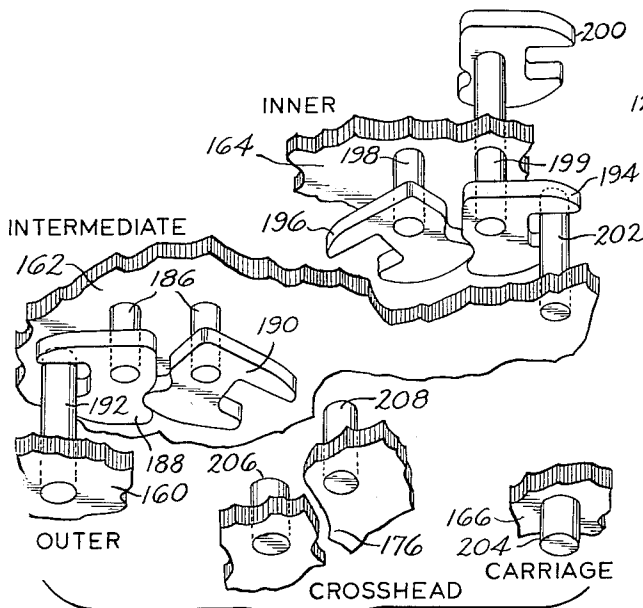


Fig. 11.

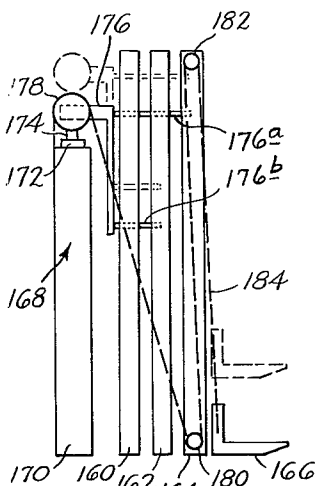


Fig. 12.

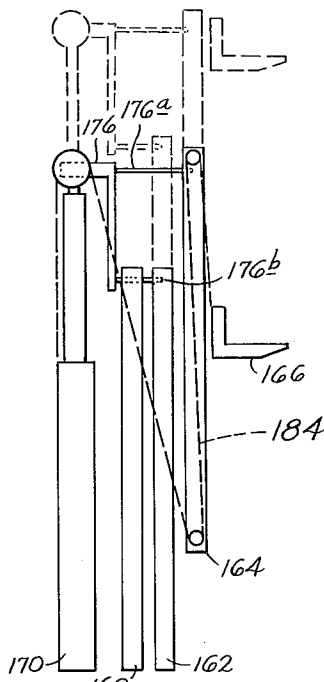


Fig. 13.

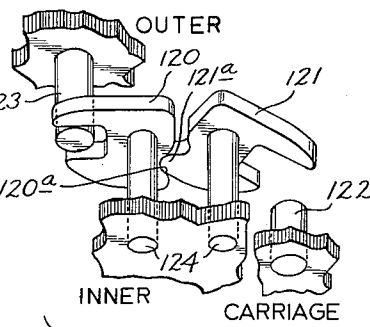


Fig. 10.

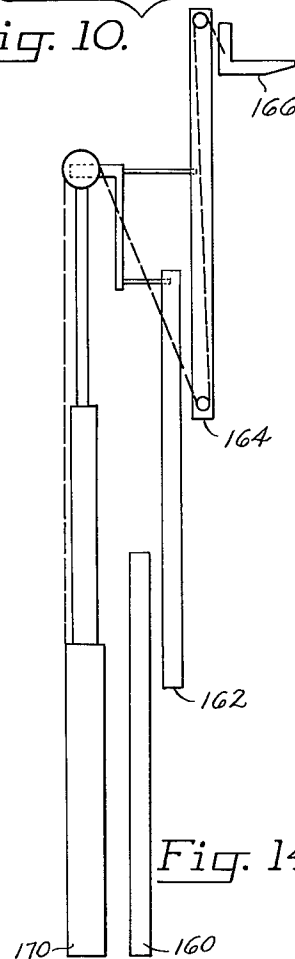


Fig. 14.

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LOAD-LIFTING STRUCTURE WITH LATCH MECHANISM

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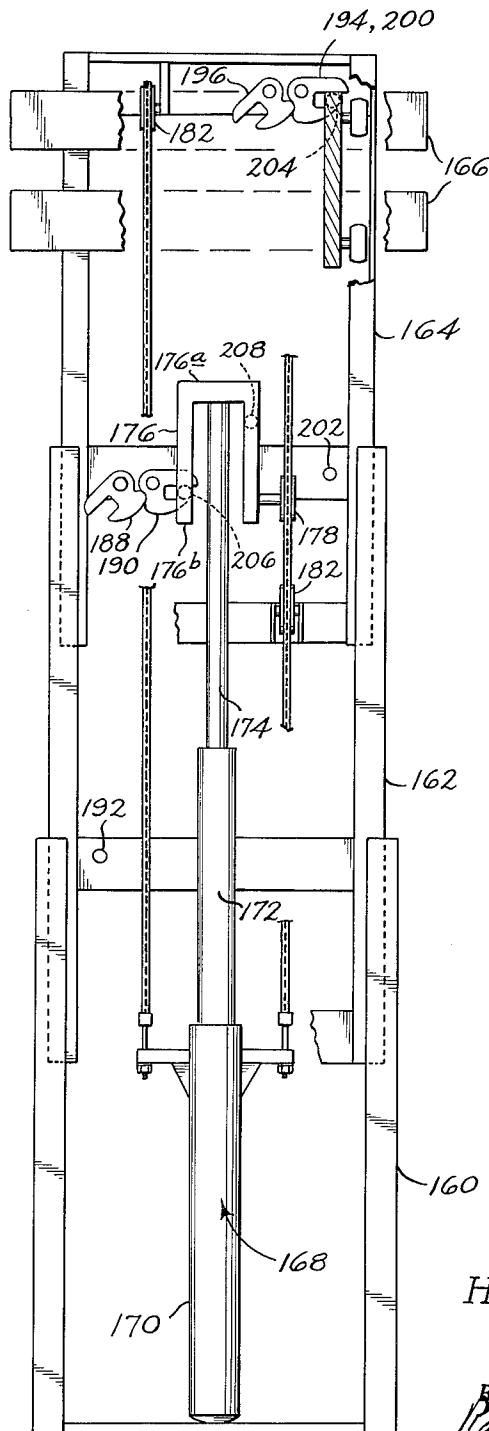


Fig. 15.

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LOAD-LIFTING STRUCTURE WITH LATCH MECHANISM

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Filed Mar. 18, 1963, Ser. No. 266,783

11 Claims. (Cl. 187-9)

This application is a continuation-in-part, of an application entitled "Lift Truck With Latch Mechanism" filed April 17, 1961, Serial No. 103,383, and now abandoned.

This invention relates to lift trucks; and more particularly to a novel latch or lock mechanism for controlling the sequence of movements of the extensible mast section or sections, and the carriage, in the extensible mast assembly of a lift truck. Included within the invention are the construction of the latch mechanism, the means whereby it is incorporated in a lift truck to control sequence of movements, and novel forms of extensible mast assemblies having movable mast sections that are locked and unlocked in such a way as to ensure at all times proper sequence of movements.

A common form of lift truck comprises a truck or tractor, and load-lifting structure mounted thereon including an extensible mast assembly and a load-lifting carriage vertically movable on the assembly. The mast assembly ordinarily has one or two extensible mast sections, which when retracted give the load-lifting structure a low minimum height. Preferably the carriage should be elevatable on the mast assembly the greatest distance possible before increasing this minimum height, and the extent to which the carriage can be raised in this manner is commonly referred to as the "free lift" or "extra lift" in the lift truck. Whether a lift truck has "100% free lift," or a free lift that is somewhat less, it is important that some mechanism be provided for suitably locking the various movable parts, so that on extension and retraction proper sequence of movement be maintained, and the truck at various elevated positions of the carriage have the lowest possible overall height.

Generally, it is an object of the invention to provide, in a lift truck having an extensible mast assembly including a load-lifting carriage, improved latch mechanism for holding and releasing, at proper times, the various movable parts in the assembly, thus to ensure proper sequence of movement.

Another object is to provide a novel form of extensible mast assembly for a lift truck, including plural movable mast sections, where selected ones of the mast sections are moved at different stages of extension in the mast assembly, with such movement at all times completely controlled.

In a lift truck having, for example, a single extensible mast section and a carriage shiftable vertically on this mast section with the extensible section held in a lowered position until the carriage reaches the top of the extensible section, whereupon the extensible section is unlocked, it is desirable that on lowering of the carriage the reverse locking sequence be applied, and that the carriage be locked in an elevated position on the extensible section until the extensible section be fully retracted, whereupon the carriage be unlocked from the extensible section. This assures that minimum height be realized on retraction as well as on extension. This same reversing of sequence on retraction is desirable, for the same reasons, in other types of lift trucks, such as trucks having two extensible mast sections, and trucks where a different sequence of movement in the parts is relied upon. It is thus another general object of the invention to provide improved latch mechanism for regulating the movement

of shiftable parts in a lift truck, that on extension of the parts is operable, after unlocking one pair of related parts, then to lock together another related pair, and that on return of the parts performs the unlocking and locking functions with respect to said other and said one pair of parts, respectively.

The load-lifting structure of a lift truck ordinarily is cycled many thousands of times during use, and it is desirable that any latch mechanism provided for regulating sequence of movements therein accommodate such frequent cycling without maintenance and repair needed. A further feature and object of the invention is the provision of such latch mechanism for a lift truck, where minimum stresses are applied to the operating parts of the latch mechanism. According to the invention, it is possible to construct a truck where elevating of the carriage and extension of a mast assembly or assemblies is performed entirely by hoist mechanism operating directly on such movable parts, without partial transmission of lifting force through the latch mechanism, even during the time that unlocking and locking is performed.

Another object of the invention is the provision of locking mechanism controlling the sequence of movement of parts in a load-lifting structure, which, as between three relatively movable parts, features the movement of one part with respect to another to produce unlocking of this other part with respect to the third, the three parts then being unlocked from each other, and that then relies on relative movement between the said other and third parts to produce locking of the one with said other. The organization minimizes lost motion tendencies in the system, while assuring proper locked and unlocked relation of the three parts at various relative positions for the parts.

A still further object of the invention is to provide improved lock or latch mechanism, characterized by the employment of two locking devices with three related operative positions. In one position, one of the locking devices is inhibited from movement in a release direction by the other device, in another position each device is free of the other, and in a third position the other locking device is inhibited from movement in a release direction by the one.

Another specific object of the invention is to provide a triple-lift load-lifting structure (where the mast assembly includes an inner and an intermediate movable mast section, in addition to an outer fixed mast section), where a novel sequence of movements in the parts is relied upon to enable fullest possible extension in the mast assembly, with such movements always being under positive control and at a predetermined rate.

Other objects and advantages of the invention will become more apparent from the following description, to be read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a view, with portions removed, looking at the front of a lift truck with load-lifting structure mounted thereon, and showing in the load-lifting structure a double mast assembly, including a fixed outer mast section and a shiftable inner mast section, and a carriage movable up and down on the inner mast section;

FIG. 2 is a section view taken along the line 2-2 in FIG. 1, and showing the usual truck or tractor to the rear of and supporting the load-lifting structure for movement over the ground;

FIG. 3 is a section view taken along the line 3-3 in FIG. 1;

FIG. 4 is a view, somewhat enlarged, of the latch mechanism contemplated by the invention, showing latch devices therein occupying one of their positions;

FIG. 5 is a view, similar to FIG. 4, but showing the latch devices in another position;

FIG. 6 illustrates, schematically, a triple-lift load-lifting structure having two extensible mast sections;

FIG. 7 illustrates, schematically, a modified form of the latch mechanism of the invention;

FIG. 8 illustrates, schematically, still another modification of the latch mechanism of the invention;

FIG. 9 illustrates, schematically, still another modification of the latch mechanism of the invention, with the latch mechanism in FIG. 9 being operable to control the sequence of movements of parts in a triple-lift load-lifting structure;

FIG. 10 illustrates further the modification of the latch mechanism of the invention shown in FIG. 7, using a somewhat different schematic form of illustration;

FIG. 11 illustrates still another modification of the latch mechanism of the invention, using the schematic form of illustration employed in FIG. 10;

FIGS. 12, 13, and 14 illustrate schematically a triple-lift load-lifting structure in various stages of extension, with the movements thereof controlled by the latch mechanism shown in FIG. 11; and

FIG. 15 shows a fully extended triple-lift structure (with portions broken away), of the type illustrated schematically in FIGS. 12, 13, and 14.

Referring now to the drawings, and more particularly to FIGS. 1, 2, and 3, at 10 there is indicated the truck or tractor portion of an industrial lift truck. The truck is supported for movement over the ground on front wheels 12 and rear wheels 14. The truck includes the usual driver's seat 16, and in front of the seat and in reach of an operator a steering wheel and post assembly 18, which may be connected in the usual manner to rear wheels 14 for steering purposes. Pivotaly mounted at 20, on a forward portion of the tractor frame, is load-lifting structure generally indicated at 22. A ram 24 interposed between the truck and structure 22 is used to swing structure 22 about pivot 20.

Considering now more specifically the construction of lifting structure 22, this comprises an outer, fixed of stationary mast section 26 (stationary in that there is no provision for vertical movement of the section), and an inner mast section 28 mounted within the outer mast section and movable vertically therefrom. In the embodiment illustrated, the outer mast section comprises opposed channel beams 32 rigidly secured together by bars 34 and base plate 36. The mast section is pivoted to the truck through ears 38 joined to the base plate. Inner mast section 28 comprises opposed channel beams 40, with top ends secured together by plate 44. Securing lower portions of the channel beams together is a bar 46. Beams 40 are slidable up and down in beams 32.

Mounted for movement up and down on inner mast section 28 is a load-lifting carriage 50. Carriage 50 includes the usual lifting forks 52, and an apron 54. Vertical plates 56 attached to the rear of the apron extend into the space between beams 40, and rollers 58 received within beams 40 and journaled on the plates 56 guide the carriage during up-and-down movement thereof.

A hoist mechanism 60 is provided for raising the load-lifting carriage and producing extension of the inner mast section. In the embodiment illustrated, this comprises an outer cylinder 62 secured at its base to base plate 36 and extending vertically upwardly therefrom. A sleeve 64 is within the outer cylinder and extensible upwardly from the cylinder, and a rod 66 projecting out from the top of sleeve 64 is extensible from the sleeve. Extending transversely across the top of rod 66 is a cross-head 68. The rod and crosshead constitute a motor-operated vertically movable element in the construction.

Crosshead 68 carries opposed sprockets 70. Sprockets 74 are also mounted at the top of the inner mast section, and these are journaled on frame structure 72 depending from plate 44. Upstanding members 76 on

either side of cylinder 62 are secured to plate 46 of the inner mast section, and journaled on the members are sprockets indicated at 78. Trained over the various sprockets and disposed to the left of cylinder 62 in FIG. 1 is a chain 82, and trained over the various sprockets and disposed to the right of the cylinder is a chain 84. These have one set of ends anchored to cylinder 62 by fasteners 80, and their other set of ends are secured to the carriage at 81.

Briefly, explaining the operation of the load-lifting structure just described, on initial extension of hoist mechanism 60, the inner mast section remains stationary and carriage 50 is pulled upwardly by chains 82, 84 on the inner mast section, with the carriage moving a distance equal to about twice the amount of extension in the hoist mechanism. In the construction shown, there is room for the carriage to move about the full height of the inner mast section, with hoist 60 extending only about half way. On reaching the top of the inner mast section, plates 56 of the carriage strike the underside of plate 44, and on further extension of the hoist, the inner mast section is extended from the outer, fixed mast section, through the carriage pulling the inner mast section upwardly by reason of its contact with plate 44. Plates 56 and plate 44 thus constitute abutment means that engage to produce upward movement of the inner mast section. The inner mast section is raised at the same rate as the carriage, or at about twice the speed of the extension of the hoist.

A latch mechanism is provided to control the sequence of movements of the various movable mast sections. This is indicated at 86, and comprises parallel rods 90, 91 journaled in depending frame structure 72. On the front side of the frame structure, and fixed to the front ends of the rods, for pivotal movement on rotation of the rods, are a pair of locking or latch members 92, 94. Similarly, secured to the rear ends of the rods on the rear side of the frame structure, are another pair of locking or latch members 96, 98. The two locking members secured to rod 90 and the rod itself constitute one locking device in the mechanism, and rod 91 and the two locking members secured to it constitute another locking device. Locking members 96, 98 have the same outline as locking members 92, 94, and if locking members 96, 98 were visible in FIG. 1, they would appear exactly as the locking members 92, 94 shown.

With reference now to FIG. 4, here locking members 92, 94 in the position of FIG. 1 are shown, but slightly enlarged, and with portions of member 94 removed, so that rear locking member 98 is visible. In the position shown for the members in solid outline in FIG. 4 (which is one interlocked position for the members), members 94, 98 and rod 91 are prevented from rotating in a clockwise direction, by member 92 (and also member 96 which is in the same position as member 92). This results from the fact that, considering either pair of members 92, 94 or pair of members 96, 98, the members of a pair have opposed and facing surface portions, with the surface portion of each defining an indent and farther out from the member's pivot axis a detent. Such indents are indicated for members 92, 94 at 100 and 101, respectively, and the detents are indicated at 102, 103. With locking members 92, 94 as shown in FIG. 4, detent 102 of member 92 sits within indent 101 of member 94, which blocks movement of the lower part of member 94 to the left and up in the figure.

If the locking members secured to rod 90 are pivoted in a clockwise direction to the position shown in dashed outline in FIG. 4 for member 92, detent 102 of member 92 moves free of indent 101 of member 94 (and the same happens with respect to members 96, 98). The members now are in their unlocked position. With the members in their unlocked position, the right set of members 94, 98 can be pivoted in a clockwise direction, to position detent 103 within indent 100 (with similar action

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occurring in the rear pair of locking members). This places the locking members in another interlocked position, the position shown in FIG. 5, where the left set of members are inhibited from rotating in a counterclockwise direction by the right set of members.

Referring again to FIGS. 1 and 3, projecting rearwardly from load-lifting carriage 50, and thus part of it, is a finger or lug 110. On the carriage reaching an elevated position on the inner mast section, finger 110 moves into a catch or recess 112 provided on locking member 92 which is directly adjacent. Projecting forwardly from bar 34, and thus part of the outer, fixed mast section, is a finger or lug 114. With the parts as shown in FIG. 1, this is received within a recess or catch 116 provided on the locking member 98 directly adjacent (see FIG. 4).

Explaining now how the locking mechanism works, and referring to FIGS. 4 and 5, on initial extension of the hoist mechanism and upward movement of carriage 50, the inner mast section is positively locked to the outer mast section and prevented from rising, since finger 114 is in catch 116 and member 98 cannot rotate in a clockwise direction so as to free the finger. On the carriage reaching the top of the inner mast section, finger 110 of the carriage passes into recess 112, and the left set of locking members are swung in a clockwise direction, to place the various members in an unlocked position. On further upward movement of the carriage, the tops of plates 56 strike the underside of plate 44 (see FIG. 2), and the inner mast section starts rising, with finger 114 swinging member 98 (and member 94) to the position for the members shown in FIG. 5, their other interlocked position. Once this condition is reached, and should it be desired to lower the carriage, movement of the carriage downwardly with respect to the inner mast section is prevented, since finger 110 is within recess 112 and member 92 is prevented from pivoting in such a direction as to free the finger. Relative movement of the carriage and inner mast section can only occur on the inner mast section reaching its lowered position, with finger 114 now acting to move the right set of locking members in a counterclockwise direction, thus to free the left set of locking members. Note that the fingers alternately act as hold and release means in the construction, during cycling of the lift structure. Detent 102 and indent 101 function as a locking means preventing shifting of finger 114 out of catch 116, and detent 103 and indent 100 constitute another locking means operable, when interengaged, to prevent release of finger 110 from catch 112.

In FIGS. 7 and 10, a modification of the invention is shown which in functioning is quite similar to the modification of the invention just described. The principal difference between the modification of FIGS. 7 and 10, and the just-described modification, is that in the structure of FIGS. 7 and 10, only two side-by-side locking members 120, 121, are used.

In FIG. 7, the structure is shown schematically according to a system which is thought to expedite an understanding of the structure. Thus, the block labeled "inner" represents the inner extensible mast section of a double-lift truck, similar to the one just fully described above. Parts labeled "outer" and "carriage" indicate parts of an outer mast section and a carriage, respectively. A pair of locking members of the type just described is represented at 120, 121, and these are pivoted to the inner mast section by pivots 124. At 122 and 123 are fingers mounted on the carriage and outer mast section, respectively. In understanding the schematic illustration of FIG. 7, it will be assumed that with one locking member shown over another locking member (as member 120 is shown over member 121) the upper member (member 120, in this case) is the one locked in position by the other member (the lower member).

In FIG. 10, the structure shown schematically in FIG. 7 is shown again, also schematically, in a view that may be described as a diagrammatic, perspective view. Frag-

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mentary portions of the outer mast section, inner mast section, and carriage are shown, as are the locking members 120, 121, and fingers 122, 123, that cooperate with the members in producing a locked condition. In FIG. 10, what is meant by the locked position of member 120 is clearly seen, since in FIG. 10 detent 121a of member 121 is shown lodged within the indent 120a of member 120, whereby member 120 is locked in place.

Explaining the operation of the modification of the invention shown in FIGS. 7 and 10, with the mast assembly contracted and the carriage at the base of the mast assembly, and with member 120 locked in position, finger 123 of the outer mast section cannot move with respect to the locking members and the inner mast section supporting the locking members. Thus, the inner and outer mast sections are held from relative vertical movement. On movement of the carriage and its finger 122 upwardly to a raised position, the finger eventually engages locking member 121, and swings member 121 to a position releasing member 120, and placing the locking members in their unlocked position. This enables the inner mast section to rise with respect to the outer fixed mast section, with pin 123 of the outer mast section (on relative movement of the inner mast section) then pivoting member 120 so as to lock member 121. When this occurs, the carriage and inner mast section are locked from relative movement, and this state is maintained throughout the remainder of the upward movement of the carriage. On lowering, the reverse occurs, with the carriage locked in position initially and then unlocked, with this followed by locking together of the inner and outer mast sections.

In FIG. 8, a system is disclosed such as might be used where movement of the crosshead (or motor-operated vertically movable element, since the crosshead is part of the hoist mechanism) is relied upon to produce a locking transition. In certain lift trucks with a double mast assembly, the sequence of operation is such that during the initial upward movement of the carriage the inner mast section remains lowered in the outer mast section. As the carriage moves upwardly on the inner mast section, it eventually reaches a position part way up the inner mast section, where movement of the inner mast section with the crosshead occurs simultaneously with movement of the carriage upwardly on the inner mast section. The carriage subsequently reaches the top of the inner mast section, and at this time the inner mast section and carriage move upwardly together, and at a faster rate than the rate at which the crosshead is moving which is producing the vertical movement.

In FIG. 8, the rectangle labeled "inner" represents an inner, extensible mast section, and fingers 126, 127, 128 are connected to and form part of the crosshead, outer mast section, and carriage, respectively. Locking members, pivoted by pivots 133 to the inner mast section, are indicated at 130, 131, 132. It will be assumed again that in considering a pair of locking members, the overlying member is locked by the one shown under it (thus, member 131 is locked by member 130).

Explaining the operation of the system in FIG. 8, since initially member 131 is locked by member 130, at the start the inner and outer mast sections are locked from relative movement. On upward extension of the hoist mechanism and upward movement of the carriage, finger 126 of the crosshead or vertically movable element eventually engages locking member 130, causing it to release member 131, and on release the member 131, the inner mast section can move upwardly, conjointly with the crosshead. On upward movement of the inner mast section relative to the outer, fixed mast section, finger 127 shifts member 131 so as to lock member 130, with the crosshead and inner mast section now being locked together. On the crosshead and inner mast sections being locked together, and on upward movement of the crosshead, the two move upwardly and at the same rate of speed. The carriage all this time is moving upwardly

under the action of the hoist at a somewhat faster speed, and on the carriage reaching the top of the inner mast section, finger 128 of the carriage engages locking member 132, shifting it (and member 131 connected to it), so as to release the inner mast section from the crosshead. This enables the inner mast section, which formerly was locked to the crosshead, to travel upwardly away from the crosshead with the carriage. On further upward movement of the inner mast section, the carriage and inner mast section are locked together (because relative movement between the inner mast section and crosshead causes finger 126 to shift locking member 130 to a position locking member 131 and with it member 132).

In FIG. 6 there is indicated, schematically, a triple-lift, load-lifting structure, comprising an outer, fixed or first mast section 140, an intermediate or second, extensible mast section 142, an inner or third, extensible mast section 144, a hoist 145 including a crosshead 146, and a load-lifting carriage 148. In such a construction, during elevation of the carriage, the sequence desired in some constructions is that first load-lifting carriage 148 be raised to the top of the inner mast section 144, that then the inner mast section be raised to the top of intermediate mast section 142, and that then the intermediate mast section be raised to the top of outer mast section 140. A locking system which would be employed to control such a sequence is illustrated in FIG. 9.

Referring now to this figure, the rectangle labeled "inner" indicates the inner mast section, and the one labeled "intermediate" represents the intermediate mast section. At 150, 151, 152, and 153 are indicated fingers that are part of the carriage, intermediate, inner, and outer mast sections, respectively. Locking members are shown at 154, 156, 157, 158. Members 154, 156 are pivoted by pivots 160 on the inner mast section, and members 157, 158 are pivoted by pivots 162 on the intermediate mast section.

Initially, and with the mast assembly contracted and the carriage at the base of the mast assembly, the outer and intermediate mast sections are locked together by locked locking member 158, and the inner and intermediate mast sections are locked together by locked locking member 156. The carriage is free to move upwardly on the mast assembly. After a predetermined amount of raising of the carriage, finger 150 engages member 154 and swings member 154 clear of member 156, to release member 156. This is the first locking change that occurs. The release of member 156 enables the inner mast section to move upwardly with respect to the intermediate mast section, and such relative movement produces swinging of locking member 156 such as to produce locking of member 154, so that the carriage and inner mast section now are locked together. When the inner mast section reaches the top of the intermediate mast section, finger 152 which is part of the inner mast section engages locking member 157 to move member 157 free of locking member 158. This releases the intermediate mast section from the outer mast section. On upward movement of the intermediate mast section relative to the outer mast section, finger 153 moves member 158 into member 157, so as to lock together the intermediate and inner mast sections. On lowering of the mast assembly and carriage, the reverse sequence occurs.

In FIG. 11, a locking system is illustrated, diagrammatically and in perspective (a form of illustration similar to the one used in FIG. 10), that is employed to control the extension of the triple-lift, load-lifting structure illustrated schematically in FIGS. 12, 13 and 14, and shown fully extended in FIG. 15. The load-lifting structure comprises an outer mast section shown at 160, an intermediate and extensible mast section shown at 162, an inner extensible mast section shown at 164, and a load-lifting carriage shown at 166. A ram or hoist 168, including a fixed cylinder 170, an extensible sleeve 172, and a rod 174 extensible from the sleeve, is provided for producing ex-

tension of the mast sections and lifting of the load-lifting carriage. Secured to the top of rod 174 is a crosshead 176 carrying sprockets such as sprocket 178. Trained over this sprocket, as well as sprockets 180, 182 journaled on the inner mast section are chains such as chain 184 (shown by a dashed line), which is fastened at one end to cylinder 170 and at its other end to the load-lifting carriage.

In the triple-lift, load-lifting structure of FIGS. 12, 13, 14 and 15, it is desired to produce full extension of the intermediate and inner mast sections from the outer mast section. Such requires a ram or hoist of considerable length, and with such a ram it is not possible to raise the carriage to the top of the inner mast section before the top of the ram (and crosshead) travels beyond the collapsed height of the mast assembly. Thus, according to this invention, a novel sequence of movements is contemplated, wherein first the carriage is partially raised on the inner mast section while all the mast sections remain stationary. After such partial raising, the crosshead becomes attached to the inner mast section, and the two move as one, during additional upward movement of the load-lifting carriage on the inner mast section. On still further extension of the ram or hoist, the crosshead, intermediate, and inner mast sections are connected, so that all move upwardly as one, with the carriage during this portion of the extension of the assembly moving to the top of the inner mast section. On the remainder of the extension of the mast assembly, the crosshead and the intermediate mast section move as one, while the inner mast section rises with the carriage, to produce full extension of the mast assembly.

With such an organization, the carriage, throughout its full upward range of movement, moves upwardly with respect to ground level at twice the rate of the extension of the ram. Further, and very important, a locking system may be included whereby, during the entire range of extension of the mast assembly, each part either is fixed, or has a definitely prescribed rate of movement relative to the other parts, and whereby, with the fixed parts locked together and with the definitely prescribed rate of movement occurring in the other parts, proper sequence in the movement of the parts may be assured.

Referring to FIG. 11, where a locking system according to this invention is illustrated that produces the result indicated, in this figure a fragmentary portion of the intermediate mast section is indicated at 162, and fragmentary portions of the inner and outer mast sections are indicated at 164 and 160 respectively. A portion of the load-lifting carriage is indicated at 166, and portions of the crosshead at 176.

Pivoted on the intermediate mast section, by pivots 186, are a pair of locking members 188, 190, with member 188 shown locked by member 190. Finger 192, which is part of the outer mast section, is locked by member 188 from movement, and thus the intermediate and outer mast sections are locked together.

Pivotaly mounted on the inner mast section are locking members 194, 196. The members are pivoted by means of pins or rods 198, 199. Rod 199 for locking member 194 has another locking member 200 secured thereto, which moves in the same manner as locking member 194. With the parts as shown, member 196 locks member 194, and finger 202 joined to the intermediate mast section is held in place by locking member 194, so that the inner and intermediate mast sections are locked together.

Carriage 166 has a finger 204 joined thereto, which is movable up and down in a path vertically aligned with member 200, so that when the carriage is raised far enough, its finger 204 will engage locking member 200 to cause pivotal movement thereof. Cross head 176 has fingers 206, 208 joined thereto, movable in paths vertically aligned with locking members 190 and 196, respectively.

Crosshead 176 has an abutment means shown schematically at 176a in FIGS. 12 and 13, which engages the upper end of inner mast section 164 when the crosshead moves to adjacent top of the inner mast section (as shown by the dashed outline for means 176a in FIG. 12) and which is operable to produce upward movement of the inner mast section when it moves upwardly after engaging the inner mast section. Crosshead 176 also has an abutment means shown schematically at 176b, which engages the upper end of the intermediate mast section 162 when the abutment means moves to adjacent the top of the intermediate mast section (as shown by the solid outline for the abutment means in FIG. 13), and which is operable to produce upward movement of the intermediate mast section when it moves upwardly after engaging the intermediate mast section.

The various locking members that are pivoted on the intermediate and inner mast sections are mounted in the assembly adjacent the tops of these sections. The fingers described above that actuate the locking members are mounted on the various parts in positions whereby upon suitable extension of the mast assembly they come into engagement with the necessary locking members.

Explaining the operation of the various locking members and the load-lifting structure, which are illustrated in FIGS. 11-15, during initial extension of ram 168, as already indicated the intermediate and outer mast sections are locked together, by locked locking member 188, and the intermediate and inner mast sections are locked together by locked locking member 194. The crosshead and carriage are free to move and, on initial upward movement of the crosshead, the carriage moves upwardly on the inner mast section, at twice the rate at which the crosshead moves, until the crosshead and carriage reach the position indicated in dashed outline in FIG. 12, which is when the crosshead reaches the top of the inner mast section.

With the crosshead reaching the top of the inner mast section, finger 208 of the crosshead moves up into and engages member 196 on the inner mast section, causing the same to pivot out of and thus unlock locking member 194. This releases the inner mast section from the intermediate mast section. The crosshead on further extension of the ram, through engagement of abutment means 176a with the top of the inner mast section, raises the inner mast section, which produces movement of the inner mast section relative to the intermediate mast section. This results in locking of the crosshead to the inner mast section, because movement of the inner mast section is accompanied with swinging of locking member 194 to a position where member 196 is locked. As the ram further extends, the inner mast section moves up on the intermediate mast section at a rate equal to the rate that the ram extends, and the carriage moves up on the inner mast at the same rate.

The inner mast section and carriage continue movement in this manner, on extension of the ram, until the position indicated in solid outline in FIG. 13 is reached. On reaching the position indicated by the solid outline in FIG. 13, finger 206 of the crosshead engages locking member 190 on the intermediate mast section, causing the locking member to swing out of engagement with locking member 188. This releases the intermediate mast section from the outer mast section, enabling it to rise with the crosshead. Abutment means 176b of the crosshead at this time engages the top of the intermediate mast section, so that on further extension of the ram the crosshead is operable to lift up the intermediate mast section. Upon the intermediate mast section moving upwardly out of the outer mast section, locking member 188 is swung to a position where locking member 190 is locked, so that the crosshead and intermediate mast sections become locked together. The carriage continues to be moved upwardly on the inner mast section.

This condition continues until the load-lifting carriage reaches the top of the inner mast section, or until the parts reach the positions shown in dashed outline in FIG. 13. When this occurs, finger 204 of the carriage engages locking member 200 mounted on the inner mast section, causing it to swing in a direction whereby member 194 connected to it releases locking member 196. On further extension of the ram, since the carriage cannot move farther upwardly on the inner mast section, the inner mast section is carried upwardly, on the intermediate mast section. This causes locking member 196 to swing to a position wherein locking member 194 is locked by member 196. With member 194 locked, member 200 connected to it also becomes locked, with the result that the carriage and inner mast section become locked together.

By way of summary, during initial extension of the ram, the outer, intermediate, and inner mast sections are locked together, and the crosshead and carriage are free to move upwardly, with the carriage moving at twice the speed of the crosshead. On the crosshead reaching the top of the inner mast section, the crosshead becomes locked to the inner mast section, and the inner mast section is released from the intermediate mast section, the outer and intermediate mast sections remaining locked together and the carriage still being free to move. This condition permits movement of the inner mast section, whereby clearance is provided for the ram. On the inner mast section reaching the full-line position shown in FIG. 13, the intermediate mast section is released from the outer mast section, and the crosshead, inner, and intermediate mast sections become locked together, with the carriage still being free to move. With the parts reaching the position shown in dashed outline in FIG. 13, the carriage and inner mast section become locked, the crosshead and intermediate mast section remain locked, and the inner mast section is released from the crosshead. Like the other locking systems discussed, on contraction of the ram and downward movement of the parts, the reverse locking sequence takes place.

It should be noted that all vertically movable parts in the structure are either locked together during extension of the mast assembly, or positively forced upwardly at a predetermined rate. In this way, all movable parts are under control at all times. By locking the inner mast section to the crosshead and lifting the inner mast section during an intermediate range of movement, clearance is provided within the mast assembly for the extending ram, which of necessity must have considerable length for the mast section to reach the fully extended position of FIG. 14.

While various embodiments of the invention have been described, modifications and variations are possible without departing therefrom. It is desired to cover all such modifications and variations that would be apparent to one skilled in the art, and that come within the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. In an industrial truck having at least two vertically disposed telescopic mast sections with one extensible in an upward direction from the other, elevatable carriage mechanism at the base of and vertically shiftable along said one section, and vertically shiftable hoist mechanism connected to and for moving the carriage mechanism, the improvement comprising

means operable during raising of one of said mechanisms to maintain the sequence of first movement of the mechanism upwardly relative to said one section and then upward movement of said one section relative to the other section, and operable on return of the mechanism to maintain a reverse sequence,

said means comprising a pair of latch devices mounted on said one section in an interlocked position, means on said other section operated upon by said

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latch devices with the latter in such interlocked position to prevent movement of said one section relative to said other section, and

means mounted on said one of said mechanisms engageable with one of said latch devices on positioning of said mechanism upwardly on said one section and operable on engagement to produce unlocking of the devices from each other and freeing of said one section for movement upwardly on the other section,

said means on said other section engaging the other of said latch devices and operating to place the latch devices in another interlocked position after freeing of said one section and on movement of said one section upwardly on the other with the latch devices in this latter position then operating on said means on said one of said mechanisms to prevent movement of said one section relative to said one of said mechanisms.

2. In an industrial truck having at least two vertically disposed telescopic mast sections with one extensible in an upward direction from the other, an elevatable carriage at the base of and vertically shiftable along said one section, and vertically shiftable hoist mechanism connected to and for moving the carriage, the improvement comprising

means operable during raising of the hoist mechanism to maintain the sequence of first no movement in said one section and then upward movement of said one section together with the hoist mechanism relative to the other section, and operable on return of the hoist mechanism to maintain a reverse sequence,

said means comprising a pair of latch devices mounted on said one section in an interlocked position,

means on said other section operated upon by said latch devices when in such interlocked position to prevent movement of said one section relative to said other section, and

means mounted on and movable with said hoist mechanism engageable with one of said latch devices on extension of the hoist mechanism and positioning of the carriage upwardly on said one section,

said means being operable on engagement to produce unlocking of the latch devices from each other and freeing of said one section for movement upwardly on the other section,

said means on said other section engaging with the other of said latch devices and operating to place the latch devices in another interlocked position after freeing of said one section and on movement of said one section upwardly on the other with the latch devices in this latter position then operating on said means on said hoist mechanism to prevent movement of the hoist mechanism relative to said one section.

3. In an industrial truck having at least two vertically disposed telescopic mast sections with one extensible in an upward direction from the other and an elevatable carriage at the base of and vertically shiftable along said one section, the improvement comprising

means operable during raising of the carriage to maintain the sequence of first movement of the carriage upwardly on the one section and then movement of the one section relative to the other section, and operable on return of the carriage to maintain a reverse sequence,

said means comprising a pair of latch devices mounted on said one section in an interlocked position,

means on said other section operated upon by said latch devices with the latter in such interlocked position to prevent movement of said one section relative to the other section, and

means mounted on said carriage engageable with one of said latch devices on positioning of the carriage upwardly on said one section, and operable on engagement to produce unlocking of the devices from

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each other and freeing of said one section for movement upwardly on the other section,

said means on said other section engaging the other of said latch devices and operating to place the latch devices in another interlocked position after freeing of said one section and on movement of said one section upwardly on the other with the latch devices in this latter position then operating on said means on said carriage to prevent movement of the carriage relative to said one section.

4. In an industrial truck having at least two vertically disposed telescopic mast sections with one extensible from the other in an upward direction, and an elevatable carriage at the base of and vertically shiftable along said one section, the improvement comprising

abutment means on the carriage and abutment means on said one section engageable with each other on the carriage being raised to a position adjacent the top of said one section and on further upward movement of the carriage operable to lift said one section with the carriage relative to the other section,

a pair of latch devices mounted on said one section and with the carriage at the base of said one section occupying an interlocked position,

means on said other mast section operated upon by said latch devices with such devices in such interlocked position to prevent movement of said one mast section relative to said other mast section, and

means mounted on the carriage engageable with one of said latch devices on positioning of the carriage at said position adjacent the top of said one section and operable on engagement to produce unlocking of the latch devices from each other and freeing of said one section for movement upwardly on the other section,

said means on said other section engaging the other of said latch devices and operating to place the devices in another interlocked position after freeing of said one section and no movement of said one section upwardly of the other with the latch devices in this latter position then operating on said means on said carriage to prevent movement of the carriage relative to said one mast section.

5. In an industrial lift truck having a first, stationary mast section, a second mast section elevatable on the first mast section, a third mast section elevatable on the second mast section, carriage mechanism elevatable on the third mast section, and vertically shiftable hoist mechanism connected to and for moving the carriage mechanism, the improvement comprising

means operable during raising and lowering of the carriage mechanism to control the sequence of movements of the second and third mast sections relative to the first mast section,

said means comprising a pair of latch devices mounted on said second mast section in an interlocked position and in such position engaging hold means on the first mast section thus to prevent relative movement of the first and second mast sections,

a second pair of latch devices mounted on said third mast section in an interlocked position and in such position engaging hold means on the second mast section thus to prevent relative movement of the second and third mast sections,

means for engaging one of the latch devices of one pair on the carriage reaching one elevation and operable on engagement to produce unlocking of the latch devices from each other,

means for engaging one of the latch devices of the other pair, on the carriage reaching a higher elevation than said one elevation, and operable on engagement to produce unlocking of the latch devices from each other,

said hold means on the first mast section, after unlocking of the latch devices mounted on the second mast section, being operable to place the latch de-

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vices on the second mast section in an interlocked position on relative vertical movement of the first and second mast sections,

said hold means on the second mast section, after unlocking of the latch devices mounted on the third mast section, being operable to place the latch devices on the third mast section in an interlocked position on relative vertical movement of the second and third mast sections.

6. In an industrial truck having at least two vertically disposed telescopic mast sections with one vertically extensible in an upward direction from the other, elevatable carriage mechanism at the base of and vertically upwardly shiftable along one section, and vertically shiftable hoist mechanism connected to and for moving the carriage mechanism,

a pair of latch devices mounted on said one section pivotable about parallel axes,

said latch devices having an unlocked and first and second interlocked positions, and with the carriage at the base of said one section, occupying their first interlocked position,

hold means mounted on said other section and with said one section nonextended held by one of the latch devices from movement downwardly of the one latch device, and

means mounted on one of said mechanisms engageable with the other of said latch devices on raising of the carriage mechanism and operable upon engagement to pivot the device whereby the devices occupy their unlocked position,

said hold means on downward movement relative to said one latch device pivoting the one latch device to place the latch devices in their second interlocked position.

7. In combination with a triple-lift extensible mast assembly including a fixed outer mast, and nested therein vertically movable intermediate and inner masts; a carriage vertically movable on the inner mast; power-operated hoist mechanism including a vertically movable element for producing extension of the mast assembly and raising of the carriage;

means operable with the assembly contracted to lock together the outer, intermediate, and inner masts, and maintain them locked during initial upward movement of said element and until said element nears the top of said mast;

means on said element for then first releasing the inner mast from the other masts and after such release locking the inner mast to said element on further upward movement of said element;

said later condition being maintained during another portion of the upward movement of said element; means on said element for then first releasing said intermediate mast from said outer mast and after such release locking the intermediate mast to said element with such condition being maintained during another portion of upward movement of said carriage; and

means on said carriage for then releasing said inner mast from said element.

8. In an industrial truck having at least two vertically disposed telescopic mast sections, with one bottomed in and extensible upwardly from the other, elevatable carriage mechanism at the base of and vertically shiftable upwardly along one section, and vertically shiftable hoist mechanism connected to and for moving the carriage mechanism, the improvement comprising

a pair of latch devices, pivotally mounted on said one section and each of which has a detent and an indent means, said latch devices with said one section bottomed in the other section and the carriage mechanism at the base of said one section occupying a position where the detent means of one device fits within

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the indent means of the other, and in this position being constructed and arranged so that said other latch device is restrained from pivotal movement in one direction,

means on said other mast section, engaged by said other latch device with the one mast section bottomed in the other section and the carriage at the base of the one section, operable to prevent extension of said one mast section from the other mast section with said other latch device so restrained, and

means mounted on one of said mechanisms, engageable with said one latch device when the carriage mechanism is raised from its position at the base of said one mast section, operable on such engagement to pivot the one latch device in a direction freeing its detent means from the indent means of the other latch device,

said one mast section then being free to extend from said other mast section and said means on the other mast section operating on extension of the one mast section to pivot said other latch device so as to place its detent means within the indent means of the one latch device,

said latch devices in this position being constructed and arranged so that the one latch device is restrained from pivotal movement in one direction.

9. In an industrial truck having at least two vertically disposed telescopic mast sections with one vertically extensible in an upward direction from the other, elevatable carriage mechanism at the base of and vertically upwardly shiftable along one mast section, and vertically shiftable hoist mechanism connected to and for moving the carriage mechanism,

a pair of latch devices pivotally mounted on said one mast section,

said latch devices having an unlocked, and first and second interlocked positions, and with the carriage mechanism at the base of said one mast section occupying their first interlocked position, each of said latch devices having detent means and indent means positioned thereon, and said first interlocked position being the result of the detent means of one fitting within the indent means of the other latch device,

hold means on said other mast section, and with said one mast section nonextended and with said latch devices in their said first interlocked position, held by the latch devices from movement downwardly relative to the latch devices, and

means mounted on one of said mechanisms engageable with said one latch device on raising of the mechanism, operable upon engagement to pivot said one latch device whereby the devices occupy their unlocked position thus to free said other mast section, said hold means on said other mast section, with said latch devices in their unlocked position, and on movement of said other mast section downwardly relative to the one mast section operating to pivot said other latch device to place the latch devices in their second interlocked position,

said second interlocked position being defined by the detent means of said other latch device fitting within the indent means of said one latch device.

10. In an extensible system having a pair of members extensible from each other and a third member mounted on one of said pair for movement therealong in a direction paralleling extensible movement of said pair,

a pair of latch devices pivotally mounted on one of said pair of members and each of which has a detent and an indent means,

said latch devices occupying an interlocked position where there is an interfitting of indent and detent means in respective latch devices, and in this position being constructed and arranged so that one of the latch devices is restrained from pivotal movement in one direction,

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means on said other of said pair of members engaged by the latch devices with the latch devices in such interlocked position and preventing relative movement of the pair of members by reason of being held by the latch device which is so restrained from pivotal movement, 5

means on said third member shiftable with movement of the third member into engagement with said latch devices and on such engagement causing repositioning of the latch devices whereby the latch device which formerly was restrained from pivotal movement in one direction becomes free to pivot in said one direction, and in so doing frees the pair of members for relative movement, 10

said means on the other of said pair of members with such freeing of the pair of members and on their relative movement producing another repositioning of the latch devices whereby there is interfitting of indent and detent means in respective latch devices, the latch devices after so being repositioned being constructed and arranged so that the other latch device then becomes restrained from pivotal movement in one direction. 20

11. For a lift truck having an extensible mast assembly including three parts, each movable relative to each of the other two parts, in paths that substantially parallel each other, releasable latch mechanism controlling relative movement of the parts comprising 25

latch means comprising a pair of latch devices mounted on one of said parts, 30

said latch devices having two interlocked positions and an unlocked position, and in one of said inter-

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locked positions holding a combination of two of the parts from movement relative to each other, means movable in a path paralleling the paths of relative movement of the parts, operable only after a predetermined amount of movement of the third part relative to the other two parts, and mounted on the third part operable to shift said latch devices from said one interlocked position to their said unlocked position where said combination of two parts are released from each other, and

means on one of said combination of two parts made operable after the latch devices are placed in their unlocked position, for shifting the latch devices from said unlocked to the other of said interlocked positions where a combination of two parts different from the first-mentioned combination of parts is held from relative movement and the remaining part is free to move, said means operating on relative movement of said remaining part.

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