June 15, 1965 G. F. QUAYLE 3,189,205

STACKING MECHANISM

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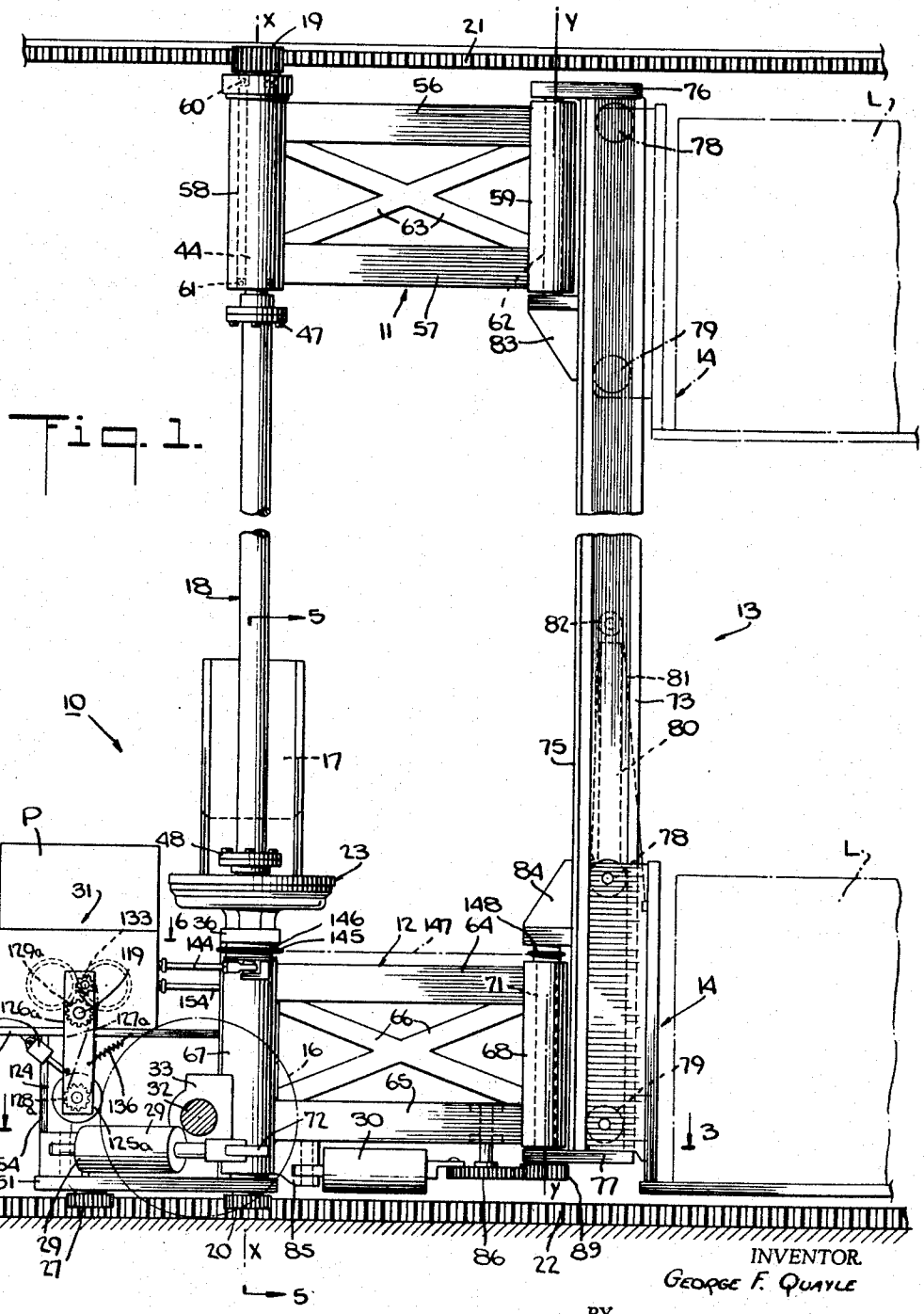


Fig. 1.

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STACKING MECHANISM

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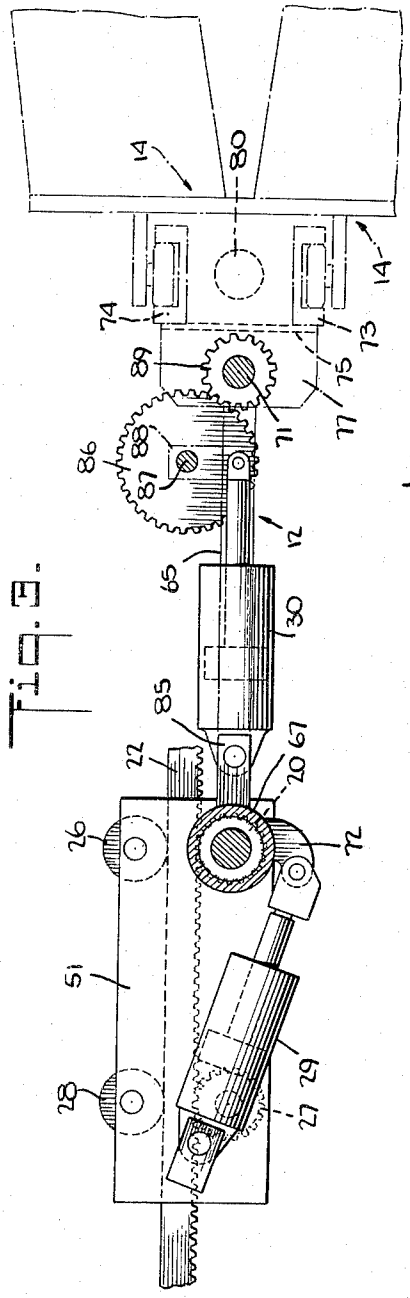


Fig. 1.

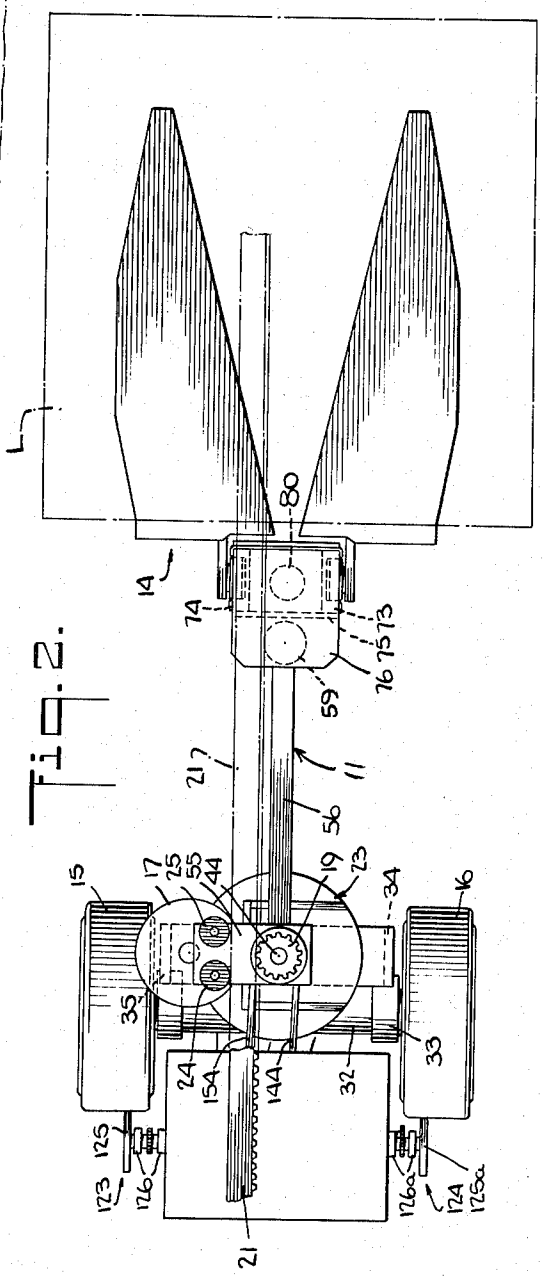


Fig. 2.

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STACKING MECHANISM

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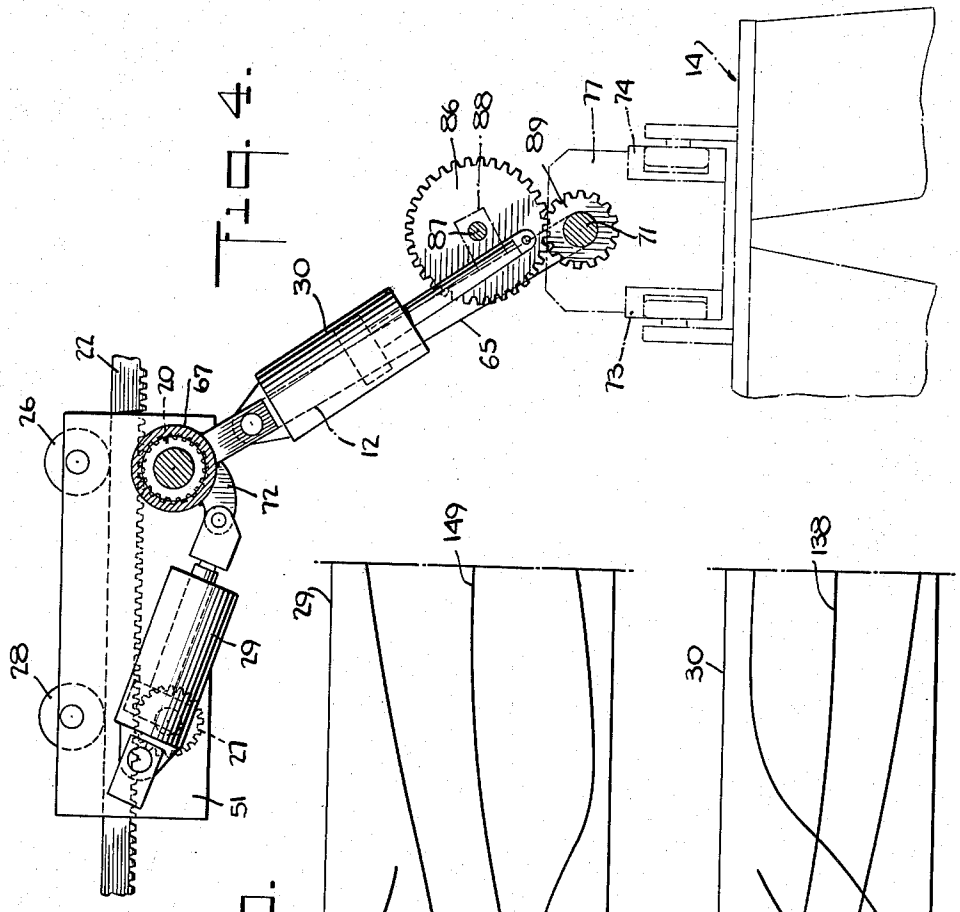


Fig. 4.

Fig. 10.

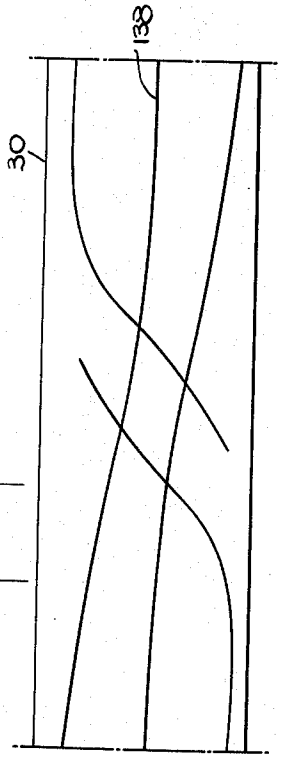


Fig. 9.

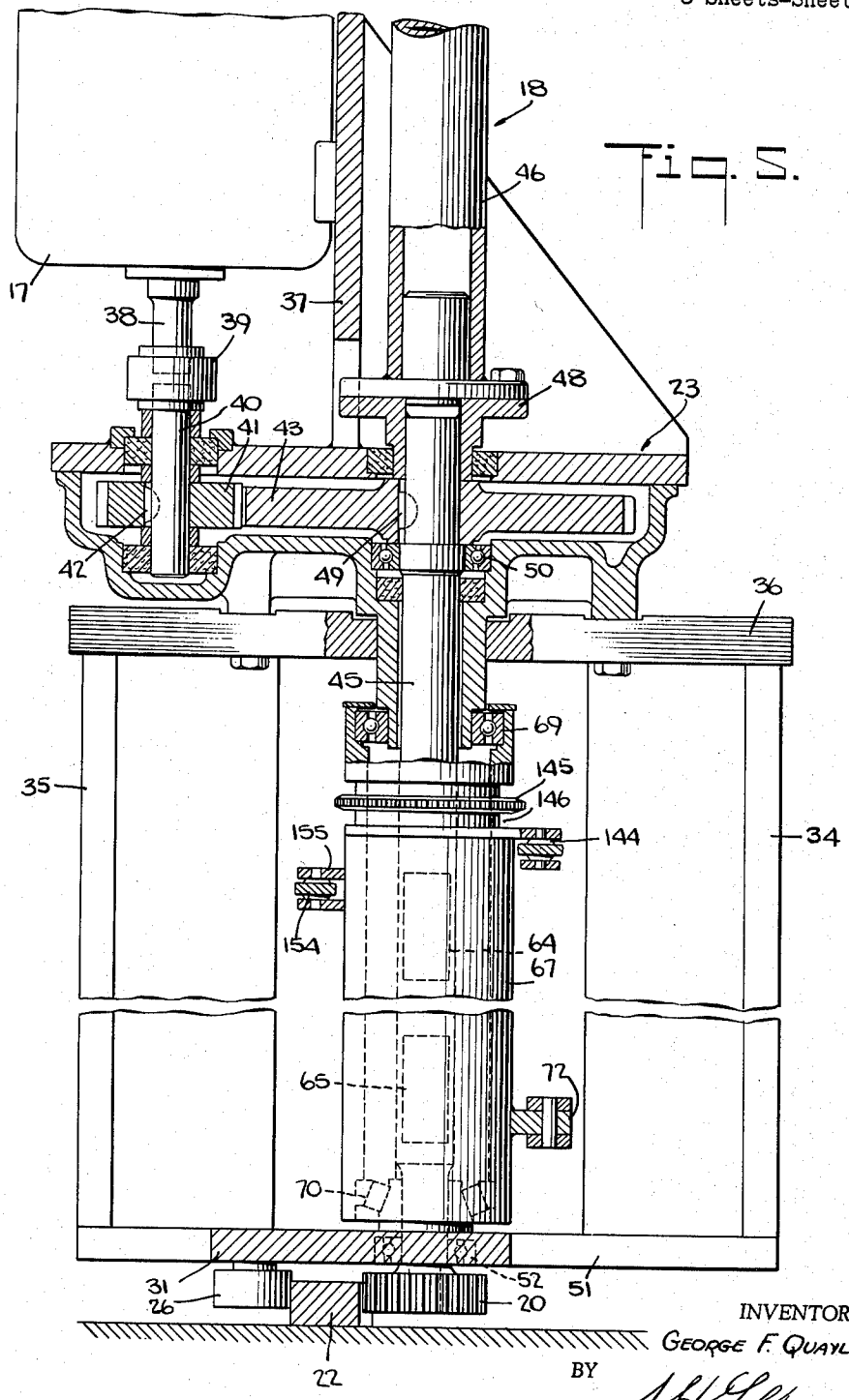
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STACKING MECHANISM

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Fig. 5.



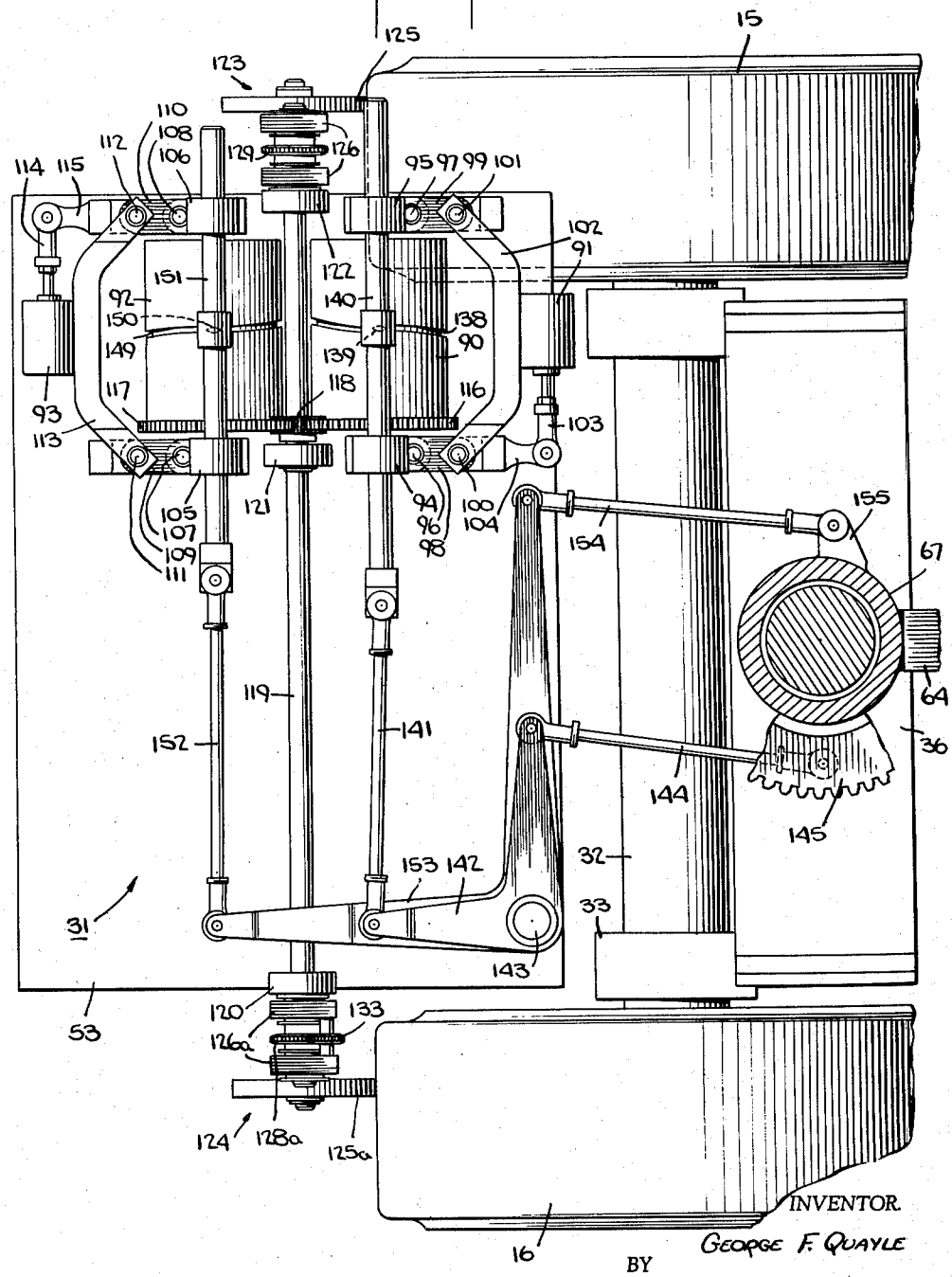
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STACKING MECHANISM

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Fig. 6.



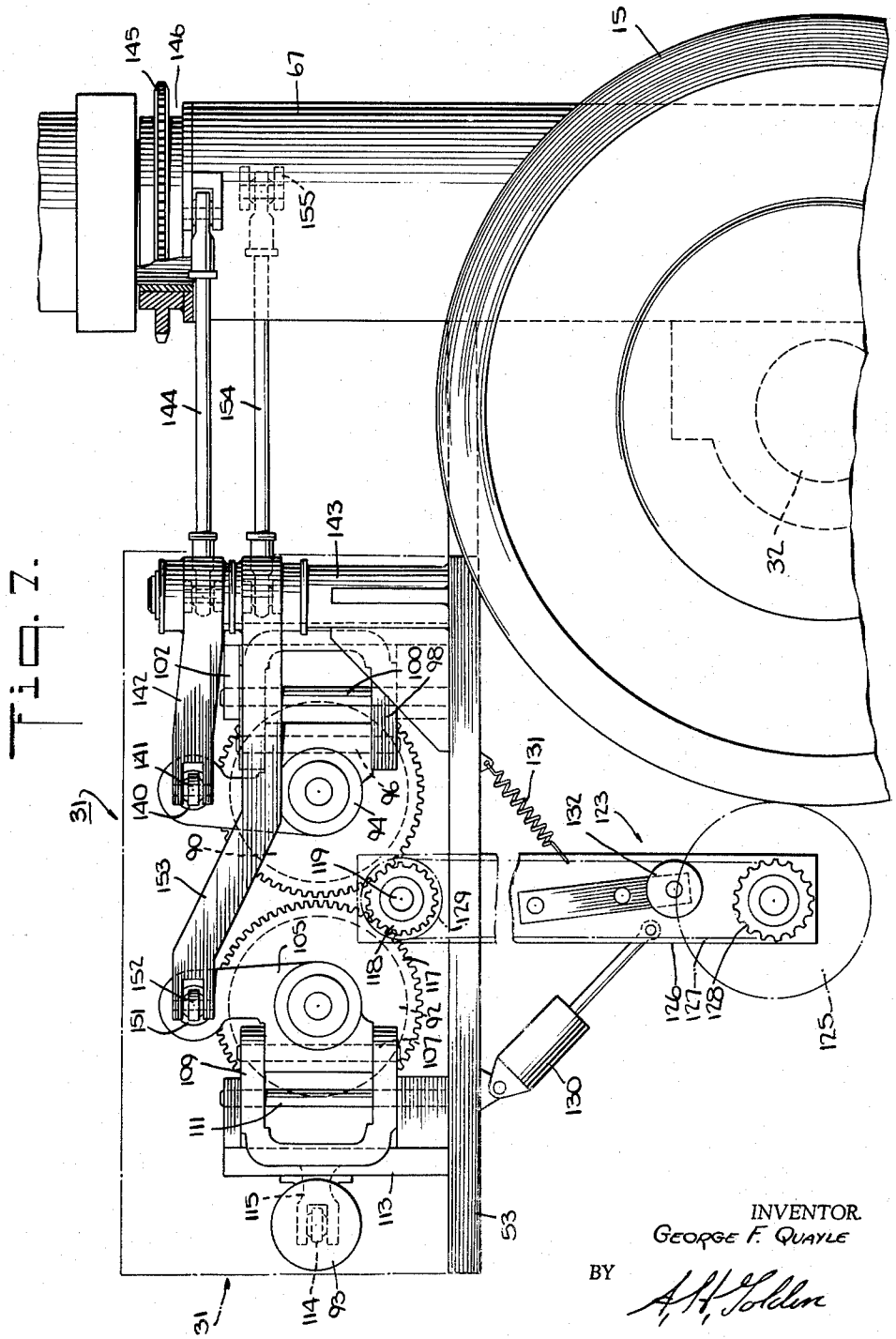
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Fig. 7.



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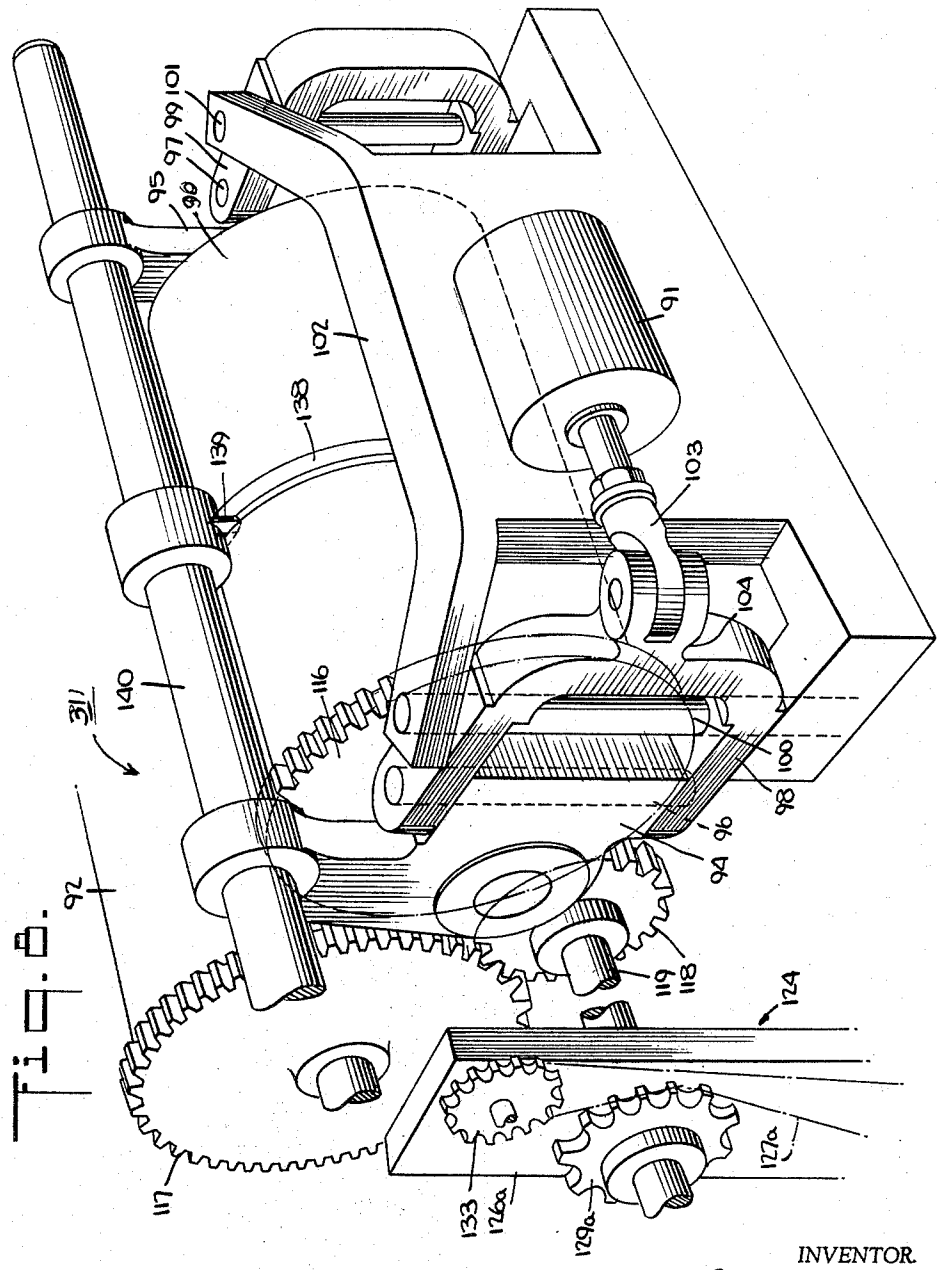


Fig. 8.

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STACKING MECHANISM

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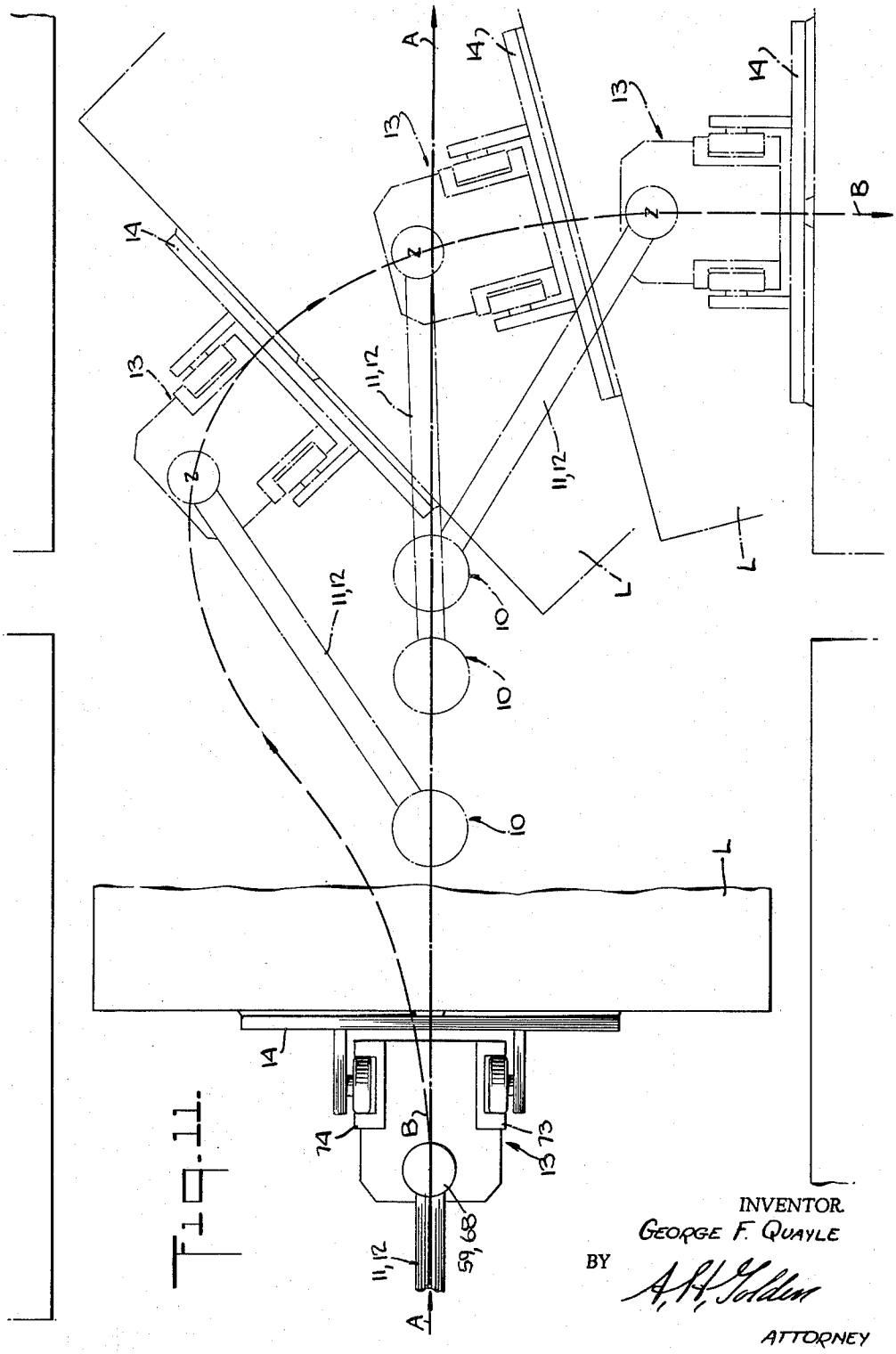


FIG. 11.

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United States Patent Office 3,189,205 Patented June 15, 1965

3,189,205

STACKING MECHANISM

George F. Quayle, Philadelphia, Pa., assignor, by mesne assignments, to Yale & Towne, Inc., New York, N.Y., a company of Ohio

Filed Nov. 8, 1962, Ser. No. 236,263
8 Claims. (Cl. 214—670)

This invention relates to a stacking mechanism for transporting and stacking loads.

The purpose of the invention is to provide a mechanism of this type which is capable of transporting a load along an aisle only slightly wider than the load and rotating said load horizontally, while inserting the load into a storage space at the side of the aisle which is also only slightly wider than the load. Thus, by the use of the invention, aisle space in storage facilities, such as warehouses, may be kept to a minimum, allowing more efficient utilization of available space for storage. The invention is also particularly suitable for automatic operation whereby loads may be transported, stacked, or removed from a stack through remote controls or automatic programming systems.

To this end, the stacking mechanism of the invention includes a traveling support, with means for moving the traveling support along a predetermined linear path along the aisle. A support arm is pivotally mounted at one end on said traveling support for horizontal pivotal movement relatively to the traveling support, and means are provided for pivoting the support arm relatively to the traveling support. A load supporting and lifting structure in turn is pivotally mounted for horizontal pivotal movement on the other end of the support arm, and means are provided for pivoting the load supporting and lifting mechanism relatively to the support arm. Control means are provided for effecting combined, correlated pivotal movement of the load supporting structure relatively to the support arm, pivotal movement of the support arm relatively to the traveling support and linear movement of the traveling support along the aisle.

When transporting of a load along the aisle, the support arm and the load supporting and lifting mechanism are held aligned with the aisle, with the load transported through movement of the traveling support along the aisle. In a preferred form of the invention, the traveling support moves along the aisle with the load supporting and lifting structure trailing behind the traveling support. When an appropriate sensing system indicates that the stacking mechanism has passed an empty storage space at the side of the aisle, the direction of linear movement of the traveling support is automatically reversed and the control means actuated to effect combined, correlated pivotal movement of the load supporting structure relatively to the support arm, pivotal movement of the arm relatively to the traveling support and linear movement of the traveling support longitudinally along the aisle to rotate the load supported on the load supporting structure 90° while extending the load through the combined pivotal movement into the storage space at the side of the aisle. Thus, the load is rotated and stacked from an aisle which is only slightly wider than the load.

The invention and its advantages having been broadly described, a detailed description of a specific embodiment of the invention is given hereafter by reference to the accompanying drawings wherein:

FIG. 1 is a side elevational view of a stacking mechanism constructed in accordance with the invention, showing in solid lines the position of the load carriage in the lowered position and in broken lines the position of the load carriage in the elevated position;

FIG. 2 is a top plan view of the stacking mechanism in FIG. 1;

FIG. 3 is a sectional view taken on the line 3—3 of FIG. 1;

FIG. 4 is a sectional view similar to that of FIG. 3, but showing the supporting arms and load supporting and lifting structure rotated to insert a load into a storage space at one side of an aisle;

FIG. 5 is a sectional view taken on the line 5—5 of FIG. 1;

FIG. 6 is a sectional view taken on the line 6—6 of FIG. 1;

FIG. 7 is a sectional view taken on the line 7—7 of FIG. 6;

FIG. 8 is a perspective view of a portion of the control mechanism for controlling the combined linear and pivotal movement of the parts of the load lifting mechanism;

FIG. 9 and FIG. 10 are developments of the cams of the control mecahnism; and

FIG. 11 is a sequence diagram showing the path of movement of the elements of the load lifting mechanism in inserting a load into a storage space at one side of an aisle.

Referring to the drawings and in particular to FIG. 1, the stacking mechanism of the invention includes a traveling support, generally designated by the reference numeral 10, which is adapted to move longitudinally along an aisle. Upper and lower supporting arm structures 11 and 12 are mounted at one end on the traveling support 10 for horizontal pivotal movement relatively to the traveling support about a vertical axis X—X, and a load lifting mechanism, generally designated by the reference numeral 13 is mounted on the outer ends of the arm structures 11 and 12 for horizontal pivotal movement about a vertical axis Z—Z. The load lifting mechanism 13 includes a vertically movable load carriage 14.

A load L supported on the load carriage 14 is adapted to be moved along an aisle to a storage space at the side of the aisle by movement of the traveling support 10 longitudinally along the aisle, while the arm structures 11 and 12 and the load lifting mechanism 13 are held aligned with the aisle. When the stacking mechanism reaches a proper position relatively to a storage space at the side of the aisle, the load supported on the load carriage 14 is rotated and simultaneously inserted into the storage space through combined, correlated pivotal movement of the load lifting mechanism 13 relatively to the outer ends of the supporting arm structures 11 and 12, pivotal movement of the arm structures 11 and 12 relatively to the traveling support 10 and longitudinal linear movement of the traveling support 10 along the aisle.

This combined pivotal and linear movement of the load supporting structure 13, the supporting arm structures 11 and 12 and the traveling support 10 is illustrated in the sequence diagram of FIG. 11, wherein a load L, supported on the load carriage 14, is shown being rotated and simultaneously inserted into a storage space at one side of the aisle. In FIG. 11, the straightline A—A indicates the path of movement of the traveling support 10 along the aisle, while the curved line B—B indicates the path of movement of the pivot axis Z—Z between the load lifting structure 13 and the supporting arm structures 11 and 12. Three different pivotal positions of the supporting arm structures 11 and 12 are shown in the diagram.

Referring to FIGS. 1, 2 and 5, the traveling support 10 is supported for movement along the aisle by lower ground engaging wheels 15 and 16, and is moved along the aisle through an electric motor 17 which rotates a vertically extending drive shaft 18 having pinions 19 and 20 secured to the upper and lower ends thereof which mesh respectively with an overhead rack 21 and a floor

mounted rack 22 which extend longitudinally along the aisle. Thus operation of the electric motor 17 serves to move the traveling support 10 longitudinally along the aisle through rotation of the pinions 19 and 20 in driving engagement with the stationary racks 21 and 22. The provision of the two pinions 19 and 20, one at the top and one at the bottom, connected together through the common drive shaft 18, holds the traveling support 10 vertical and prevents tipping of the stacking mechanism in the direction of movement of the traveling support 10 due to the load supported on the load carriage 14. If desired, stationary roller chains may be used in place of the racks 21 and 22, and chain sprockets used in place of the pinions 19 and 20. A gear type speed reducer 23 is provided between the electric drive motor 17 and the shaft 18, so that the shaft 18 is rotated at a reduced speed.

As best shown in FIG. 2, the upper pinion 19 is held engaged with the overhead rack 21 by rollers 24 and 25, which are disposed on and engage the opposite side of the rack 21 from the pinion 19, and, as best shown in FIGS. 3 and 4, the lower pinion 20 is held engaged with the floor mounted rack 22 by a roller 26 which is disposed on and engages the opposite side of the rack 22. The traveling support 10 is held in alignment with the aisle through a pinion 27, which also engages the lower rack 22 and is spaced from the pinion 20. The pinion 27 is held engaged with the lower rack 22 by a roller 28, which is disposed on and engages the opposite side of the rack 22. The pinion 27 is merely an idler pinion and serves no driving function.

The supporting arm structures 11 and 12 are adapted to be pivoted relatively to the traveling support 10, in either direction from a centered position, by a hydraulic ram 29 which, as best shown in FIGS. 1, 3 and 4, is attached at one end to the lower arm structure 12 and attached at the other end to the traveling support 10. The load lifting mechanism 13 is adapted to be pivoted relatively to the supporting arm structures 11 and 12, in either direction from a centered position, by a hydraulic ram 30 which is connected at one end to the lower arm structure 12 and operatively connected at the other end to the load lifting mechanism 13.

Thus, the load lifting mechanism may be pivoted relatively to the supporting arm structures 11 and 12, in either direction, through operation of the ram 30; the arm structures 11 and 12 may be pivoted relatively to the traveling support 10, in either direction, by operation of the ram 29; and the traveling support 10 may be moved longitudinally along the aisle through operation of the electric drive motor 17. When inserting or removing a load from a storage space at the side of the aisle, the operation of the rams 29 and 30 is correlated with the linear movement of the traveling support 10 along the aisle through a control mechanism generally designated at 31.

The main elements of the stacking mechanism of the invention and their function having been broadly described, a more detailed description of each element is given hereafter.

Traveling support

Referring to FIGS. 1 and 2, the supporting wheels 15 and 16 of the traveling support 10 are secured to opposite ends of an axle 32, which in turn is carried by an axle housing 33. The axle housing 33 is secured at opposite ends to laterally spaced, vertically extending frame plates 34 and 35, as shown in FIG. 2. If desired, the axle housing 33 may be mounted for transverse rocking or articulating movement so that the wheels may adjust to any unevenness in the floor.

As best shown in FIG. 5, an upper horizontal frame plate 36 is secured to and supported on the upper ends of the vertical frame plates 34 and 35, and the speed reducer 23 is secured to the upper surface of the horizontal frame plate 36. The electric drive motor 17 is supported on a vertically extending bracket 37, which is secured to the upper surface of the speed reducer 23, and the shaft 38 of the electric drive motor 17 is secured by means of a suitable coupling 39 to a stub shaft 40 which is keyed to a pinion 41 of the speed reducer 23 by a key 42. The pinion 41 in turn meshes with a reduction gear 43 of the speed reducer 23.

As shown in FIG. 1, the vertically extending drive shaft 18 is conveniently formed in three sections, including an upper solid shaft section 44, a lower solid shaft section 45, best shown in FIG. 5, and an intermediate tubular shaft section 46, which is secured at its upper and lower ends to the solid shaft sections 44 and 45 through suitable couplings 47 and 48. The overall length of the drive shaft 18 may be easily changed by substitution of an intermediate section 46 of different length.

As best shown in FIG. 5, the lower solid shaft section 45 extends through the speed reducer 23 and the upper horizontal frame plate 36, and is keyed to the reduction gear 43 by means of a key 49, so that operation of the drive motor 17 serves to rotate the shaft 18 at a reduced speed through the pinion 41 and the reduction gear 43 of the speed reducer 23. The solid shaft section 45 of the drive shaft 18 is supported for rotation in the speed reducer 23 by a suitable antifriction bearing 50.

The lower end of the solid shaft section 45 extends through a lower horizontal frame plate 51, which is secured to the lower ends of the vertical frame plates 34 and 35, and is supported for rotation through a suitable anti-friction bearing 52. The roller 26, which holds the lower pinion 20 in engagement with the floor mounted rack 22, and the idler pinion 27 and roller 28, which hold the traveling support aligned with the aisle, are also supported for rotation on the lower horizontal frame plate 51, as shown in FIGS. 3 and 4.

As shown in FIG. 1, the control mechanism 31 is conveniently supported on a horizontal plate 53 which is secured at one end to the vertical plates 34 and 35 and is supported at the other end by a vertical plate 54 which is secured to and extends upwardly from the lower horizontal frame plate 51. A suitable source of fluid pressure, for operating the various hydraulic rams, such as an electric motor driven pump, generally indicated at P, is conveniently mounted on the plate 53 above the control 31. Electric power for operating the electric drive motor 17 and the electric motor driven pump P may be supplied from a stationary power source, through overhead trolley wires and a trolley, not shown, or by batteries, also not shown, which may be conveniently mounted on the traveling support 10 adjacent the pump P.

As shown in FIG. 2, the rollers 24 and 25 which hold the upper pinion 19 in engagement with the overhead rack 21 are mounted for rotation on a plate 55, which in turn is rotatably mounted on the upper end of the upper solid shaft section 44 of the drive shaft 18.

Supporting arm structures

Referring to FIG. 1, the upper supporting arm structure 11 includes upper and lower horizontally extending, vertically spaced plates or bars 56 and 57, which are secured at opposite ends to elongated, vertically extending sleeves 58 and 59. The sleeve 58 is rotatably mounted on the upper solid shaft section 44 of the drive shaft 18 through upper and lower anti-friction bearings 60 and 61. A vertically extending pivot shaft 62, which is secured to the upper end of the load lifting mechanism 13, is journalled in the sleeve 59, whereby the load lifting mechanism 13 is pivotally supported on the outer end of the upper supporting arm structure 11. The plates or bars 56 and 57 are reinforced by diagonally extending brace members 63.

The lower supporting arm structure 12 is similarly formed of upper and lower horizontally extending, vertically spaced plates or bars 64 and 65, which are reinforced

by brace members 66, and which are secured at opposite ends to vertically extending sleeves 67 and 68. As best shown in FIG. 5, the sleeve 67 surrounds the lower solid shaft section 45 of the drive shaft 18 and is supported for rotation by upper and lower anti-friction bearings 69 and 70, carried, respectively by a lower vertical extension of the speed reducer 23 and the lower horizontal frame plate 51. Referring again to FIG. 1, a vertically extending pivot shaft 71, which is secured to the lower end of the load lifting mechanism 13, is suitably journalled in the sleeve 68, whereby the load lifting mechanism 13 is pivotally supported on the outer end of the lower supporting arm structure 12.

The ram for pivoting the upper and lower supporting arm structures 11 and 12 relatively to the traveling support 10 is pivotally attached at one end to the lower frame plate 51 of the traveling support 10 and is pivotally attached at the other end to the outer end of a lever arm 72 which, as best shown in FIGS. 3 and 4, extends from and is rigidly secured to the sleeve 67. Operation of the hydraulic ram 29 therefore serves to pivot the supporting arm structures 11 and 12 relatively to the traveling support 10.

Load lifting mechanism

Referring to FIGS. 1, 2 and 3, the load lifting mechanism 13 includes vertically extending, outwardly facing, channel-shaped uprights 73 and 74 which are secured together in spaced relation by a vertically extending back plate 75 and by horizontal bracket plates 76 and 77 provided at the top and bottom of the uprights. The load carriage 14 is supported for vertical movement on the uprights 73 and 74 through rollers 78 and 79 which extend into the channels of the uprights, and the load carriage 14 is adapted to be elevated on the uprights 73 and 74 through a lift ram 80. The lift ram 80 is mounted between the uprights and is connected to the load carriage 14 through lift chains 81 which are secured at one end to the load carriage 14, extend over sheaves 82 carried by the upper end of the ram 80, and are anchored at the other end to the ram cylinder or the uprights, so that the load carriage 14 is elevated at twice the speed of the ram when the ram 80 is extended.

The upper pivot shaft 62, through which the load lifting mechanism 13 is supported for pivotal movement on the outer end of the upper arm structure 11, is rigidly secured at one end to the upper bracket plate 76 and is rigidly secured at the other end to a bracket 83, which is secured to and extends from the back plate 75.

The lower pivot shaft 71, through which the load lifting mechanism 13 is supported for pivotal movement on the outer end of the lower arm structure 12, is rigidly secured at the upper end to a bracket 84, which is secured to the back plate 75, and is rigidly secured to and extends through the lower horizontal bracket plate 77.

As best shown in FIGS. 1, 3 and 4, the hydraulic ram 30, which serves to pivot the load lifting mechanism 13 relatively to the supporting arm structures 11 and 12, is pivotally secured at one end to a bracket 85, which is attached to the sleeve 67 and the lower side of the bar 65. The opposite end of the ram 30 is pivotally secured to a gear 86. Gear 86 is mounted for rotation by means of a shaft 87 in a bearing 88, which in turn is secured to the side of the lower plate or bar 65. Gear 86 meshes with a pinion 89, which is secured to the lower portion of the pivot shaft 71 which extends through the bracket 77. Operation of the ram 30, therefore, serves to rotate the gear 86 which in turn rotates the pinion 89 to pivot the load lifting mechanism 13 relatively to the supporting arm structures 11 and 12, as shown in FIG. 4.

Control mechanism

Referring to FIGS. 6, 7 and 8, the control mechanism 31 includes a first drum cam 90 for actuating a valve 91 for controlling operation of the ram 30 which pivots the load lifting mechanism 13 relatively to the supporting arm structures 11 and 12, and a second drum cam 92 for actuating a valve 93 for controlling the operation of the ram 29 which pivots the supporting arm structures 11 and 12 relatively to the traveling support 10.

The drum cam 90 is supported for rotation at each end by bearing members 94 and 95. Bearing members 94 and 95 in turn are pivotally secured through vertical pivots 96 and 97 to parallel links 98 and 99, and the parallel links 98 and 99 are pivotally connected through vertical pivots 100 and 101 to opposite ends of a stationary link or supporting bracket 102, which is secured to the supporting plate 53. The links 98 and 99, therefore, form a parallel linkage system which supports the drum cam 90 for slight lateral movement. The valve 91 for controlling flow of fluid under pressure from the fluid pressure source P to the ram 30 is secured to the back of the bracket 102 and is connected through a link 103 to an extension 104, of the link 98, so that the valve 91 is actuated to admit fluid under pressure to the ram 30 through lateral movement of the drum cam 90.

The drum cam 92 is similarly mounted for slight lateral movement through bearing members 105 and 106 which are pivotally secured through vertical pivots 107 and 108 to the ends of parallel links 109 and 110. Parallel links 109 and 110 are pivotally secured through vertical pivots 111 and 112 to opposite ends of a stationary link or bracket member 113, which is secured to the supporting plate 53. The valve 93 for controlling flow of fluid under pressure from the fluid pressure source P to the ram 29 is secured to the back of the link or bracket member 113 and is connected through a link 114 to an extension 115 of the link 110, so that the valve 93 is actuated to admit fluid under pressure through lateral movement of the drum cam 92.

A gear 116 is secured to the end of the drum cam 90 and a gear 117 is secured to the end of the drum cam 92. A pinion 118 meshes with both the gears 116 and 117 so that cams 90 and 92 are rotated simultaneously in the same directions by rotation of the pinion 118. The pinion 118 is secured to a transversely extending shaft 119 which is supported for rotation in suitable spaced bearings 120, 121 and 122 which are secured to the supporting plate 53.

The shaft 119 is adapted to be rotated in one direction, or the other, from either wheel 15 or wheel 16 through selective engagement of either a friction drive 123, shown in FIGS. 2, 6 and 7, at one end of the shaft 119 with the wheel 15, or engagement of a friction drive 124, shown in FIGS. 1, 2, 6 and 8, at the other end of the shaft 119 with the wheel 16, depending upon whether a load is to be inserted into a storage space on one side or the other of the aisle. It will be appreciated that by driving the cams 90 and 92 from the wheels 15 and 16, the rotation of the cams 90 and 92 is correlated with the linear movement of the traveling support 10 along the aisle.

As best shown in FIGS. 6 and 7, the friction drive 123 includes a friction wheel 125 which is rotatably mounted on the outer end of a pair of lever arms 126 and is adapted to engage the outer periphery of the wheel 15. The lever arms 126 are pivotally mounted on the end of the shaft 119, and a chain 127 interconnects a sprocket 128 which is rotatably mounted on the end of the arms and is secured to the friction wheel 125, and a sprocket 129 which is secured to the end of the shaft 119. The friction wheel 125 is normally held out of engagement with the wheel 15 by ram 130, which is pivotally connected at one end to the plate 53 and at the other end to the levers 126. When fluid pressure on the ram 130 is released, a spring 131, connected between the lever 126 and the plate 53, pivots the levers 126 to press the friction wheel 125 against the periphery of the wheel 15 to provide a driving connection between the wheel 15 and the shaft 119. An idler sprocket 132 carried by the levers 126 may be adjusted to take up slack in the chain 127.

As best shown in FIGS. 1 and 8, the friction drive 124, at the opposite end of the shaft 119, is similar to the friction drive 123 and includes lever arms 126*a* pivotally mounted on the end of the shaft 119, a sprocket 128*a*, which is rotatably mounted on the end of the arms 126*a* and is secured to a friction wheel 125*a*, a sprocket 129*a* which is secured to the shaft 119, and a chain 127*a*. The friction drive 124 differs from the friction drive 123 in that it includes a reversing sprocket 133 which is mounted on the arms 126*a*. The chain 127*a* extends around the sprocket 128*a* and the reversing sprocket 133, and is held in mesh with the sprocket 129*a* by the sprocket 133. Engagement of the friction wheel 125*a* with the wheel 16, as shown in FIG. 1, therefore, serves to rotate the shaft 119 in the opposite direction from that in which it is rotated by engagement of the friction drive 123. A ram 135 normally holds the friction wheel 125*a* out of engagement with the wheel 16, while a spring 136 presses the friction wheel 125*a* into engagement with the wheel 16 when the fluid pressure on the ram 135 is released.

Referring to FIG. 6, the drum cam 90 has a cam groove 138 in the outer surface thereof which is engaged by a cam follower 139. A development of the cam groove 138 is shown in FIG. 9. The cam follower 139 is secured to a rod 140 which is mounted for axial sliding movement in the bearing members 94 and 95, which also support the drum cam 90. As the drum cam 90 is rotated, it is shifted laterally by the cam follower 139, due to the curvature of the cam groove 138, thereby actuating valve 91 to effect pivotal movement of the load lifting mechanism 13 by the ram 30.

The rod 140 forms a part of a follow-up mechanism through which pivotal movement of the load lifting mechanism relatively to the supporting arm structures 11 and 12 is transmitted back to the cam follower 139 and drum cam 90 to shift the drum cam 90 in a direction to correct the position of the valve 91 as necessary to assure precise correlation between the pivotal movement of the load lifting mechanism 13 by the ram 30 and the linear movement of the traveling support 10 along the aisle.

As best shown in FIG. 6, this follow-up mechanism for the drum cam 90 includes a link 141, which is pivotally secured at one end to the rod 140 and is pivotally secured at the opposite end to the outer end of one arm of a bellcrank lever 142. The bellcrank lever 142 is pivotally mounted on a vertical pivot 143 which is secured to the supporting plate 53.

A second link 144 is pivotally connected to the outer end of the other arm of the bellcrank lever 142, and is pivotally connected at the opposite end to a sprocket 145. As best shown in FIGS. 1, 5 and 7, the sprocket 145 is mounted for free rotation on a reduced portion 146 of the sleeve 67 which surrounds the lower solid shaft section 45 of the drive shaft 18. A chain 147, best shown in FIG. 1, interconnects the sprocket 145 and a sprocket 148 which is secured to the vertical pivot shaft 71 of the load lifting mechanism 13.

Thus, pivotal movement of the load lifting mechanism 13 relatively to the arm structures 11 and 12 by the ram 30 is transmitted back through the sprocket 148, the chain 147, the sprocket 145, the link 144, the bellcrank lever 142, the link 141, and the rod 140 to the cam follower 139, to shift the drum cam 90 in a lateral direction to correct the position of the valve 91 as necessary to provide precise correlation between pivotal movement of the load lifting mechanism 13 by the ram 30 and the linear movement of the traveling support 10 along the aisle.

Referring to FIG. 6, the drum cam 92 has a cam groove 149 in the outer surface thereof which is engaged by a cam follower 150. A development of the cam groove 149 is shown in FIG. 10. The cam follower 150 is secured to a rod 151 which is mounted for axial sliding movement in the bearing members 105, 106. As the drum cam 92 is rotated, it is shifted laterally by the cam follower 150 due to the curvature of the cam groove 149, thereby actuating the valve 93 to effect pivotal movement of the supporting arm structures 11 and 12 relatively to the traveling support 10 by the ram 29.

The rod 151 forms a part of a follow-up mechanism which serves to shift the drum cam 92 laterally in a direction to correct the position of the valve 93 as necessary to assure precise correlation between the pivotal movement of the supporting arm structures 11 and 12 by the ram 29 with the linear movement of the traveling support along the aisle.

As best shown in FIG. 6, this follow-up mechanism for the drum cam 92 includes a link 152 which is pivotally attached at one end to the end of the rod 151 and is pivotally attached at the other end to the outer end of one arm of a bellcrank lever 153. The bellcrank lever 153 is pivotally mounted on the vertical pivot 143. A link 154 is pivotally secured at one end to the outer end of the other arm of the bellcrank lever 153, and is pivotally connected at the opposite end to the outer end of an arm 155. The arm 155 is rigidly secured to the lower sleeve 67 through which the lower arm structure 12 is supported for pivotal movement relatively to the traveling support 10.

Thus, pivotal movement of the supporting arm structures 11 and 12 relatively to the traveling support 10 is transmitted back through the arm 155, the link 154, the bellcrank lever 153, the link 152, and the rod 151 to the cam follower 150, to shift the drum cam 92 in a direction to correct the position of the valve 93 as necessary to provide a precise correlation between the pivotal movement of the arms 11 and 12 by the ram 29 relatively to the traveling support 10, and the linear movement of the traveling support 10 along the aisle.

Operation

Assuming that it is desired to move a load which is supported on the load carriage 14, down an aisle and to deposit the load in a storage space at one side of the aisle, the electric drive motor 17 is first operated to rotate the vertical drive shaft 18 whereby the stacking mechanism is moved longitudinally down the aisle through the rotation of the pinions 19 and 20 in engagement with the upper and lower racks 21 and 22. In the preferred form of the invention, the traveling support 10 moves along the aisle with the arm structures 11 and 12, and the load lifting mechanism 13 trailing behind the traveling support 10. At this time, the rams 130 and 135 of the friction drives 123 and 124 are both actuated to hold the drives out of frictional engagement with the wheels 15 and 16, and the supporting arm structures 11 and 12 and the load lifting mechanism 13 are held aligned with the aisle by the rams 29 and 30.

Assuming that the stacking mechanism is under the control of an automatic programming system, and the load has been elevated to proper elevation by operation of the lift ram 80, the stacking mechanism passes by the storage space in which the load is to be deposited in accordance with the predetermined program. As the stacking mechanism passes the particular storage space, a suitable sensing system senses whether the storage space is in fact empty. If the storage space is empty, the direction of linear movement of the traveling support is automatically reversed by reversing the direction of operation of the electric drive motor 17 and fluid pressure on either the ram 130 or 135 of friction drive 123 or 124 is released, by operation of a suitable valve (not shown) depending on which side of the aisle the load is to be deposited, whereby the spring 131 or 136 of the friction drive moves the friction wheel into driving engagement with the supporting wheels 15 or 16. The reversing of the drive motor 17 and the releasing of the fluid pressure on either ram 130 or 135 can, of course, be performed manually. Thereafter, on longitudinal movement of the traveling support 10 in the reverse direction, the drum cams 90 and 92 are

rotated simultaneously in the same directions through rotation of the shaft 119 and the pinion 118.

This rotation of the drum cams 90 and 92, in cooperation with the cam followers 139 and 150 and the follow-up mechanism of the drum cams 90 and 92, results in a lateral shifting of the drum cams 90 and 92 and actuation of the valves 91 and 93 to effect a precise operation of the rams 29 and 30 which is correlated with the linear movement of the traveling support 10 along the aisle. The arm structures 11 and 12 are thereby pivoted relatively to the traveling support 10, the load lifting mechanism pivoted relatively to the supporting arm structures 11 and 12, while the traveling suport 10 is moved linearly down the aisle, so that the load supported on the load carriage 14 is rotated and simultaneously inserted into the storage space at the side of the aisle, as shown in the sequence diagram of FIG. 11.

Assuming that the load is supported on a pallet, the load carriage 14 is then lowered slightly to deposit the load on a storage rack through operation of the lift ram 80, and the load carriage 14 then withdrawn from the pallet through a reverse sequence of pivotal movement between the load lifting mechanism and the supporting arm structures 11 and 12, pivotal movement of the arm structures 11 and 12 relatively to the traveling support 10, and linear movement of the traveling support along the aisle, until the supporting arm structures 11 and 12 and load lifting mechanism 13 are again aligned with the aisle. The rams 130 and 135 are then both actuated to release the friction drives 123 and 124, and the stacking mechanism moved along the aisle through operation of the electric drive motor 17.

From the preceding description, it can be seen that there is provided a very novel stacking mechanism by which a load may be transported along an aisle which is only slightly wider than the load and then rotated and deposited in a storage space which is also only slightly wider than the load. Thus, by the use of the stacking mechanism of the invention, aisle space and storage facilities may be kept to a minimum, thereby allowing more efficient utilization of the available space for storage.

Because the stacking mechanism is held against tipping by the engagement of the driving elements of the traveling support with the floor mounted and overhead guide rails or racks, the stacking mechanism may be used to handle extremely heavy loads.

Further, the stacking mechanism may be operated through remote controls or automatic programming systems, or may be operated manually. In the latter case, a simple platform may be provided on the mechanism to accommodate the operator during operation of the stacking mechanism.

While one form of the invention has been shown and described, it will be appreciated that this is for the purpose of explanation, and that changes and modifications may be made therein without departing from the spirit and scope of the invention.

I now claim:

1. A load stacking mechanism comprising,
a traveling support,
upper and lower elongated stationary racks for guiding said traveling support along a predetermined path,
upper and lower pinions carried by said traveling support and meshing with said racks whereby to prevent tipping of said traveling support,
means on said traveling support directly connected with said pinions for simultaneously rotating said pinions to move said traveling support along said predetermined path,
a supporting arm structure pivotally mounted at one end on said traveling support for horizontal pivotal movement relatively to said traveling support,
means for pivoting said supporting arm structure relatively to said traveling support,

a load supporting and lifting mechanism pivotally mounted on the other end of said supporting arm structure,
means for pivoting said load supporting and lifting mechanism relatively to said supporting arm structure, and
control means including cam means cooperating with cam followers for effecting combined, correlated, pivotal movement of said supporting arm structure relatively to said traveling support, means for correlating rotation of said cam means and cam followers with linear movement of said traveling support along said predetermined path for effecting pivotal movement of said load supporting and lifting mechanism relatively to said supporting arm structure and linear movement of said traveling support to rotate said load supporting and lifting mechanism horizontally through an angle of substantially 90° while moving said load supporting and lifting mechanism transversely of said linear path, whereby a load supported on said load supporting and lifting mechanism is rotated and inserted into a storage space at the side of said path.

2. A load stacking mechanism comprising,
a traveling support,
means for moving said support along a predetermined linear path,
a supporting arm structure pivotally mounted at one end on said traveling support for horizontal pivotal movement relatively to said traveling support,
means for pivoting said supporting arm structure relatively to said traveling support,
a load supporting structure pivotally mounted on the other end of said supporting arm structure,
means for pivoting said load supporting structure relatively to said supporting arm structure, and
control means including a first rotatable cam for controlling said means for pivoting said load supporting structure relatively to said supporting arm structure, a second rotatable cam for controlling said means for pivoting said supporting arm structure relatively to said traveling support, and means for correlating rotation of said first and second rotatable cams with linear movement of said traveling support along said predetermined path to effect combined, correlated pivotal movement of said supporting arm structures relatively to said traveling support, pivotal movement of said load supporting structure relatively to said supporting arm structure and linear movement of said traveling support to rotate said load supporting structure horizontally through an angle of substantially 90° while moving said load supporting structure transversely of said linear path whereby a load supported on said load supporting structure is rotated and inserted into a storage space at the side of said path.

3. A load stacking mechanism comprising,
a traveling support,
means for moving said support along a predetermined linear path,
a supporting arm structure pivotally mounted at one end on said traveling support for horizontal pivotal movement relatively to said traveling support,
means for pivoting said supporting arm structure relatively to said traveling support,
a load supporting and lifting mechanism pivotally mounted on the other end of said supporting arm structure,
means for pivoting said load supporting and lifting mechanism relatively to said supporting arm structure, and
control means including a first rotatable cam for controlling said means for pivoting said load supporting and lifting mechanism relatively to said support

arm, a second rotatable cam for controlling said means for pivoting said supporting arm structure relatively to said traveling support, and means for correlating rotation of said first and second rotatable cams with linear movement of said traveling support along said predetermined path to effect combined, correlated pivotal movement of said supporting arm structure relatively to said traveling support, pivotal movement of said load supporting and lifting mechanism relatively to said supporting arm structure and linear movement of said traveling support to rotate said load supporting and lifting mechanism horizontally through an angle of substantially 90° while moving said load supporting and lifting mechanism transversely of said linear path whereby a load supported on said load supporting and lifting mechanism is rotated and inserted into a storage space at the side of said path.

4. A load stacking mechanism comprising,

a traveling support,

means for moving said support along a predetermined linear path,

a supporting arm structure pivotally mounted at one end on said traveling support for horizontal pivotal movement relatively to said traveling support,

fluid pressure operated means for pivoting said supporting arm structure relatively to said traveling support,

a load supporting and lifting mechanism pivotally mounted on the other end of said supporting arm structure,

fluid pressure operated means for pivoting said load supporting and lifting mechanism relatively to said supporting arm structure,

control means including a first rotatable cam for actuating a valve for controlling fluid pressure to said fluid pressure operated means for pivoting said supporting arm structure relatively to said traveling support, a second rotatable cam for actuating a valve for controlling fluid pressure to said fluid pressure actuated means for pivoting said load supporting and lifting mechanism relatively to said support arm, and

means for correlating rotation of said first and second cams with linear movement of said traveling support along said path whereby to effect combined, correlated operation of said first and second valves to cause pivotal movement of said supporting arm structure relatively to said traveling support, pivotal movement of said load supporting and lifting mechanism relatively to said supporting arm structure and linear movement of said traveling support to rotate said load supporting and lifting mechanism horizontally through an angle of substantially 90° while moving said load supporting and lifting mechanism transversely of said linear path, whereby a load supported on said load supporting and lifting mechanism is rotated and inserted into a storage space at the side of said path.

5. A load stacking mechanism comprising,

a traveling support,

means for moving said support along a predetermined linear path,

a supporting arm structure pivotally mounted at one end on said traveling support for horizontal pivotal movement relatively to said traveling support,

fluid pressure operated means for pivoting said supporting arm structure relatively to said traveling support,

a load supporting and lifting mechanism pivotally mounted on the other end of said supporting arm structure,

fluid pressure operated means for pivoting said load supporting and lifting mechanism relatively to said supporting arm structure,

control means including a first rotatable cam for actuating a first valve for controlling fluid pressure to said fluid pressure operated means for pivoting said supporting arm structure relatively to said traveling support, a second rotatable cam for actuating a second valve for controlling fluid pressure to said fluid pressure actuated means for pivoting said load supporting and lifting mechanism relatively to said supporting arm structure,

means for correlating rotation of said first and second cams with linear movement of said traveling support along said path whereby to effect combined, correlated operation of said first and second valves to cause pivotal movement of said supporting arm structure relatively to said traveling support, pivotal movement of said load supporting and lifting mechanism relatively to said supporting arm structure and linear movement of said traveling support to rotate said load supporting and lifting mechanism horizontally through an angle of substantially 90° while moving said load supporting and lifting mechanism transversely of said linear path, whereby a load supported on said load supporting and lifting mechanism is rotated and inserted into a storage space at the side of said path, and

a first follow-up mechanism operably connected with said supporting arm structure for correcting the position of said first valve as necessary to provide precise predetermined pivotal movement of said supporting arm structure relatively to said traveling support, and a second follow-up mechanism operably connected with said load supporting and lifting mechanism for correcting the position of said second valve as necessary to provide precise predetermined pivotal movement of said load supporting and lifting mechanism relatively to said supporting arm structure.

6. A load stacking mechanism comprising,

a traveling support,

upper and lower horizontal elongated stationary guide means for guiding said traveling support along a predetermined linear path,

driving means on said traveling support in driving engagement with said upper and lower guide means for moving said traveling support along said predetermined linear path,

a supporting arm structure pivotally mounted at one end on said traveling support for horizontal pivotal movement relatively to said traveling support,

means for pivoting said supporting arm structure relatively to said traveling support,

a load supporting and lifting mechanism pivotally mounted on the other end of said supporting arm structure,

means for pivoting said load supporting and lifting mechanism relatively to said support arm, and

control means including a first rotatable cam for controlling said means for pivoting said load supportnig and lifting mechanism relatively to said supporting arm structure, a second rotatable cam for controlling said means for pivoting said supporting arm structure relatively to said traveling support, and means for correlating rotation of said first and second rotatable cams with linear movement of said traveling support along said predetermined path to effect combined, correlated pivotal movement of said supporting arm structure relatively to said traveling support, pivotal movement of said load supporting and lifting mechanism relatively to said supporting arm structure and linear movement of said traveling support to rotate said load supporting and lifting mechanism horizontally through an angle of substantially 90° while moving said load supporting and lifting mechanism transversely of said linear path whereby a load supported on said load supporting and lifting mechanism is rotated and inserted into a storage space at the side of said path.

7. A load stacking mechanism comprising,
a traveling support,
upper and lower elongated stationary racks for guiding said traveling support along a predetermined path,
upper and lower pinions carried by said traveling support and meshing with said racks whereby to prevent tipping of said traveling support,
means for simultaneously rotating said pinions to move said traveling support along said predetermined path,
a supporting arm structure pivotally mounted at one end on said traveling support for horizontal pivotal movement relatively to said traveling support,
means for pivoting said supporting arm structure relatively to said traveling support,
a load supporting and lifting mechanism pivotally mounted on the other end of said supporting arm structure,
means for pivoting said load supporting and lifting mechanism relatively to said supporting arm structure, and
control means including a first rotatable cam for controlling said means for pivoting said load supporting and lifting mechanism relatively to said supporting arm structure, a second rotatable cam for controlling said means for pivoting said supporting arm structure relatively to said traveling support, and means for correlating rotation of said first and second rotatable cams with linear movement of said traveling support along said predetermined path to effect combined, correlated pivotal movement of said supporting arm structure relatively to said traveling support, pivotal movement of said load supporting and lifting mechanism relatively to said supporting arm structure and linear movement of said traveling support to rotate said load supporting and lifting mechanism horizontally through an angle of substantially 90° while moving said load supporting and lifting mechanism transversely of said linear path whereby a load supported on said load supporting and lifting mechanism is rotated and inserted into a storage space at the side of said path.

8. A load stacking mechanism comprising,
a traveling support,
means for moving said support along a predetermined linear path,
a supporting arm structure pivotally mounted at one end on said traveling support for horizontal pivotal movement relatively to said traveling support,
means for pivoting said supporting arm structure relatively to said traveling support,
a load supporting structure pivotally mounted on the other end of said supporting arm structure,

means for pivoting said load supporting structure relatively to said supporting arm structure,
a first control device operable to actuate said means for pivoting said supporting arm structure relatively to said traveling support,
a second control device operable to actuate said means for pivoting said load supporting structure relatively to said supporting arm structure,
control means for correlating operation of said first and second control devices with linear movement of said traveling support along said predetermined path to effect combined, correlated pivotal movement of said supporting arm structure relatively to said traveling support, pivotal movement of said load supporting structure relatively to said supporting arm structure and linear movement of said traveling support to rotate said supporting structure horizontally through an angle of substantially 90° while moving said load supporting structure transversely on said linear path whereby a load supported arm of said load supporting structure is rotated and inserted into a storage space at the side of said path,
a first follow-up mechanism operatively connected with said supporting arm structure for correcting the operation of said first control device as necessary to provide precise predetermined pivotal movement of said supporting arm structure relatively to said traveling support, and
a second follow-up mechanism operatively connected with said load supporting and lifting mechanism for correcting the operation of said second control device as necessary to provide precise predetermined pivotal movement of said load supporting and lifting mechanism relatively to said supporting arm structure.

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