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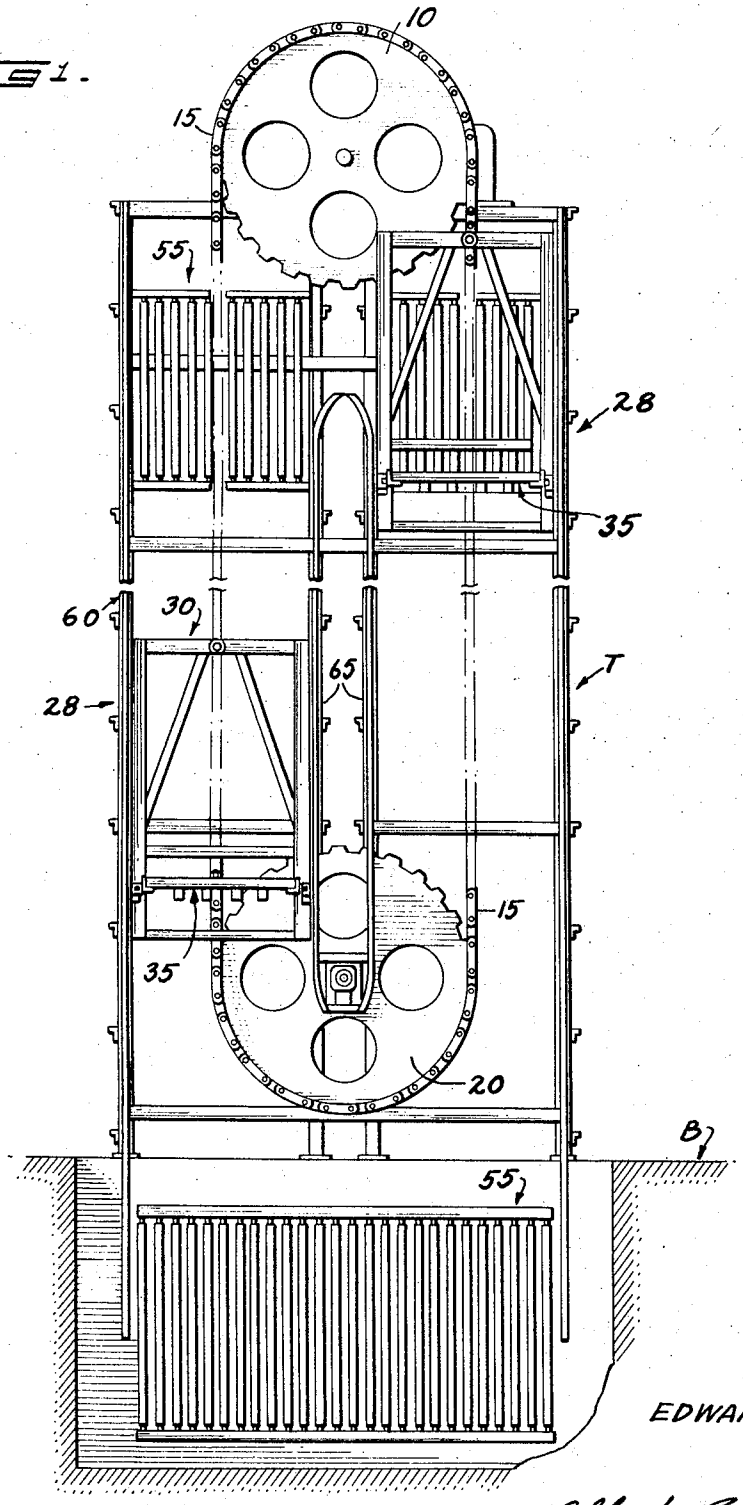
VERTICAL SORTING SYSTEM

Filed Sept. 9, 1966 6 Sheets-Sheet 1

FIG 1.



INVENTOR
EDWARD A. WENTZ

BY Albert W. Zalkind

ATTORNEY

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VERTICAL SORTING SYSTEM

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Fig 2a

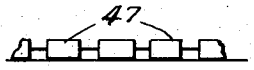

Fig 2.

VERTICAL SORTING SYSTEM

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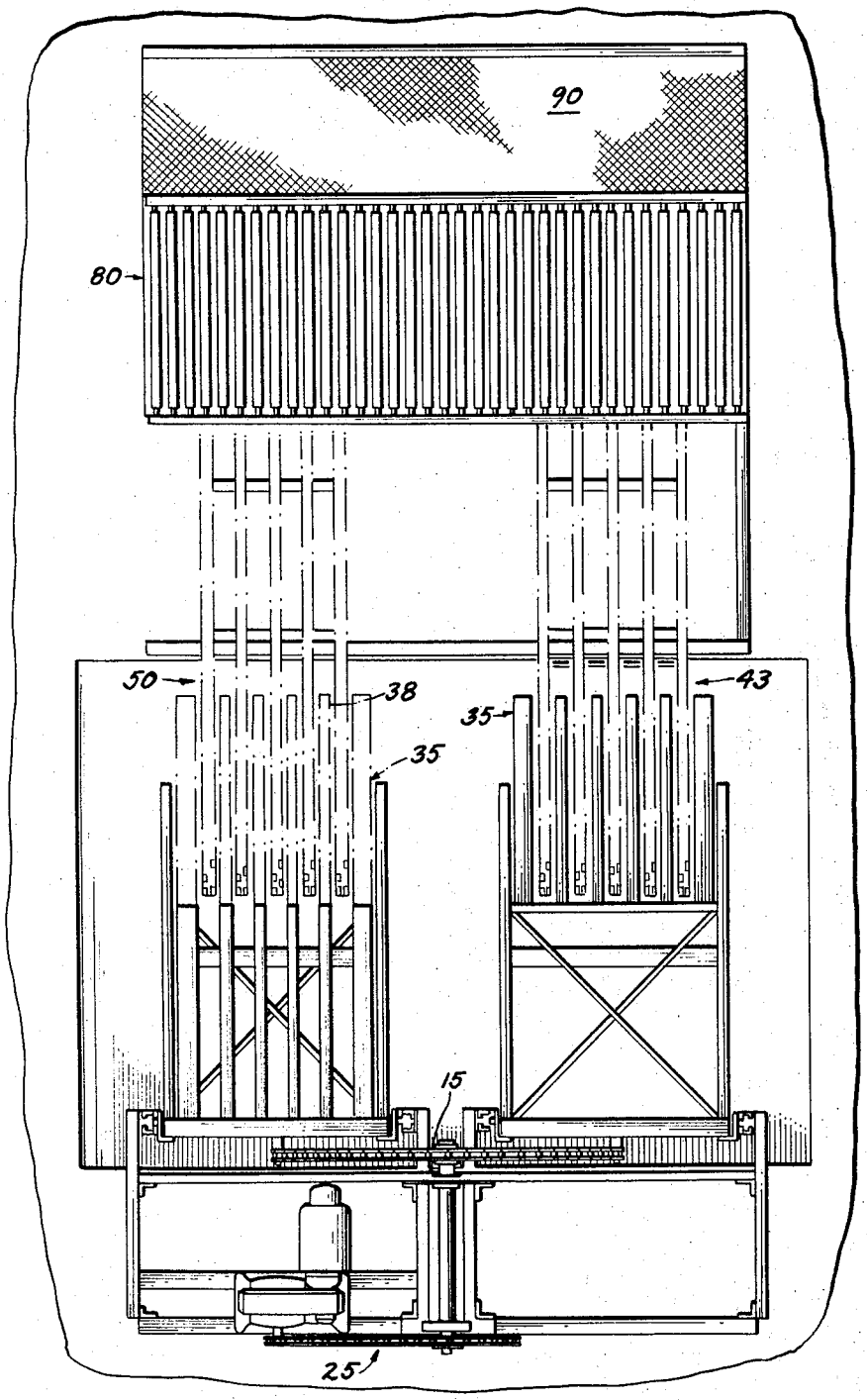

FIG. 3.

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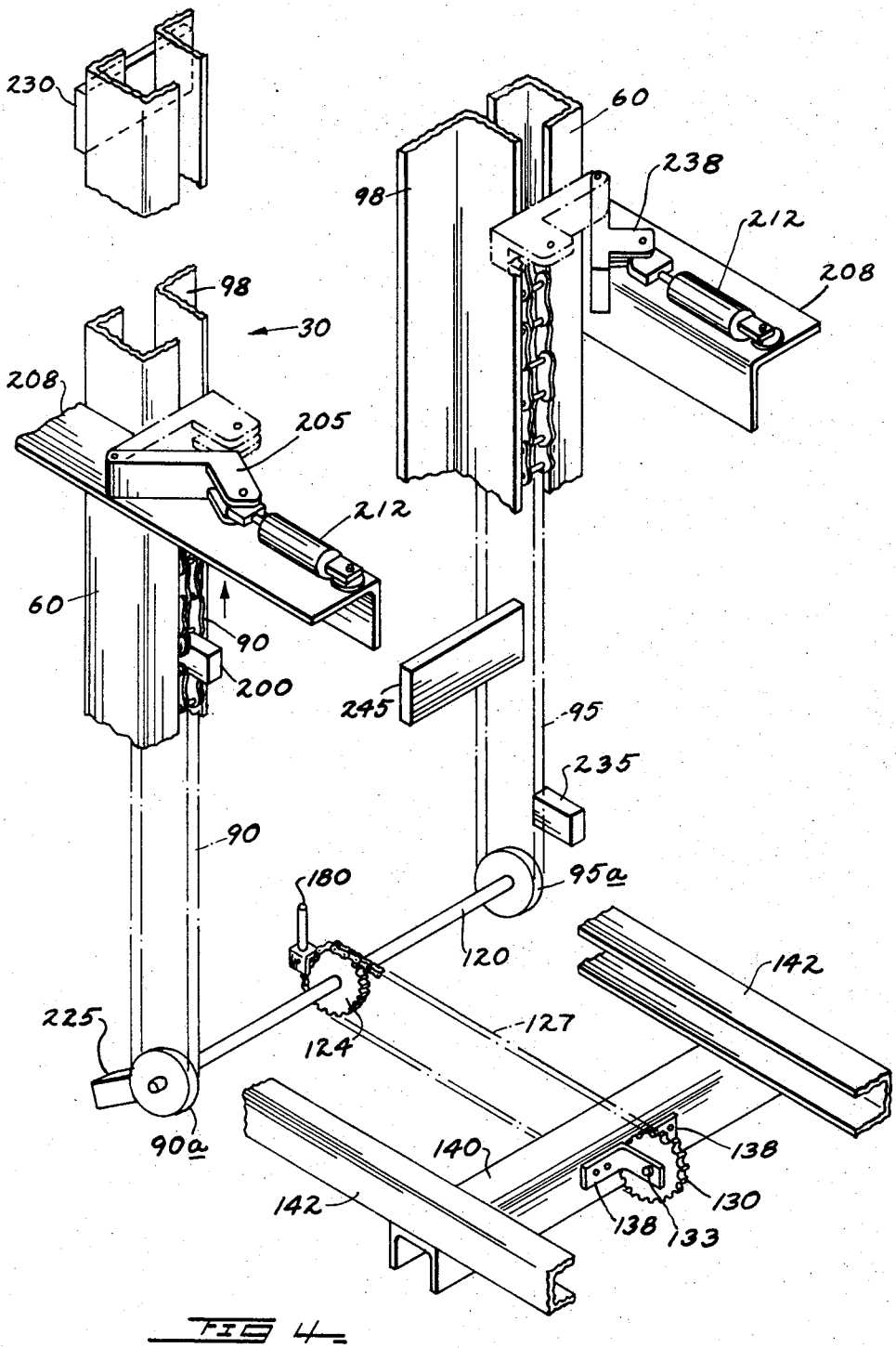

FIG 4

VERTICAL SORTING SYSTEM

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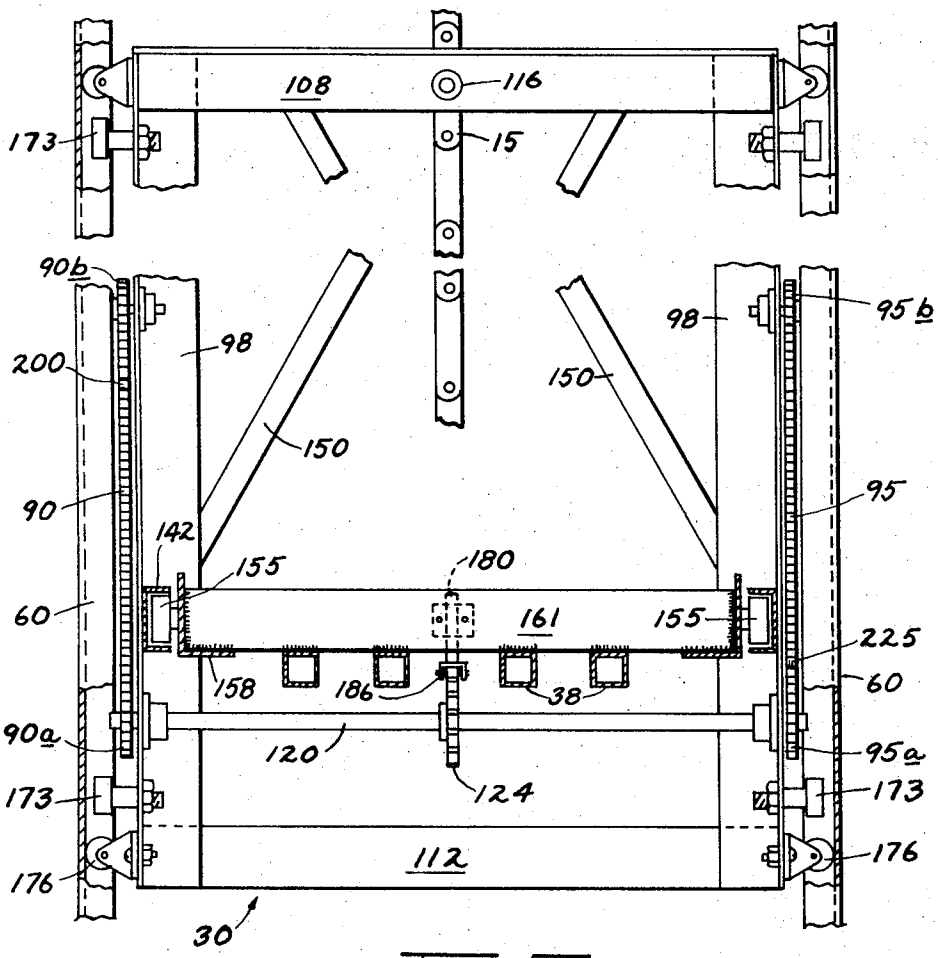

FIG 5.

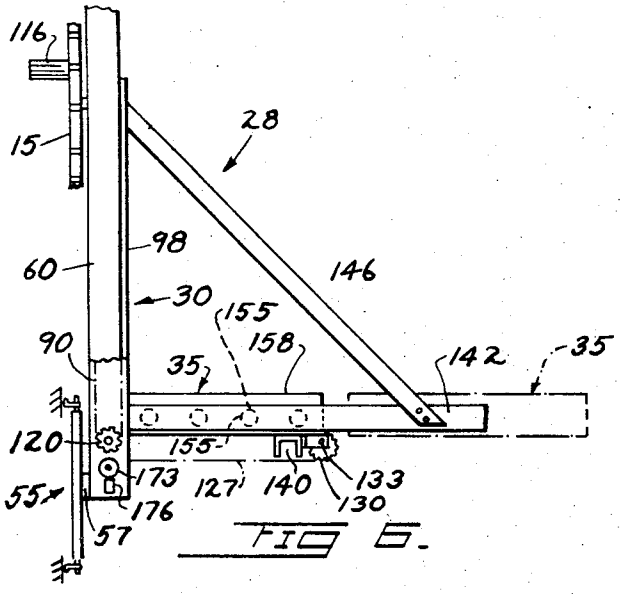

FIG 6.

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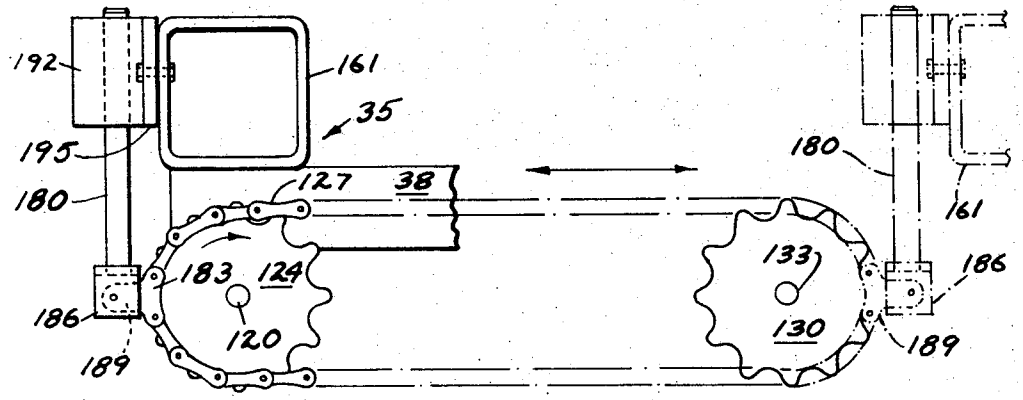

FIG 7.

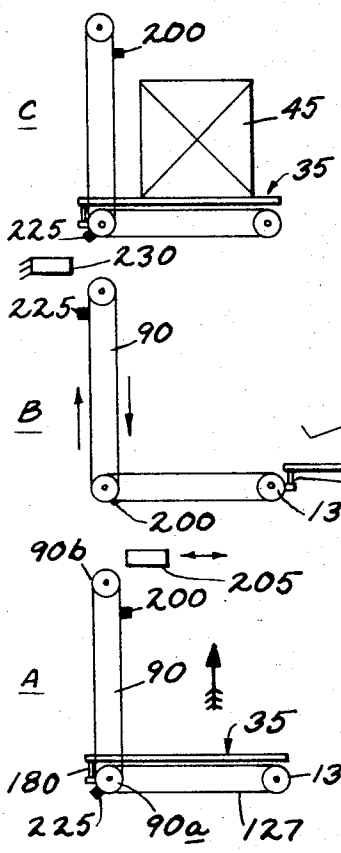

FIG 8.

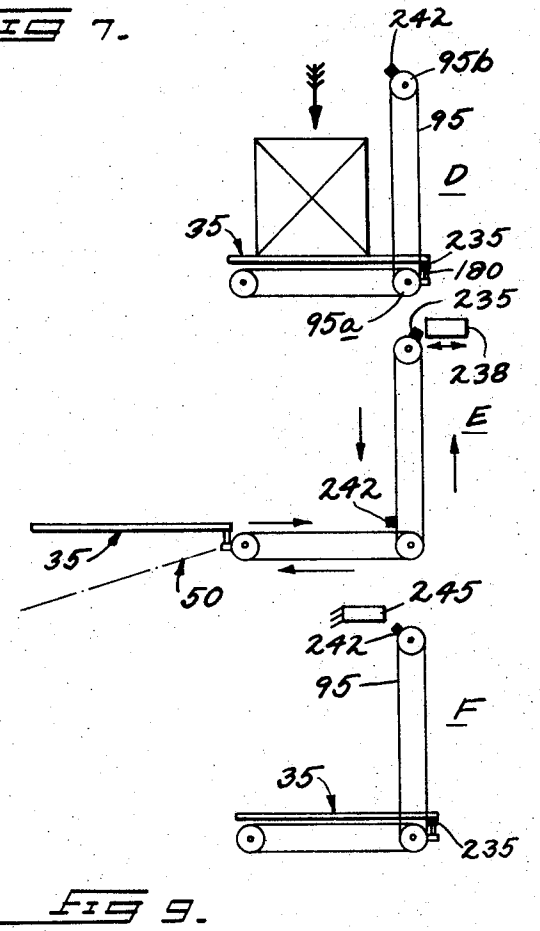

FIG 9.

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3,369,648

VERTICAL SORTING SYSTEM

Edward A. Wentz, Silver Spring, Md., assignor to Aerojet-General Corporation, El Monte, Calif., a corporation of Ohio

Filed Sept. 9, 1966, Ser. No. 578,405
11 Claims. (Cl. 198—157)

ABSTRACT OF THE DISCLOSURE

This invention relates to sorting systems and more particularly to a system which entails the sorting of loads such as cartons and the like by means of a continually operating vertical conveyor. The construction contemplates a carrier chain continuously traveling in a vertical plane and carrying a series of trays each comprised of a plurality of spaced fingers which can move transversely of the travel path to interdigitate with in-feed or off-feed banks of rollers. The rollers are supported so as to be suitably spaced to permit the fingers to move upwardly therebetween to pick up loads, or downwardly therebetween to discharge loads. The roller banks are at different levels of a storage building and the tray fingers are moved transversely to extend or retract by parasitic drive utilizing the motion of the carrier chain by programmed coupling thereto of a mechanism associated with each tray.

It is an object of the system to provide a vertical sorting conveyor capable of being constructed in a large size for sorting loads deliverable at various storage levels of a building possibly up to 15 floors high.

Another object of the invention is to provide a machine capable of handling heavy cartons, 100 to 200 pounds or more, of various sizes, with a minimum of labor and a maximum of safety.

It is a still further object of the invention to provide a system having relatively simple components and economical to manufacture and assemble.

It is an even further object of the invention to provide a vertical conveyor sorting system which can be made completely automatic for programming on-feed and off-feed of loads at various levels and wherein the loads are not subjected to any undue loading or unloading shock.

Other objects and features of the invention will be apparent from the description that follows.

Briefly, the system contemplates operation in an elevator shaft of a building wherein a large sprocket wheel is provided at the top and at the bottom of the shaft, around which wheels rotates a carrier chain moving continually in one direction. The carrier chain carries a plurality of equally spaced trays which have only translatory motion. Each tray is comprised of a support frame pivotally secured to the carrier chain and a tray member which can extend from the frame toward a bank of rollers at any level of the building for picking up loads or for discharging loads. Thus, the tray members have spaced fingers which interdigitate with parallel rows of rollers. At the rising side of the chain a tray member can be extended while moving upwardly to interdigitate with an in-feed roller bank and thus pick up a load from that roller bank. Thereafter, the tray member and the load which it carries are retracted and continue to travel to the down flight of the chain after passing around the upper sprocket. While moving downwardly the load can discharge to an off-feed bank of spaced rows of rollers by interdigitating therewith at a selected level of the building. Thus, the tray member moves outwardly just before reaching such rollers and deposits its load thereon

while moving downwardly therepast, once more retracting when it has passed that bank of rollers.

The particular mechanism for effecting extension and retraction of tray members comprises a parasitically powered system wherein each tray assembly carries a pair of driving chains disposed in vertical planes, one such chain being on each side of the assembly and movable therewith. At each loading or unloading level a controllable stop disposed there can be shifted to be engaged by a dog on a respective tray driving chain thereby causing that chain to rotate as the tray assembly moves with respect to the controllable stop. The driving chains are coupled to a driven chain carried by the tray assembly which is coupled to extend or retract the tray member depending upon direction of movement of the driven chain. When the tray assembly is moving upwardly, extending of the tray member is effected by a dog on one of the driving chains and when it is moving downwardly extension is effected by a dog on the other driving chain. In order to effect retraction subsequent to an extended tray member moving past a roller bank to pick up or deposit on a load, a fixed stop is disposed to engage a second dog at the opposite side of each driving chain thereby effecting retraction.

Thus, the construction is relatively cheap and simple and one which is reliable, no large stresses being effected on any of the components and in a manner which will be later disclosed the movement of the tray member has initially simple harmonic motion which minimizes impact between the controllable and fixed stops and the chain dogs as well as minimizing shock on loads.

The system is capable of loading at any point on the upwardly rising flight of the carrier chain. Further, while it is contemplated that the spacing between tray assemblies will be a foot or two greater than the spacing between floors, that is storage levels, the system is not inherently limited to any particular spacing between tray assemblies except as to the size of the assemblies and the maximum size of cartons to be handled.

A detailed description of the invention now follows in conjunction with the appended drawing in which:

FIG. 1 is a front elevation showing an exemplary system, one tray assembly being disclosed moving upwardly and another moving downwardly;

FIG. 2 is a side elevation of the construction shown in FIG. 1;

FIG. 2*a* is a partial front view of a feed-in roller bank;

FIG. 3 is a plan view of the construction.

FIG. 4 is a fragmentary perspective view showing basic components of the drive system for extending and retracting the tray or carriage;

FIG. 5 is a front elevation partially in section showing the basic components of the carriage or tray assembly and the extending and retracting drive means for the tray;

FIG. 6 is a side elevation showing components of the tray assembly and guide roller bank for guide assembly in cross-over movement when passing from the up to the down flight of the main carrier chain;

FIG. 7 is an elevation showing basic components of the driven mechanism which extends and retracts the carriage or tray;

FIG. 8 is a diagrammatic view showing the sequence of the movements of a carriage or tray assembly with extending or retracting of the tray while in upward motion; and

FIG. 9 is a diagrammatic showing of the sequence of movements of the carriage or tray assembly while in downward motion with extending and retracting of the tray.

Referring to FIGS. 1–3 the invention comprises an installation in a building B wherein a suitable shaft, such as elevator shaft or appropriate vertical passageway, has a tower T constructed therein at the top of which is rotatively mounted a sprocket wheel **10** around which is carried a continuous carrier member, such as chain **15**, passing also around a lower sprocket **20** pivotally supported at substantially ground level.

The construction of the tower and chain details are conventional and, accordingly, no further description of the tower is necessary. Suitable motor and driving gear means **25** are provided at the top of the tower for driving sprocket wheel **10** whence it will be understood that the chain rotates continuously moving upwardly at the left on FIG. 1 and downwardly at the right. Carried on the chain at suitably spaced intervals are cargo carriage means or tray assemblies **28** comprised of a support frame **30** and an extensible and retractable carriage member or tray **35**. With particular reference to FIG. 2, it will be noted that the lower tray assembly is shown in extended position and moving upwardly, it being understood to be on the left flight of the chain (FIG. 1). The upper tray assembly is on the down flight.

As seen in FIG. 3, the carriage or tray is a comb-like assembly having spaced tines or fingers **38** which can pass upwardly by interdigitating with spaced rows of rollers **40** which make up feed-in roller banks such as **43**. Thus, if the carriage is extended as shown and there is a carton **45** (phantom) on a roller bank **43**, the spaced fingers **38** will pick up the carton and carry it upwardly. Each row **40** of bank **43** terminates in a fixed finger **47** to retain cartons until picked off.

As viewed in FIG. 2, the lower tray assembly is shown for a retracted condition of the tray in moving upwardly. If it is to pick up a load from the feed-in roller bank **43**, it extends to the dotted position. Thereafter, it retracts and travels to the down flight of chain **15** as shown by the upper tray illustrated in solid lines. For off-feed to a roller bank **50** the tray extends to the dotted position. After passing roller bank **50**, the tray retracts as shown in phantom.

Thus, comparing FIG. 1 with FIG. 3, it will be seen that the upwardly rising extended carriage **35** will interdigitate with roller bank **43** while the retracted downwardly moving carriage **35** will avoid the off-feed bank **50**, unless the carriage is extended, in which case the cargo will be deposited on roller bank **50** to gravitate to the floor F.

It will be obvious from the foregoing that all in-feed roller banks are slanted downwardly to the left, as viewed in FIG. 2, while all off-feed roller banks are slanted to the right, whereby cargo movement to and from carriages is effected by gravity.

A roller bank **55** (FIGS. 1 and 2) is disposed parallel to each sprocket wheel to guide the tray assemblies in crossing from the up to the down flight of chain **15**. As illustrated in more detail in FIG. 6, the tray assembly **28** has a rear plate **57** which rides on the rollers of bank **55** in the cross-over movement.

The frames **30** are suitably roller guided in their movement by means of side channels **60** on each side of the tower and by center channels **65** (FIGS. 1 and 2), during the course of vertical up or down movement. However, in the cross-over movement there is no lateral guidance, the tray assemblies being maintained in a vertical plane by rolling contact with roller banks **55**, since it is apparent that channels **60** and **65** are open-ended and must terminate at the points shown in FIG. 1 to free the tray assemblies for cross-over between chain flights. Details of the roller guidance of tray assemblies in channels **60** and **65** are shown in FIG. 5 to be later described.

Load feed to the roller bank **43** is readily accomplished by a gravity feed roller conveyor **80** which brings cartons from a distant point adjacent a platform **85** on which an operator stands who merely slides the cartons onto the in-feed roller bank and also punches keys of a programming control system in a manner well understood. The same roller bank **80** receives cartons from the off-feed bank to be conveyed away from the operator station.

FIGS. 4, 5 and 6 show the arrangement and construction of the tray **35** and mechanism for extending and retracting it. Thus, referring to FIGS. 4 and 5, a pair of spaced drive chains **90** and **95** are carried on respective pairs of sprocket wheels **90***a*, **90***b* and **95***a*, **95***b*. The sprocket wheels are each carried on spaced angle iron members **98** which form the sides of the tray assembly frame **30**. The frame is completed at the top by another angle iron member **108** and at the bottom by the plate **57** (heretofore mentioned), suitably riveted or welded to the side angle irons. The upper structural member **108** has a heavy pivot pin **116** which will be understood to be secured to the carrier chain member **15** and the tray assembly is thereby pivotally suspended so as to have purely translatory motion as chain **15** rotates.

The lower sprocket wheels **90***a* and **95***a* are keyed to a transverse shaft **120** having bearing support in angle irons **98** and having a sprocket wheel **124** keyed to the center thereof. Sprocket wheel **124** has a driven chain **127** therearound which extends forwardly to a sprocket wheel **130**. The sprocket wheels **124** and **130** thus support the chain **127**, sprocket wheel **130** being carried on a stub shaft **133** having suitable bearing support in brackets **138** on a cross bar channel **140** which is secured at its ends to horizontal side U-channel members **142** which are part of the frame **30**, secured at their rear to angle iron **98** and braced by respective metal tension straps **146**, Thus, straps **146** are fastened at their lower ends to the respective members **142** and at their upper ends to the respective members **98**, all as will be understood from FIGS. 5 and 6.

The support frame **30** is further braced at its rear by diagonally extending metal straps, such as **150**, as shown in FIG. 5, which are secured at the rearward sides of members **98** and **108**.

Channels **142** effect roller guides for rollers such as **155** which support the tray **35**, it being understood that a plurality of rollers **155** may be provided at each side on members **158**. The tray **35** comprises the pair of horizontal angle iron members **158** having a rearward cross bar **161** welded thereto. The cross bar **140** provides slide support for the spaced fingers or tines **38** welded to the underside of the cross bar **161** (FIG. 5).

From the above description, it will be understood that the tray **35** can roll in or out of the plane of the paper, as viewed on FIG. 5, the extended position being shown in phantom on FIG. 6.

The entire tray assembly moves vertically in the fixed vertical guide channels **60** (FIGS. 1, 5 and 6) of the tower, there being rollers such as **173** (FIG. 5) carried by the vertical angle irons **98** for fore-and-aft restraining, and rollers **176** for lateral restraining in a manner which will be readily understood from FIG. 5.

The particular manner in which the tray **35** is extended and retracted will now be described, it being noted that the chain **127** carries a finger **180** as seen in solid line position on FIG. 7. The details of the finger-carrying mechanism are shown in FIG. 7. A special link **183** is provided in chain **127** to which is secured a yoke **186**, finger **180** being rigidly secured to the yoke. Thus, the yoke **186** is pivotally secured to the extending portion **189** of link **183** so that finger **180** can maintain a vertical position at all times as it is motivated by the chain around the sprocket wheel **124** in either direction and it will be understood that such vertical position is maintained for finger **180** in moving around the forward sprocket wheel **130**. The extent of arcuate movement of yoke **186** is 90° around either of the sprocket wheels and in either direction. Finger **180** is maintained vertical in a guide collar **192** in which it is slidable, which collar is securely fastened to the rear bar **161** of tray **35** such as by being

secured to a plate **195** in turn bolted at its sides to bar **161**. Accordingly, assuming chain **127** rotates clockwise, finger **180** is moved upwardly from a starting position at sprocket wheel **127** for a 90° travel around sprocket wheel **124** to the upper flight of chain **127** to drive tray **35** to extended position, the limit of motion being demarcated by the final phantom position of the finger at sprocket wheel **130**. Reverse movement of finger **180** retracts the tray **35**.

Referring now to FIG. 4, it will be noted that chain **90** carries a dog **200** intermediate a pair of links, which dog is shown in initial position when the chain is being carried upwardly with frame **30**, the tray being retracted at that time and the finger **180** being in the solid line retracted position shown on FIG. 7 with respect to sprocket **124**. In moving upwardly, dog **200** moves in the slot (FIGS. 4 and 5) formed by the spacing between channel **60** and angle iron **98**.

Ordinarily, the tray frame assembly **28** (FIG. 6) moves upwardly with the drive chain **90** remaining static unless dog **200** abuts a stop member **205** (FIG. 4) movable into the upwardly moving path of dog **200**. Should such abutment occur, it will be apparent that the continued upward traverse of the tray assembly will result in relative rotation of chain **90** with respect to the tray assembly. Actually, the chain is forced to remain stationary by such interference but the sprocket wheels **90***a* and **90***b* (FIG. 6) will be rotated thus rotating shaft **120**, sprocket wheel **124**, chain **127**, and sprocket wheel **130**. Finger **180** will then move from the solid line position shown in FIG. 7 to the phantom position shown driving the tray **35** to the extended position shown in phantom in FIG. 6.

Interference with dog **200** is provided by means of the selectively operable stop member **205** (FIG. 4) pivoted to an angle iron **208** secured to fixed vertical channel **60**. As shown in FIG. 4, the stop **205** is in retracted position, being controlled by an air cylinder **212**. Thus, the dog **200** will not abut stop **205** in moving upwardly. However, upon actuation of the air cylinder the stop swings to the phantom line position and dog **200** will engage it, thereby setting in motion the train of events previously described which results in forward or extending movement of tray **35**. It will, of course, be understood that actuation of the stop **205** is operator-controlled through any suitable programming system at any floor level at which cargo is to be picked up. For cargo discharge, however, a corresponding stop device is provided at each level of the building, as later described.

Referring now to the diagrammatic illustrations of FIG. 8, the solid lines show the initial condition, i.e., the retracted position of tray **35** (position A). Assuming the tray assembly is moving upwardly along with chain **90** and stop **205** being actuated to interfere with dog **200**, abutment of the dog with the stop will cause clockwise rotation of chain **90** indicated by arrows adjacent position B to rotate sprocket wheel **124** whence finger **180** will drive the tray to the extended position shown in position B. At this limiting position of tray **35**, the dog **200** has moved downwardly to the position shown on the lower sprocket wheel **90***a* having escaped beyond stop **205**. The tray is now in a position to pick up cargo **45** by interdigitation with conveyor bank **43**. At this time finger **100** has moved from a position at a midway point on sprocket wheel **124** through a 90° arc thence to sprocket wheel **130** and around sprocket wheel **130** for 90° which is the limit of its travel since dog **200** has escaped past stop **205** and the chain is no longer driven by the stop.

After cargo has been picked up, it is necessary to retract the tray so that the extended tray will not abut with any further in-feed roller bank nor with any off-feed roller bank, such as **50** in FIG. 2, in its downward traverse on the other flight of chain **15** except for a selected off-feed roller bank.

To effect automatic retraction, dog **225** is carried on chain **90** at the initial point in position A (also see FIG. 4) with respect to sprocket wheel **90***a*. Dog **225** moves around to the point shown in position B when chain **90** is initially actuated.

A fixed stop **230** is secured across the slot between channel **60** and frame member **98** (FIG. 4) to be abutted by dog **225** thereby driving chain **90** counter-clockwise, whence finger **180** moves in a direction to retract tray **35** to its initial position, as shown in position C.

Accordingly, the motivation of a tray on the upwardly rising flight of chain **15** (FIG. 1) is completed, and all trays are thus controlled.

On the downwardly moving flight of chain **15** (FIG. 1) the initial retracted position of the tray **35** is shown in FIG. 9 (position D) and the chain **95** at the other side of the tray frame assembly carries a dog **235** which can abut a movable stop member **238** (FIG. 4) which is similar to stop **205** there being a stop **238** actuatable under operator control at each floor level of the building. Thus, the chain **95** is actuated to effect extension of tray **35** (position E). Accordingly, cargo is deposited on the next off-feed roller bank **50** downstream of the point at which the tray was extended. Subsequently, tray **35** is retracted by coaction between a dog **242** (corresponding to dog **225**) on chain **95** abutting a fixed stop **245** (corresponding to stop **230**) carried in interfering position, whence tray **35** is actuated to the retracted position (position F).

Attention is called to a particular feature of the invention, with reference to FIGS. 7–9. It will be noted that the finger **180** has a limiting or rest position at points midway of the peripheries of the sprocket wheels **124** and **130**. Thus, in moving in either direction finger **180** translates and follows a 90° arc from rest position. It will be apparent that the horizontal component of motion commences at zero velocity and progresses to maximum velocity as finger **180** reaches the upper flight of chain **127**. Accordingly, finger **180** has simple harmonic motion wherein the increasing horizontal velocity is gradual in moving the tray from or to a rest position. This considerably reduces shock effects on the mechanism as well as on loads carried by the tray.

For purposes of effecting suitable scope in the claims to follow, the chain **15** is referred to as a "carrier member" and the roller banks **43** and **50** as "cargo station support means," while the fingers **38** are referred to as "tray cargo carrying means." Other suitable broad language is employed, thus chains **90** and **95** are referred to as "drive elements," chain **127** is referred to as a "driven element" and finger **180** as a "drive member." It will be apparent that breadth of terminology is justified since equivalent components could be used for any of these elements without departing from the spirit of the invention, as well as for other elements utilized in the combination of the invention and which are described in terms of means throughout the claims.

What is claimed is:

1. A vertical sorting conveyor system comprising a supporting structure, a carrier member movable on said support structure, tray means secured to said carrier member for movement therewith and comprising a tray supported for reversible movement from an initial to an extended position for cargo transfer, said tray comprising cargo carrying means, and cargo station support means disposed so that said tray cargo carrying means moves therepast for cargo transfer, and actuator means for extending said tray when said tray is in a predetermined position approaching said cargo station support means, wherein said tray means comprises a support frame for said tray, said actuator means comprising driving means carried by said frame and movable relative thereto, a drive dog carried by said driving means, and controllable stop means operative to be disposed in the path of said drive dog for engagement thereby to actuate said driving means as said tray means is carried past said stop means, and connection means connecting said driving means with said

tray for extending said tray toward said cargo station support means for cargo transfer.

2. In a system as set forth in claim 1, including a fixed stop means operative to actuate said driving means subsequent to movement of said tray beyond said cargo station support means to effect retraction of said tray, said driving means having another driving dog engageable by said fixed stop means for effecting retraction.

3. In a system as set forth in claim 2, wherein said driving means is provided on each side of said tray means to coact with respective controllable stop means movable to effect extension of said tray toward said cargo station support means, one said controllable stop means being disposed to be operative when said tray means is moving upwardly and the other said controllable stop means being disposed to be operative when said tray means is moving downwardly.

4. In a system as set forth in claim 3, each said drive means comprising a drive element supported for movement in a vertical plane relative to said tray, said dogs being carried by respective drive elements.

5. A system as set forth in claim 1, including a fixed stop means operative to actuate said driving means subsequent to movement of said tray beyond said cargo station support means to effect retraction of said tray, said driving means having another driving dog engageable by said fixed stop means for effecting retraction; wherein a driving means is provided on each side of said tray means to coact with respective controllable stop means movable to effect extension of said tray toward a cargo station support means, one said controllable stop means being operative when said tray is moving upwardly and the other said controllable stop means being operative when said tray is moving downwardly; each said driving means comprising a drive element supported for movement in respective vertical plane relative to said tray, said dogs being carried by respective drive elements; wherein said connection means connects said drive elements to said tray and comprises a driven element supported for generally horizontal movement and said connection means further comprises actuatable members between said driven element and said drive elements.

6. A system as set forth in claim 5, said drive elements and said driven element being endless belt-like members having adjacent ends and having support wheels at said ends on a common shaft, said driven and driving elements having support wheels at respective opposite ends, a drive member disposed to actuate said tray upon motivation by said driven element and having at least one motion limiting position which is on the periphery of one of said wheels of said driven element, whereby initial driven movement of said drive member is gradually effected by an arcuate motion followed by a subsequent linear motion.

7. A vertical sorting conveyor system comprising a supporting structure, a carrier member movable on said support structure, tray means secured to said carrier member for movement therewith and comprising a tray supported for reversible movement from an initial to an extended position for cargo transfer, wherein said tray means comprises a support frame, a tray being movable carried thereon, and an actuating mechanism for effecting said reversible movement of said tray and being carried by said support frame, said actuating mechanism having a first abutment means movable relative to said support frame, an operator controlled abutment means disposed to be moved into the path of said first-mentioned abutment means so as to be engaged thereby during vertical movement of said support frame, means connecting said first-abutment means with said tray and operative to effect movement of said tray in a direction to extend it from said support frame responsive to engagement of said first abutment means with said operator controlled abutment means.

8. A system as set forth in claim 7, said actuating mechanism having a second abutment means movable relative to said support frame, and said support structure having a fixed abutment means engageable by said second abutment means to drive said actuating mechanism in a direction to effect retraction of said tray.

9. A system as set forth in claim 8, said actuating mechanism comprising a belt-like member and said first and second abutment means being carried thereby.

10. A vertical sorting conveyor system comprising a supporting structure, a carrier member movable on said support structure, tray means secured to said carrier member for movement therewith and comprising a tray supported for reversible movement from an initial to an extended position for cargo transfer, machanism for moving said tray from and to said initial position comprising means actuated by relative motion between said tray and said support structure and a belt-like member driven thereby and having an element movable between two limiting positions and connected to said tray, said belt-like member extending between and at least partially around a pair of wheels spaced so that said element has a rest position on an arcuate portion of each wheel for a respective limiting position whereby a gradual linear motion of said element is effected by rotation of said wheels.

11. A vertical sorting conveyor as set forth in claim 10, said mechanism comprising sprocket chains and a respective pair of vertically alined sprocket wheels carrying a respective chain and being carried by said tray means; said belt-like member comprising a sprocket chain and said pair of wheels being horizontally alined sprocket wheels carrying said latter chain and being carried by said tray means; a common shaft to which are keyed the lowermost wheels of said vertically alined wheels and a wheel of said horizontally alined wheels, and said element being carried by said latter chain and comprising a pin, said tray havng a collar in which said pin is slidable in the initial movement from either of said limiting positions.

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RICHARD E. AEGERTER, *Primary Examiner.*

EVON C. BLUNK, *Examiner.*

M. L. AJEMAN, *Assistant Examiner.*