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**CONVEYING APPARATUS**

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For Reference.

**FIELD OF THE INVENTION**

The present invention is related to conveyors. In particular, the present  
5 invention is related to the conveyors for non-palletized cargoes.

**BACKGROUND OF THE INVENTION**

Conveyor belts come in many forms and are used in numerous  
applications such as for transferring goods, materials and cargoes from one  
end of the conveyor to a desired location at the other end. These belts are  
10 normally constructed by means of rollers or chains or combination thereof.

The conventional conveyor belts have numerous limitations due to their  
design. Firstly, a gap is present at the junction between two conveyor belts,  
which results in instability when a cargo is transferred across two  
contiguous belts. Therefore, most cargoes have to be transferred on pallets.  
15 Secondly, due to the presents of rollers or wheels, the belt tends to shift and  
move at the slightest urging. For example, a cargo placed on conveyor in a  
moving vehicle may shift according to the movement of the vehicle. Unless  
brakes are applied to the conveyor, such movements may become  
dangerous. Thirdly, the conveyors tend to be bulky, as the rollers have  
20 minimum working diameters. Furthermore, due to presence of belts and  
chains, conventional conveyors tend to require frequent maintenance.

## **OBJECT OF THE INVENTION**

It is therefore an object of the present invention to provide a conveying apparatus to overcome the shortcomings as stated above.

It is another object to provide a conveying apparatus which can transfer  
5 unpalletized cargoes.

It is yet another object of the present invention to provide a safe method to transfer cargoes.

## **SUMMARY OF THE INVENTION**

The present invention is a conveying apparatus and system comprising a  
10 conveyor having a plurality of longitudinally aligned bars aligned to form a platform whereon a cargo for conveying may be placed. Reciprocating vertical actuator is provided to raise and lower at least one bar in a direction substantially normal to its longitudinal axis and to a pre-set distance from the platform. Reciprocating longitudinal actuator is also provided to allow at  
15 least one bar to shift forwards and backwards along its longitudinal axis for a predetermined distance, The vertical and longitudinal actuators are coordinated in operation such that a cargo placed on the conveyor will be urged forward from one end to the other end through cycles of incremental steps of a predetermined distance. Each cycle involves a forward load-  
20 shifting step and a backward retracting step. In the most preferred embodiment of the invention, the bars include at least one support bar and at least one shifting bar. In one embodiment, the reciprocating vertical actuator is coupled to at least one support bar, and the reciprocating longitudinal actuator is coupled to at least one shifting bar. The forward step

is achieved by the shifting bar shifting forward while supporting the cargo. The backward step is achieved by transferring the weight of the load to the support bar and then shifting the shifting bar backwards without touching the cargo.

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## **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1A is a longitudinal cross-sectional view of a loaded conveyer showing the general features of the present invention.

Figures 1B is a top view of a loaded conveyer showing the general features  
10 of the present invention.

Figures 2A-D are traverse cross-sectional views of a loaded conveyer according to one embodiment of the present invention showing the operational steps sequentially.

Figures 2E-H are top views of a loaded conveyer corresponding to Figures  
15 2A-D respectively.

Figures 3A-D are traverse cross-sectional views of a loaded conveyer according to another embodiment of the present invention showing the operational steps sequentially.

Figures 3E-H are top views of a loaded conveyer corresponding to Figures  
20 3A-D respectively.

Figures 4A-F are traverse cross-sectional views of a loaded conveyer according to another embodiment of the present invention showing the operational steps sequentially.

Figures 4G-L are top views of a loaded conveyor corresponding to Figures 4A-G respectively.

Figure 5A is a longitudinal cross-sectional view of two conveyors according to the present invention aligned end-to-end.

5 Figure 5B is a top view of the same conveyors in Figure 5A.

Figure 6 is a longitudinal cross-sectional view of a combined vertical and longitudinal actuator. Figures 6A-D shows the sequential steps of the mechanism.

## 10 DESCRIPTION OF THE INVENTION

Figure 1 shows the general concept of the conveying apparatus in accordance with the present invention. The present conveying uses longitudinally aligned rigid bars (reference numerals 20 and 22 of Figure 1A to C) to form a platform 24 whereon loads and cargoes 26 may be placed. The bars can be generally grouped into at least two groups : the shifting bars 20 and the support bars 22. A base 25 is also provided whereon all actuators and fixtures may be coupled. The cargo 26 is urged forward from one end of the conveying apparatus to the other end via cycles of incremental steps provided by the bars.

20 At least one reciprocating vertical actuator is provided on some of the bars to allow the bar to be raised or lowered in a direction substantially normal to their longitudinal axis. At least one reciprocating longitudinal actuator is also provided to allow some of the bars to be shifted forward and



backward along their longitudinal axis. The vertical and longitudinal actuators cooperate to provide cycles of load shifting and bar retraction. During the load shifting step, the shifting bar is used to support the load and shift it forward. During the retraction step, the shifting bar is brought back to  
5 its original position without coming into direct contact with the load. This is achieved by either raising the load or by lowering the shifting bars. The shifting directions may be reversed such that a load can be transferred in either direction. Due to the absence of rollers, chains or belts in the present invention, brakes are not necessary. Furthermore, the entire apparatus may  
10 be reduced to a very short height. For example, a 2 inch high platform with the appropriate actuators installed inside 20-foot container can transfer at least the standard cargo load of 20 tons. For a 40-foot container, the present conveying system with a 2 inch high platform may be upgraded to transfer loads of up to 50 tons.

15 In general, the shifting bars **20** and the support bars **22** may be aligned alternately (as shown in Figure 1B) for convenience. This alternating arrangement gives good results, but other arrangement are also within the scope of the present invention, for example, two shifting bars between every support bar, or vice versa. Many embodiments can be envisioned using the  
20 general concept described above. For example, the cross-sectional shapes of the bars are shown as rectangular or square bars, but may be of other shapes.

An actuator is any mechanism for moving the bars. It may be of the hydraulic type, mechanical type, pneumatic type or a combination thereof.  
25 The pumps, cylinders, gears, cam motor and other engineering parts are not

described in detail as they are well known in the art. For example, one longitudinal actuator and one vertical actuator may be coupled to the shifting and support bars respectively. The actuator may comprise a number of compressors, pumps, motors or gears as driving forces.

5 If a bar or group of bars require the coupling of both a vertical and a longitudinal actuator, they may be combined into one mechanism. An example of a combined vertical and longitudinal actuators is shown in Figure 6. In this example, the actuator is a mechanical mechanism using, for example, cylinders, gears or a hydraulic arm, which are connected to bar  
 10 **62**. Bar **61** may be a shifting bar or a support bar. In the raising and shifting step, bar **62** is pulled to the right by the pulling mechanism (not shown). As roller **63** is pulled to the right of bar **62**, bar **61** is forced to rise due to slope **64**. When roller **63** reaches arm **65**, the entire bar **61** is pulled to the right by the pulling bar **62**. As a result bar **61** is raised and shifted via one  
 15 mechanism.

The number of pumps or jacks necessary for the proper functioning of the system depends on their type and arrangement, and is within the knowledge of one of ordinary skill in the art. [Eric, this is to define what is meant by actuator in the claim. You have anything else to add ?]. The  
 20 following examples are used to illustrate the inventive concepts.

### EXAMPLE 1

Figure 2 shows an embodiment in which one set of parallel bars act as the support bars **30** (shown as hatched rectangles or squares) and another set



of parallel bars act as the shifting bars **32** (shown as open rectangles). In this embodiment, the vertical actuators (not shown) are provided to raise and lower the support bars for a pre-set distance from the platform in a upwards and downwards direction perpendicular to the platform. The longitudinal actuators (not shown) are provided to shift the shifting bars a pre-determined distance forwards and backwards relative to the support bar. The level of a bar is defined as the level of the upper surface of the bar. In this embodiment, the upper level of the shifting bars at the resting position is also considered the platform level. The level of the support bars at their resting positions is below the platform level **33**, as shown by Figure 2D. Figures 2A-H shows the sequence of steps within one cycle to shift the load one pre-determined distance. Figure 2A shows the raising of the support bars **30** and the load by the vertical actuators to a pre-set level slightly above the platform level. The shifting bars **32** then shift backwards (as shown by the arrows in Figure 2F) without touching or moving the load. Once the shifting bar has shifted backwards a pre-determined distance, the support bars are lowered to their original level below the platform level. As a result, the weight of the load is shifted directly onto the shifting bars. The arrows in Figure 2H shows the shifting forward of the shifting bar for a pre-determined distance, bringing with it the load. The cycle is repeated until the load is shifted from one end to the other end.

### Example 2

Figure 3 shows another conveyor apparatus having alternating support **36** and shifting **38** bars aligned in parallel. In this embodiment, both the vertical

and the longitudinal actuators are coupled to the shifting bar such that the shifting bar acts both to lift the load **40** and to shift it. Figures 3A-H shows the sequence of steps to complete one cycle of shifting. In this example, the upper level of the support bars is the platform level **41**. At the resting position the shifting bar is retracted below the platform level, as shown in Figure 3D. Figure 3A shows the first step in the cycle in which the shifting bar is raised by the vertical actuator to a pre-set distance above the platform. This raises the load such that it is no longer being supported by the support bars. Figure 3F shows how the shifting bars **38** are then shifted forward a pre-determined distance, moving the load with it, as shown by the arrows. To retract the shifting bars without moving the load, the shifting bars are first lowered a pre-determined distance to their resting position. At this position, the shifting bars are below the platform level, and therefore can then be shifted backwards or retracted as shown by the arrow in Figure 3H without moving the load.

### EXAMPLE 3

In the previous two examples the load shifting steps involves the raising of the load above the platform level before shifting occurs to avoid friction between the support bars and the load while the load is moving forward. Although it is necessary that this friction be somehow avoided, it is not necessary that it be achieved by raising the load. This friction may also be avoided if the relevant bars be lowered away from the load. Example 3 shows one embodiment in which this may be achieved. In this example, the support bars **42** and the shifting bars **44** are positioned at platform level **45**

as shown in Figure 4C. A vertical actuator a longitudinal actuator are coupled to the shifting Bars. A vertical actuator is also coupled to the support bar. In the first step of the cycle, to transfer the load 46 from the left hand side to the right hand side of Figure 4H, the support bar is lowered for a pre-set distance such that it is no longer supporting the cargo as shown in  
5 Figures 4A. This is followed by a forward shifting step of the shifting bar 44 for a pre-determined distance as shown by the solid arrows in Figure 4H. Then the support bar is raised again for a pre-set distance as shown in Figure 4C. This is followed by the lowering of the shifting bars as shown in  
10 Figure 4D, such that now the weight of the load is transferred to the support bar. As a result, the shifting bars may be shifted backwards without moving the load as shown by the solid arrows in Figure 4K. Once the shifting bars have retracted to its original position, they are raised to platform level again for the next cycle.

15 The main advantage of the system described in this example is that the load is not lifted above the platform level in any step of the cycle. This means that the function of the vertical actuator is only to move the bars and not to raise the cargo. As a result, this system is extremely energy efficient.

Other variations of this embodiment are contemplated. For example, both  
20 support bars and shifting bars may be coupled to vertical and longitudinal actuators, such that each group of bars essentially function as both support bars and shifting bars, with the cycles staggered. This may be achieve by performing the same steps as shown in Figures 4A to L, except that the support bars move in the opposing direction (as shown by the dotted arrows  
25 in Figures 4H and 4K) when the shifting bars are moving. Although an

additional longitudinal actuator is required for this variation, it has the advantage of doubling the speed with which the cargo may be conveyed.

From the features of the present invention, it can be seen that the entire platform may be made into a flat surface, even at the two ends. This is in contrast to conventional belt or chain systems, which typically have downward sloping ends corresponding to the terminal rollers. When two conventional conveying systems are aligned end to end, these downward sloping ends form a dip or valley at the junction between the two systems. As a result, cargoes with a relatively small base typically have to be placed on a pallet before they can be transferred securely across conventional conveying systems. Using a conveying systems according to the present invention, no dip or valley would be present because a completely flat platform is now possible. As shown in Figures 5A and 5B, two conveying systems **50** and **52** may be aligned end-to-end with a very small gap **54** at the junction as all the bars have flat ends **55**. As a result, cargo may be conveyed across different systems safely and securely without the need for pallets. Although the top edge of the ends of the bars are ideally flat for ease of alignment, the side of the bar ends may be recessed. The recess, as shown by dotted line **53**, and defined by angle **57**, is to prevent any objects from being caught in the gap between two aligned conveying systems.

The present conveying system can therefore work effectively either as a single unit or as a pair. In the most preferred embodiment, a plurality of systems work together. For example, one system may be mounted on a vehicle, a stationary platform or a container floor. The another system can be mounted on a fixed or moveable platform. The moveable platform allows

the heights of the conveying systems to be adjusted to match. The cargo could then be loaded or unloaded using a pair of the present conveying systems placed adjacent to each other with their cycles synchronized, as shown in Figure 5.

5        Since the height of bars of the present conveying system can be made very short, e.g. 2.5-5 inches, it can actually be fixedly mounted onto the inner floor of a container or van without taking up much space. The cargo can be placed on the end of the platform near the door of the container, and the present conveying system can then transfer the cargo all the way to the  
10       back of the container. As the cargo moves inwards, additional pieces of cargo may be placed on the system, until the entire container is full. To unload, the movement is simply reversed. It is extremely safe for attachment onto a container as described above, since abrupt movements of the container does not cause the platform to slide.

15       The pre-set distance may be any distance which allows the separation between the load and the relevant group of bars, and is ideally proportional to the width and height of the bars. A preferred range is 10-100% of the height of the bar. For the embodiments in which one group of bars is below the platform level, the preferred pre-set distance is 10-100% of the height of  
20       the lower bars. For example, for a system shown in example 1 in which the shifting bars are 2 inches high and the support bars are 1 1/2 inch high, the pre-set distance may be 3/4-1 1/2 inches.

      The pre-determined distance can be any distance below the length of the bars. It is also dependent on the longitudinal actuators used, and  
25       determines the longitudinal displacement of the shifting bars. For example,

the pre-determined distance may be less than or equal to 90% of the length of the bars. The preferred range is 1% to 90% of the length of the bars. A practical pre-determined distance is 2% of the length of the bars. As a further example, for a 20-foot container, the distance may be 5-220 inches,  
5 with the more preferred range being 4-8 inches.

Other features may also be added to the present system to improve performance and safety. For example, railings or panels may be provided along the side 56 or the end 58 of the apparatus to prevent cargo from tipping over.

10 While the present invention has been described particularly with references to Figs 1 to 6, it should be understood that the figures are for illustration only and should not be taken as limitation on the invention. In addition it is clear that it is contemplated that many changes and modifications may be made by one of ordinary skill in the art without  
15 departing from the spirit and the scope of the invention described.

**CLAIMS**

- 1     1.     A conveying apparatus comprising :
- 2                     a base; and
- 3                     a conveyor coupled onto said base, said conveyor having
- 4                     a plurality of longitudinally aligned bars to form a platform,
- 5                     said platform adapted for supporting a cargo;
- 6                     reciprocating vertical actuator coupled to at least one bar
- 7                     for raising and lowering said bar in a direction substantially
- 8                     normal to its longitudinal axis and to a pre-set distance from
- 9                     said platform; and
- 10                    reciprocating longitudinal actuator coupled to at least one
- 11                    bar for moving said bar forward and backward along its
- 12                    longitudinal axis for a pre-determined distance, said
- 13                    longitudinal actuator coordinated in operation with said
- 14                    vertical actuator
- 15                    whereby a cargo placed on said conveyor will be urged from one
- 16                    end of said conveying apparatus to the other end through
- 17                    incremental steps of a predetermined distance.



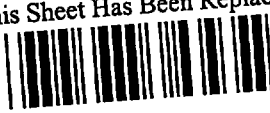
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- 1    2.    A conveying apparatus according to claim 1 wherein said bars  
2       include at least one support bar and at least one shifting bar, with the  
3       reciprocating vertical actuator being coupled to said support bar, and  
4       said reciprocating longitudinal actuator being coupled to said shifting  
5       bar.
- 1    3.    A conveying apparatus according to claim 1 wherein said bars  
2       include at least one support bar and at least one shifting bar, with the  
3       reciprocating vertical actuator and said reciprocating longitudinal  
4       actuator coupled to said shifting bar.
- 1    4.    A conveying apparatus according to claim 2 wherein a second  
2       reciprocating vertical actuator is coupled to each of said shifting bar.
- 1    5.    A conveying apparatus according to claim 4 wherein a second  
2       reciprocating longitudinal actuator is coupled to said support bar.
- 1    6.    A conveying apparatus according to any one of the preceding claims  
2       wherein the bars have a flat top surface to form a flat platform.
- 1    7.    A conveying apparatus according to any one of the preceding claims  
2       wherein the bars have flat ends adapted for matching end-to-end  
3       alignment of platforms from a plurality of said conveyors.
- 1    8.    A conveying apparatus according to any one of the preceding claims  
2       wherein the bars are aligned substantially in parallel.



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1 9. A conveying system having a base and a conveyor, said conveyor  
 2 having a plurality of longitudinally aligned bars, including at least one  
 3 support bar and at least one shifting bar, said bars aligned to form a  
 4 platform, said platform adapted for supporting a cargo; a  
 5 reciprocating vertical actuator coupled to at least one support bar for  
 6 raising and lowering said support bar in a direction substantially  
 7 normal to its longitudinal axis and to a pre-set distance from said  
 8 platform; and a reciprocating longitudinal actuator coupled to at least  
 9 one shifting bar for moving said shifting bar forward and backward  
 10 along its longitudinal axis for a pre-determined distance, said system  
 11 performing the steps of :

- 12 a) bringing the level of the support bar above the level of the  
 13 shifting bar;  
 14 b) shifting the shifting bar backwards a predetermined distance;  
 15 c) bringing the level of the support bar below the level of the  
 16 shifting bar; and  
 17 d) shifting the shifting bar forward a predetermined distances

18 whereby a load placed on said platform is urged forward from one  
 19 end to the other end.

1 10. A conveying system according to claim 9 wherein said step (a) further  
 2 involves the raising of the support bar to a pre-set distance above the  
 3 shifting bar; and said step (c) further involves lowering the support  
 4 bar to a pre-set distance below the shifting bar.



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- 1 11. A conveying system according to claim 9 wherein said reciprocating  
2 vertical actuator and said reciprocating longitudinal actuator are both  
3 coupled to said shifting bar; said step (a) further involves lowering  
4 said shifting bar to a level below the support bar; and step (c) further  
5 involves raising said shifting bar to a pre-set distance above the  
6 support bar
- 1 12. A conveying apparatus according to claim 9 wherein an second  
2 reciprocating vertical actuator is coupled to each of said support bar;  
3 said step (a) further involves raising the support bar to the same level  
4 as the shifting bar; then lowering the shifting bar to a pre-set distance  
5 below the support bar; said step (c) further involves raising the  
6 shifting bar to the same level as the support bar, then lowering the  
7 support bar to a pre-set distance below the shifting bar.
- 1 13. A conveying system according to claim 12 wherein a second  
2 longitudinal actuator is coupled to said support bar; said step (b)  
3 further involves shifting the support bar forward a pre-determined  
4 distance; said step (d) further involves shifting the support bar  
5 backwards a pre-determined distance.
- 6 14. A conveying apparatus according to any one of claims 1-6 wherein  
7 the side of at least one end of each bar is recessed.



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