United States Patent

[11] 3,584,731

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[21] Appl. No. **781,718**
[22] Filed **Dec. 6, 1968**
[45] Patented **June 15, 1971**
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[54] **FLEXIBLE CONVEYOR APPARATUS**
16 Claims, 12 Drawing Figs.

[52] **U.S. Cl.** **198/109,** 198/139
[51] **Int. Cl.** **B65g 15/50,** B65g 41/00
[50] **Field of Search** 198/109, 139, 195, 181, 189

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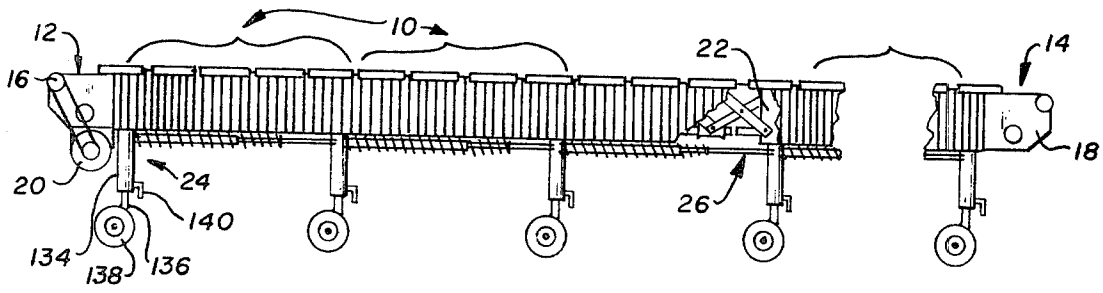
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ABSTRACT: Apparatus includes conveyor belt which is flexible laterally in its own plane for curved paths and carrier framework which is equally flexible for adjustment to any desired plan. Framework has plurality of longitudinally spaced main frames connected by lazy tong linkages at sides to expand and contract longitudinally. Spring force units between successive frames expand apparatus to tension belt. Swinging portions laterally curves the path by contracting inner side of framework while force units keep outer side extended to stretch and tension belt. Sectional track for belt is carried by frames and by lazy tong links.



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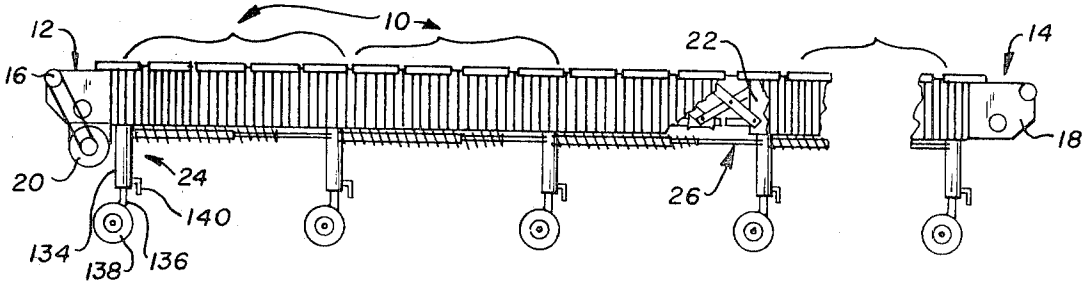


FIG. 1

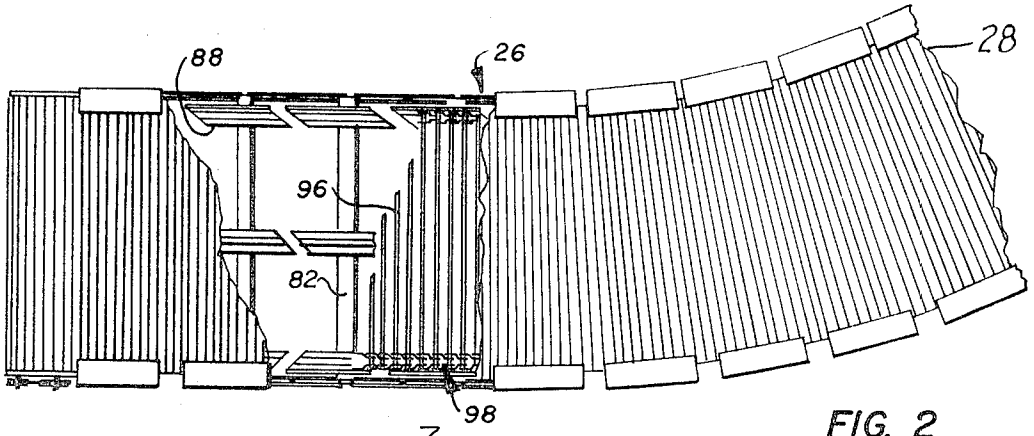


FIG. 2

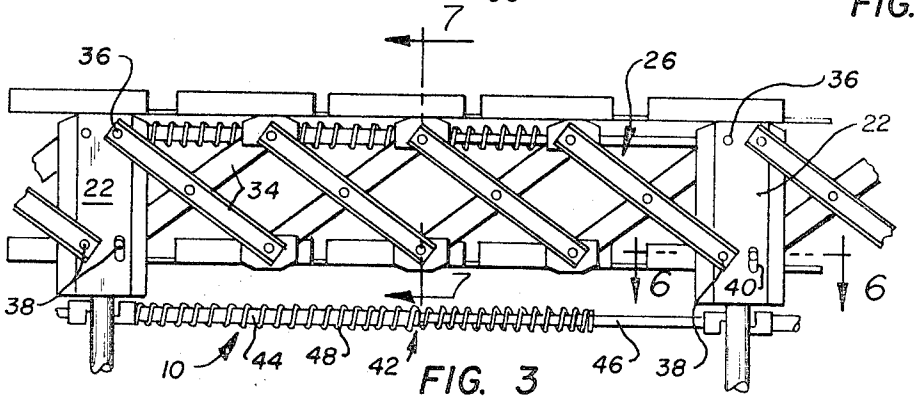


FIG. 3

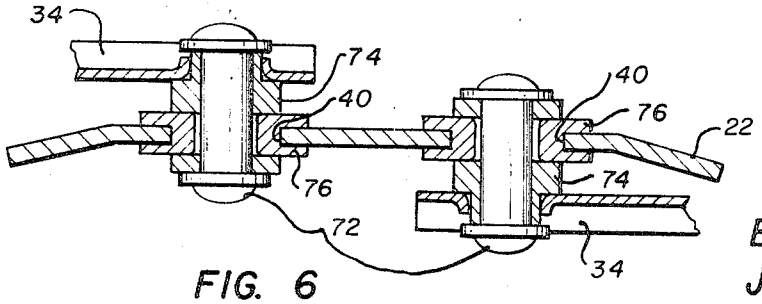


FIG. 6

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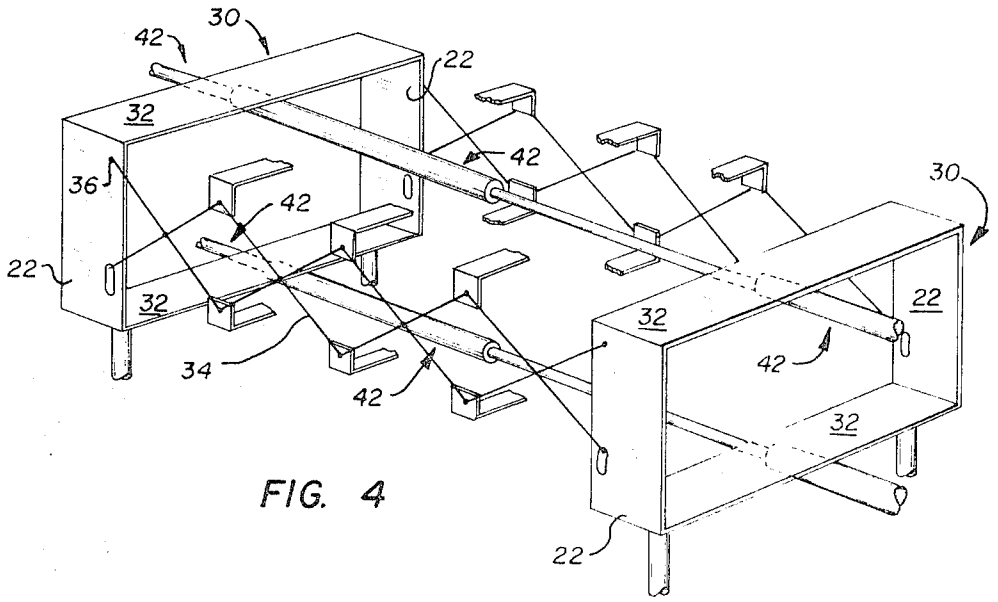


FIG. 4

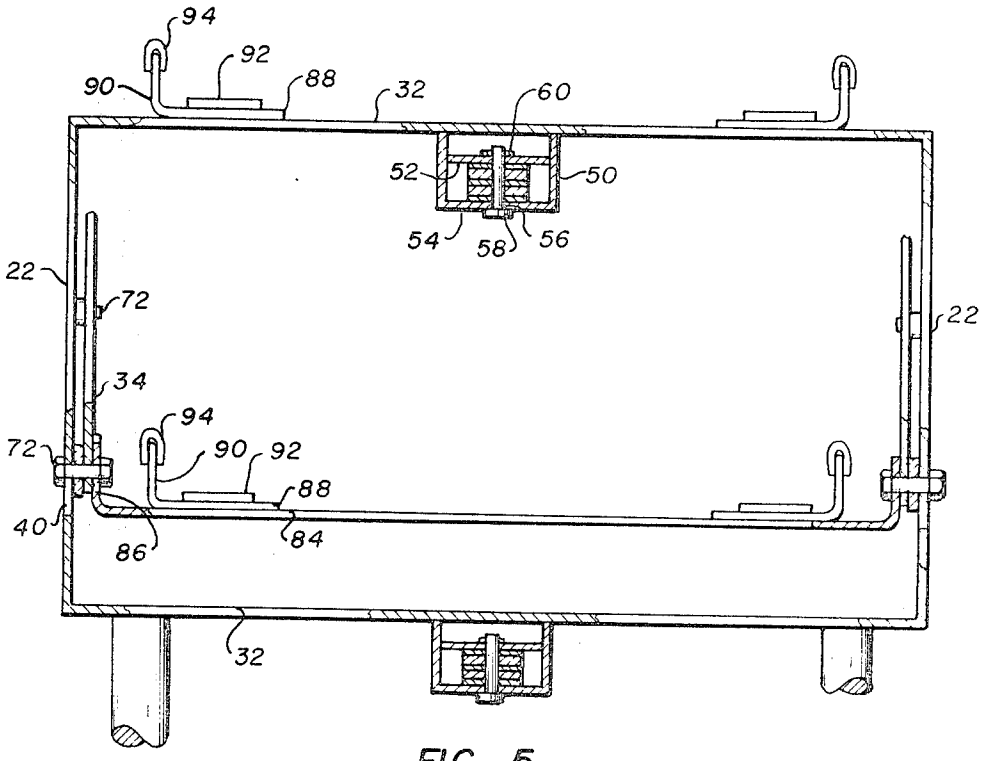


FIG. 5

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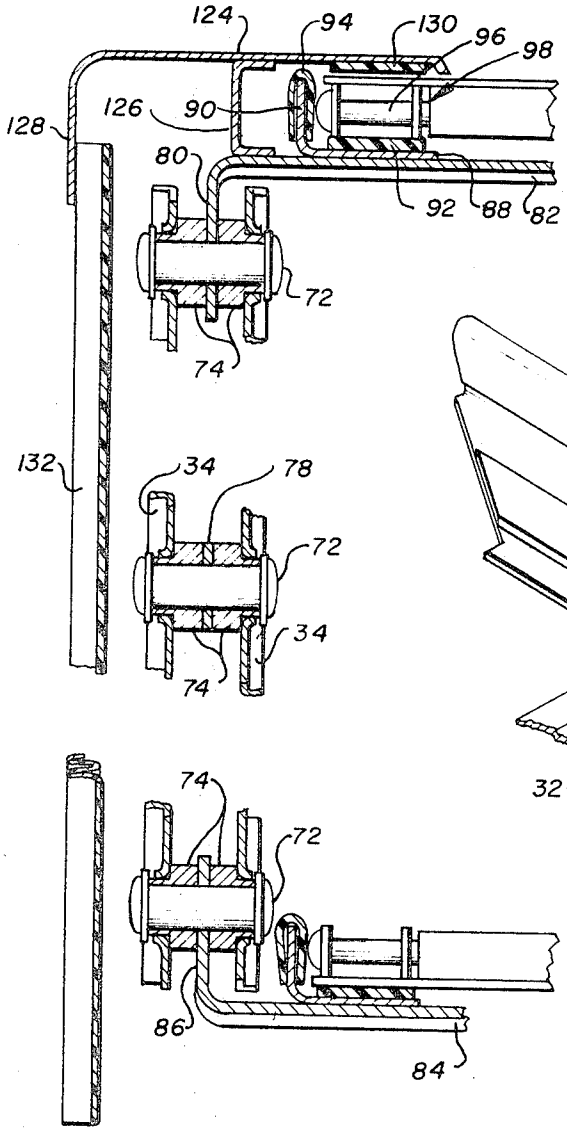


FIG. 7

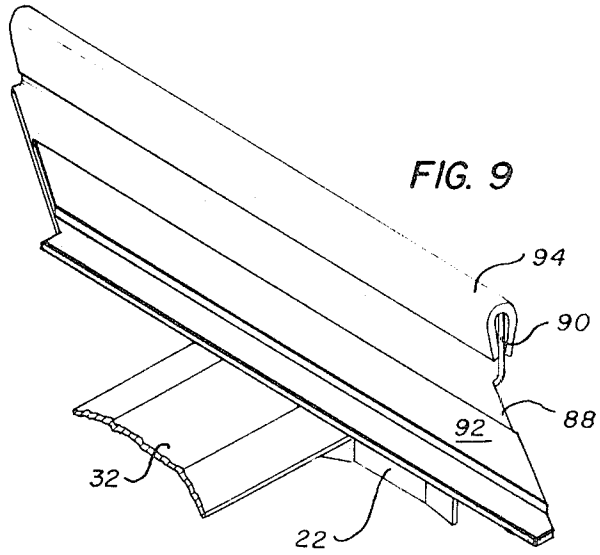


FIG. 9

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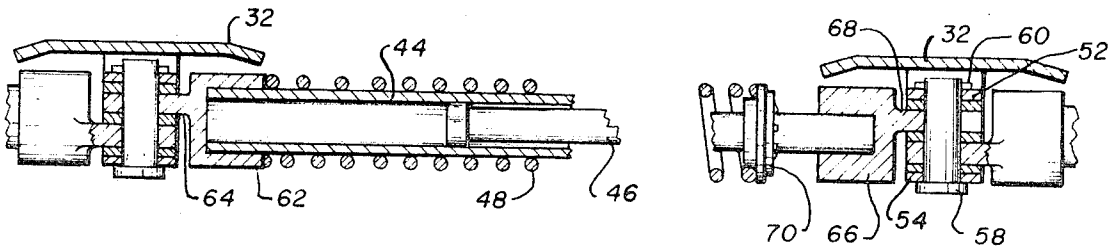


FIG. 8

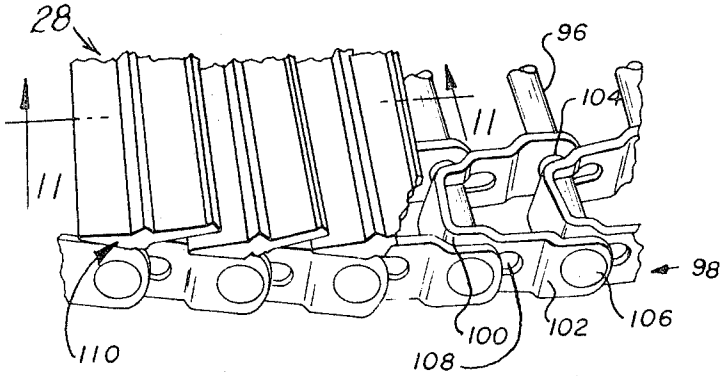


FIG. 10

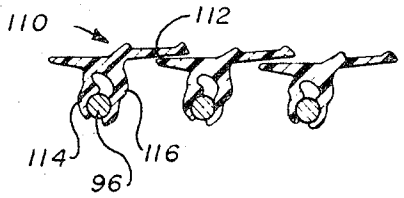


FIG. 11

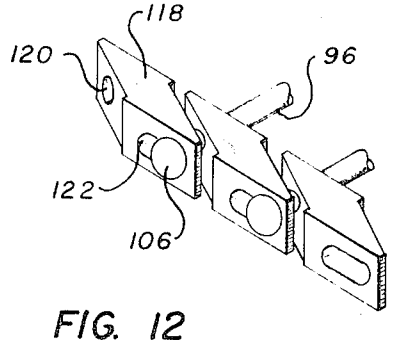


FIG. 12

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FLEXIBLE CONVEYOR APPARATUS

BACKGROUND OF THE INVENTION

This invention lies in the field of conveyor apparatus of the type which includes an endless loop flexible belt which travels along a supporting frame to carry a load between selected stations. Such belts may be merely idlers driven by the weight of the load on a down slope or they may be driven to positively transport the load. The invention is directed more particularly to apparatus of the type mentioned in which the conveyor belt is articulated in such fashion that it has a substantial range of longitudinal expansion and contraction, and each side edge may expand or contract independently of the other. With proper support and guide means such a belt can follow a path which has straight or curved portions or both in plan view, the radius of curvature of course being limited by the amount of play in the articulated linkage.

Such belts are in rather general use and carry out their primary purpose very satisfactorily. However, at the present time their utility is limited by the fact that the supporting structures are made up of fixed, rigid frameworks having some predetermined planform. Even though a belt is capable of following many varied paths it is provided with only a single one in a structure which has been designed and built for a specific installation. If it is necessary to change any part of the path for any reason, at least a part of the supporting structure must be torn down and rebuilt. Likewise, a minor miscalculation in laying out the planform originally may cause interference with other equipment and require rebuilding even before initial use.

SUMMARY OF THE INVENTION

The present invention overcomes the difficulties mentioned above and provides a total conveyor apparatus which is built of comparatively few different standard parts and may be readily constructed of any desired width, height and length. In any size it is universal in utility and may be permanently installed, modified, or moved to a different location with a minimum of time and effort.

Generally stated, the apparatus employs a generally available endless loop laterally flexible conveyor belt of any desired length. Any such belt, because of the articulation mentioned above, has a maximum length and a minimum length. Its minimum radius of curvature in a horizontal plane is a function of the width of the belt, the fully contracted length of the belt on the inside of the curve, and the fully expanded length of the belt on the outside of the curve.

The carrier support of the present apparatus is an articulated framework which is capable of expansion and contraction to a somewhat greater extent than that of the belt and is capable of being curved laterally in either direction to at least as great an extent as the belt. In its presently preferred embodiment it is made up of one or preferably several repeated sections which are about 3 feet long, the most common one at present comprising six sections and having an overall length of about 20 feet.

A typical section is generally rectangular in planform and comprises an open framework having a vertical main frame member at each corner. Each pair of laterally opposed frame member is connected by upper and lower crossmembers rigidly connected to form an open box member symmetrically disposed about a longitudinal axis of the framework. Vertical standards extend downwardly from each frame member to support the structure at a desired level, and castered wheels are provided at the lower ends of the standards to provide mobility for placement or rearrangement.

In order to obtain the desired expansion and contraction, the two main frame members at either side of a section are connected by a longitudinally extending lazy tong or parallelogram linkage having its plane generally vertical. The free ends of the linkage are attached to the respective frame member to provide a general rectangle in planform, the upper free link ends being pivotally connected close to the upper ends of the frame members and the lower free link ends being pivotally connected somewhat above the bottom ends of the frame members. The pivot pins of these latter link ends, of course, ride in vertical slots in the frame members to allow the necessary expansion and contraction of the linkage in well-known manner.

It is necessary to provide track means for longitudinal sliding of the belt. Since the framework must expand and contract longitudinally, the track is made up of discrete track portions. In addition to the crossmembers connecting the main frame members, there are also a plurality of lighter crossbars, one extending between the upper apex pivotal connection of each set of the lazy tong links and the laterally opposite similar connection. A track portion is mounted, at each side of the framework, on each of these crossbars as well as on the crossmembers connecting the main frame members, all of which lie in a common horizontal plane. It will be obvious that as the linkage expands and contracts, all of the track portions will maintain a variable but comparatively uniform spacing for best support of the sliding belt.

Whether the particular framework comprises one section or a dozen or more, the basic standard structural unit is as described above, repeated as many times as necessary to achieve the desired result. Rotary means is normally provided at each end of the framework in the form of a drum rotatable about a horizontal axis normal to the longitudinal axis of the framework to support and guide the belt into a return path. In most cases, at least one drum is power driven to produce the longitudinal movement of the belt.

Almost all installations are long enough to make it desirable or necessary to provide a supporting track for the return portion of the belt to eliminate excessive sag. Where the path has any horizontal curvature a support and guide track is essential. In the present construction, crossbars similar to the upper crossbars described above are connected to the lower apex pivotal connections of each set of the lazy tong links and also to the lower pivotal connection of one end link of each linkage to its respective main frame member. Track portions are mounted on these crossbars the same as the upper ones to make a variable-length track means.

With the construction described above, it is apparent that the framework may be longitudinally expanded and contracted through a substantial range, and also that one side may be contracted while the other remains expanded, within determinable limits, to cause the framework and track means to form a lateral curve in a horizontal plane. This is facilitated by providing a suitable amount of play in the various pivotal connections so that the "curve" is made up of a series of short straight lines. The combination of this framework with the laterally flexible belt first mentioned provides a conveyor apparatus which may be set up in a straight line or curved at any portion to avoid obstacles or to lead to any desired point, and which may readily be moved from place to place and shaped to meet new requirements.

The flexible belt must always be fully expanded at the outside of a curve in order to function properly and hence it must be tensioned to eliminate slack. This is accomplished by the use of spring means which will yieldingly expand the framework longitudinally to apply a desired degree of tension in the belt and yet which will yield to the forces of contraction when the combination is curved laterally. In the present apparatus each section is treated individually by connecting two elongate force units along the longitudinal centerline and between the upper crossmembers and the lower crossmembers of successive box frames. The units are telescoping rods and tubes with coil springs to expand them. Thus the entire framework is longitudinally yieldably expanded to apply spring tension to the belt. When one side of the framework is contracted to form a curve, one or more of the sets of spring units will be slightly contracted while the side of the framework at the outside of the curve remains fully yieldably expanded.

BRIEF DESCRIPTION OF THE DRAWINGS

Various other advantages and features of novelty will become apparent as the description proceeds in conjunction with the accompanying drawings, in which:

FIG. 1 is a side elevational view of a conveyor apparatus embodying features of the invention;

FIG. 2 is a plan view of a portion of the device of FIG. 1 to an enlarged scale showing the apparatus formed to a lateral curve;

FIG. 3 is a side elevational view of a section of the framework showing details of various articulated parts;

FIG. 4 is a diagrammatic view in perspective of a section of the framework;

FIG. 5 is an elevational view, partly in section, showing the relation of various parts;

FIG. 6 is a sectional view taken on line 6–6 of FIG. 3;

FIG. 7 is a sectional view taken on line 7–7 of FIG. 3;

FIG. 8 is a sectional view showing the connection of a force unit to a pair of crossmembers;

FIG. 9 is a perspective view of one of the track portions;

FIG. 10 is a perspective view of a portion of the side edge of a typical laterally flexible conveyor belt;

FIG. 11 is a sectional view taken on line 11–11 of FIG. 10; and

FIG. 12 is a perspective view of a portion of the side edge of a conveyor belt provided with a modified form of track-engaging show.

DESCRIPTION OF PREFERRED EMBODIMENT

The total apparatus is generally illustrated in FIGS. 1 and 2, where it will be seen that in its preferred form the framework is made up of a plurality of sections 10 which are substantially identical in construction and connected in series to make a carrier support of any desired length. Transfer apparatus 12 and 14 is provided at the ends and normally includes rollers 16 and 18. In most cases a roller 16 is driven by a motor 20 to positively move a conveyor belt along the length of the apparatus.

EAch section includes a generally rectangular box member at each end having upright main frame members 22 at each side connected by upper and lower crossmembers and supported by standards 24. The frame members on either side are connected by lazy-tong-type parallelogram linkages 26, the linkage on each side being capable of longitudinal expansion and contraction independently of the linkage on the opposite side. With this construction the contraction of one side will produce lateral curvature of the unit or section. When there are a series of sections, as is the usual case, the assembly may be readily adjusted to the planform shown in FIG. 2, where one portion of the length is straight and another portion is curved. The conveyor apparatus in general is completed by a flexible belt 28, described in more detail later, which is capable of assuming the same lateral curvature as the framework.

The details and relation of the principal parts of a section are best illustrated in FIGS. 3 and 4, where it will be seen that a generally rectangular box member 30 at each end comprises an upright frame member 22 at each side of the framework connected at their upper and lower ends by two crossmembers 32, all being rigidly connected together. The lazy tong linkage 26 extends horizontally between the frame members and its plane is vertical. The individual links 34 are pivotally connected to each other at their ends and centers in standard fashion and the upper free ends are pivotally connected to the upper ends of frame members 22 at 36. The lower free ends are also pivotally connected to frame members 22 near their lower ends, but in this case the pivot pins 38 ride in vertical slots 40 to provide for the necessary motion of the total linkage, all in known manner. With this construction it will be seen that each side of the section can be expanded or contracted in unison to change the length of the section and independently to produce a lateral curve as shown in FIG. 2.

For reasons to be explained later, it is desirable to provide means to yieldingly expand each section while allowing either side of the section to contract independently. For this purpose a pair of force units 42 are provided for each section. They lie substantially along the longitudinal centerline with one unit connected to the upper crossmember 32 and one connected to the lower crossmember 32. Each force unit generally comprises a tube 44 and a rod 46 telescoping therein, and a coil spring 48 surrounding both members and arranged to urge them apart to expand the force unit. The general arrangement of the force units is illustrated in FIGS. 3 and 4 and the detailed construction and connection is illustrated in FIGS. 5 and 8.

Each crossmember 32 is provided at its central lower side with a box bracket having sideplates 50 and cross plates 52 and 54, the cross plates having vertically aligned apertures 56 to receive a headed pivot pin 58 provided with a cotter pin 60 at its upper end to retain it in position. In FIG. 8 it will be seen that tube 44 is provided with a cap 62 having an aperture ear 64 which is mounted on pivot pin 58, the cap serving as a stop for one end of spring 48. Rod 46 is likewise provided with a cap 66 having an apertured ear 68 mounted on pivot pin 58 of the next crossmember. Rod 46 is also provided with a flange 70 which serves as a stop for the opposite end of spring 48. Since the spring is mounted under compression, it serves to yieldingly expand the force unit and hence the entire section. Because of its pivotal connections, it is possible to contract one side of the section, compressing the force unit slightly, while the other side remains expanded and the section assumes a laterally curved planform. Each box member serves as the end of one section and the beginning of another, and there are a pair of force units between each two box members as indicated in FIG. 4.

FIGS. 6 and 7 illustrate the pivotal connections between the links 34 and the main frame members 22. In FIG. 6, pins 72 pass through the links and the main frame member and are provided with spacers 74 and with grommets 76 which slide vertically in slots 40. The pins have a loose fit in the grommets so that the links may swing a few degree laterally to provide for the curvature of the framework. In FIG. 7, the pins 72 pass through the ends and the centers of links 34 and are also provided with spacers 74 as well as a washer 78 in the center connection.

At the upper pivotal connection of each set of links 34, the flange 80 of a crossbar 82 is located between the spacers 74, the crossbar extending across the width of the framework and being provided with a similar flange and connection at the opposite side. A similar crossbar 84 with an upwardly directed flange 86 is connected in the lower pivotal connection of each set of links. In order to provide track means for sliding travel of a conveyor belt, each crossbar 82 is provided near each end with a track portion 88 having an upstanding guide flange 90. A flat wear strip 92 is mounted on the track portion and a channel-shaped wear strip 94 is mounted on the guide flange. Each crossbar 84 is provided with substantially identical track portions. The upper track portions combine to form track means for the load-carrying passage of the belt and the lower track portions combine to form track means for the return passage of the belt.

The upper crossmember 32 of each box member is similarly provided with a track portion 88 to complete the track means, as shown in FIG. 9. All of the track portions lie in the same plane to avoid interference with movement of the belt 28. It will be further noted in FIG. 9 that each end of portion 88 is cut at a long angle. Referring back to FIG. 2 it will be seen that this results in angular gaps in the track assembly which can expand and contract without forming a gap at right angles to the line of travel. Thus there is continuous track support for the belt at all times.

As the lazy tong linkage expands and contracts, the lower pivotal connections of the sets of links 34 rise and fall, as do the crossbars and track portions. Consequently, no track portions can be mounted on the lower crossmembers 32 which remain at a fixed height. Instead, an additional crossbar 84 is provided in the general plane of each box member and its

flange 86 is mounted on the pivot pin 72 which slides in slot 40, as seen in FIG. 5. A track portion 88 is mounted at each end of this additional crossbar 84 to complete the lower track assembly.

The conveyor belt shown in FIG. 2 and in greater detail in FIG. 10 comprises a plurality of small rods 96 extending across the width of the belt. At each end of each rod is mounted a U-shaped link 98 having a yoke 100 and legs 102. The rod passes through circular apertures 104 in the end of each leg and is headed over at 106 to maintain the assembly. In addition, each leg is provided adjacent the yoke with an elongate aperture 108. The links are nested as shown so that each rod passes through apertures 104 of its own link and apertures 108 of the nested link. Thus the belt is flexible about the axis of each rod and may expand and contract to the extent of travel of each rod in the nested link. On a lateral curve, as in FIG. 2, the belt is fully expanded at the outside of the curve sufficiently to produce the amount of curvature desired for the particular installation. The links slide along the track portions previously described, and guide flanges 90 prevent lateral movement of the belt inwardly of its proper path around a curve.

When it is necessary or desirable to cover the open spaces between the rods, a series of individual cover plates 110 are provided. As seen in cross section in FIG. 11, each plate is generally T-shaped, having an upper crossmember 112 and a pair of depending legs 114, 116. The plate is preferably a plastic extrusion, and the material is resilient enough to snap the legs over a rod 96 into the elongate recess between the legs. In the event of damage or excessive wear, they are readily removed and replaced.

A modified form of link is shown in FIG. 12, and comprises a die-cast or molded plastic block 118 having angular ends to provide an overlapping assembly. Rod 96 passes through a circular opening 120 in its own link and through an elongate opening 122 in the next link and is headed over at 106. The action is the same as in the form of FIG. 10 but he links have a much larger rubbing surface which reduces wear on both the links and the wear strips of the track portions.

A protective curtain or shield is shown in FIG. 7 and includes a series of short strips 124 of preferably plastic material mounted in horizontal position by brackets 126 to the crossmembers 32 and crossbars 82 to overlie links 98, and having depending flanges 128. Each strip is provided with an underlying wear strip 130 slightly spaced above the links and serving to prevent them from leaving the track portions. Strips 124 also protect the hands of operators from contact with the links. Depending from flanges 128 is an accordion-type curtain 132 to shield the side portion of the framework. The accordion formation allows the curtain to expand and contract with the framework.

Since the force units are connected in series from end to end, it will be apparent that when the apparatus is in straight line attitude the framework will expand until the belt is fully expanded and spring tensioned. Slots 40 in frame members 22 are long enough so that the framework may both expand and contract to a greater extent than the belt and thus permit the belt to attain its maximum curvature when desired. In order to provide lateral bending flexibility along all portions of the framework both at and between the main frame members, all pivotal connections are provided with sufficient play to permit the necessary angular movement.

Standards 24 comprise upper tubular struts 134 and lower caster rods 136 carrying wheels 138 to facilitate movement in all directions for placement of the apparatus. This arrangement also makes it possible to change the orientation of the apparatus while it is in operation. This is particularly valuable when the receiving operator must move from place to place, as along a warehouse wall, in order to reach additional storage area. Latch means 140 serves to lock the casters against rotation when the apparatus is in a desired conformation.

It will be apparent to those skilled in the art that various changes may be made in the construction and arrangement of parts as disclosed without departing from the spirit of the invention and it is intended that all such changes shall be embraced within the scope of the following claims.

We claim:

1. The combination of an endless loop flexible conveyor belt and a carrier support therefor; said belt comprising a plurality of lost motion linkages connected to provide longitudinal expansion and contraction of the side edges of said belt jointly or separately to permit lateral curvature in the plane of the belt; said support comprising an articulated structure having an elongate generally rectangular planform and provided with means to maintain its upper portion at a desired height above ground level; said upper portion being provided with track means at each side to support the side edges of said belt for sliding movement therealong; transfer means at each end of said carrier support to engage said belt and guide it in a return direction; the articulated structure providing means for independent longitudinal expansion and contraction of each side of said support to approximately the same extent as the longitudinal expansion of said belt; and either side of said support being contractable in unison with the corresponding side edge of the belt to curve the combination apparatus laterally in a generally horizontal plane while leaving the opposite side fully expanded to maintain tension in the belt.

2. The combination as claimed in claim 1; and force-applying means to apply yieldable longitudinal expanding force to said support and produce a desired degree of tension in said belt; the contraction of one side of the support and belt serving to overcome the force-applying means sufficiently to produce the desired degree of curvature without preventing the force applying means from maintaining expansion of the other side of the support and belt.

3. The combination as claimed in claim 1; said support being expandable and contractable through a greater range than said belt to ensure full expansion and tensioning of the belt and maximum contraction of the selected side edge of the belt for minimum turn radius.

4. The combination as claimed in claim 1; said track means serving to support the load-carrying portion of said belt; and second track means spaced below the first said track means at each side of the support and serving to support the return portion of said belt.

5. The combination as claimed in claim 1; the track means at each side of said support comprising a series of longitudinally spaced discrete track portions uniformly movable toward and away from each other longitudinally as the support contracts and expands.

6. Flexible conveyor apparatus for supporting an endless loop flexible conveyor belt which is adapted to expand and contract longitudinally at each side edge jointly or independently to produce lateral curvature in the plane of the belt, comprising: An elongate framework having a generally rectangular planform and having at least two longitudinally spaced upright main frame members at each side: means to maintain the main frame members at a desired height above ground level; at least one crossmember rigidly connecting each set of two laterally opposed main frame members to maintain them in predetermined relation to each other; longitudinally expandable and contractable connector means extending between each pair of longitudinally successive main frame members at either side of said framework to provide for longitudinal separation and approach of the frame members at one side of the framework independently of the frame members at the opposite side; contraction of the connector means at one selected side while the opposite connector means remains expanded serving to produce curvature of the framework in a horizontal plane; longitudinally extending track means carried by the framework along each side to support the belt in sliding relation; and transfer means at each end of the framework to engage the belt and guide it in a return direction; the track means at each side of said framework comprising a series of longitudinally spaced discrete track portions uniformly movable toward and away from each other longitudinally as the framework contracts and expands.

7. Apparatus as claimed in claim 6; and force-applying means to apply yieldable longitudinal expanding force to said framework; said force being selectively yieldable to longitudinal contraction of either side of said framework independently of the opposite side.

8. Apparatus as claimed in claim 7; said force-applying means comprising a force unit extending between each successive pair of crossmembers; the force unit including a telescoping rod and tube having free ends connected to the successive crossmembers and a coil spring arranged to urge the rod out of the tube to increase the overall length of the force unit.

9. Apparatus as claimed in claim 8; said framework including a crossmember extending between the upper ends of each set of two laterally opposed main frame members and a second crossmember extending between the lower ends of said main frame members, all being rigidly secured to form a rigid boxlike structure; one force unit extending between each two successive upper crossmembers and one force unit extending between each two successive lower crossmembers; said force units lying substantially on the longitudinal centerline of the framework and being pivotally connected to the crossmembers.

10. Apparatus as claimed in claim 6; the connector means between two main frame members at either side of the framework comprising an articulated lazy-tong-type parallelogram linkage extending generally horizontally and with the plane of the linkage generally vertical; the free ends of the linkage being pivotally connected to the main frame members to constitute a trusslike arrangement.

11. Apparatus as claimed in claim 10; the track means at each side of said framework comprising a series of longitudinally spaced discrete track portions; one track portion being carried by the upper end of each main frame member and one track portion being carried by the upper apex pivotal connection of each set of lazy tong links; all of said track portions lying in a common horizontal plane.

12. Apparatus as claimed in claim 11; and a second set of discrete track portions at each side of said framework spaced directly below the first set and similarly connected to the lower apex pivotal connection of each set of lazy tong links and to the lower pivotal connection of one end link to each main frame member.

13. Apparatus as claimed in claim 10; the pivotal connections of the lazy tong links with each other and with the main frame members being provided with a small amount of play to provide for angular variation in a horizontal plane between each set of links and the frame members resulting in horizontal curvature of the framework.

14. Apparatus as claimed in claim 8; in which one track portion is carried by each main frame member and a plurality of track portions are arranged in spaced relation between two main frame members and carried by the connector means.

15. Apparatus as claimed in claim 6; the means to maintain the main frame members at a desired height comprising standards extending downwardly from the main frame members; and castered wheels at the lower ends of said standards to facilitate repositioning of parts of the framework while the apparatus is in operation.

16. apparatus as claimed in claim 16; and means to lock the wheels against castering to prevent displacement of the framework during operation.