

[54] **ENDLESS CONVEYOR SYSTEM**[72] Inventors: **Otto H. Meier**, Shelburne; **Richard F. Leopold**, South Burlington, both of Vt.[73] Assignee: **General Electric Company**[22] Filed: **March 31, 1970**[21] Appl. No.: **24,198**[52] U.S. Cl. .... **198/22 R, 89/33 MC, 198/131**[51] Int. Cl. .... **B65g 47/00**[58] Field of Search ..... **89/33 MC; 198/20, 22, 141, 198/143, 131**[56] **References Cited****UNITED STATES PATENTS**

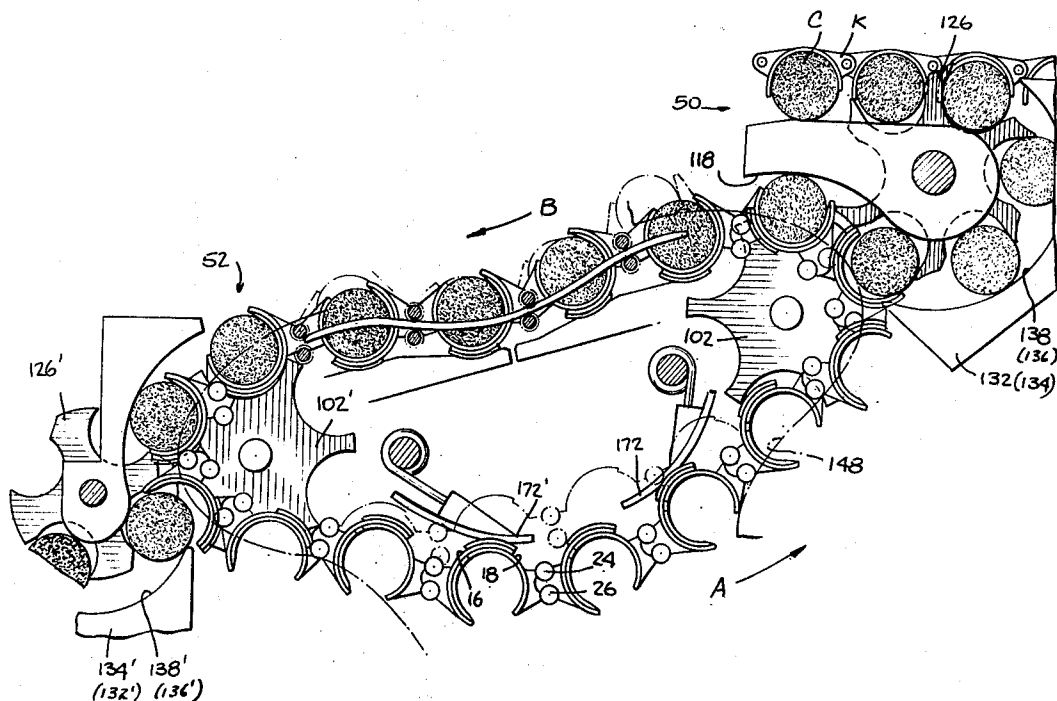
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| 737,216   | 9/1903 | Forry ..... | 198/22 X |
| 2,006,343 | 7/1935 | Brown ..... | 198/152  |

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[57]

**ABSTRACT**

A flexible conveyor assembly including an endless chain of "clam shell" units linked together. Each unit includes two unit halves formed as longitudinally-sectioned, closed-ended, hollow cylinders. These units have interlocking joints which hold the halves together, and allow the halves to rotate concentrically with respect to each other, thus allowing the unit to "clam shell" around a cartridge. Each unit assembly is attached to the next adjacent unit by a spherical double-tapered sleeve joint which holds a set pitch to pitch length while allowing roll, fan and twist misalignment between the units. At each end of the element assembly are double pin guides which fit around flexible rod guide rails.

**5 Claims, 7 Drawing Figures**

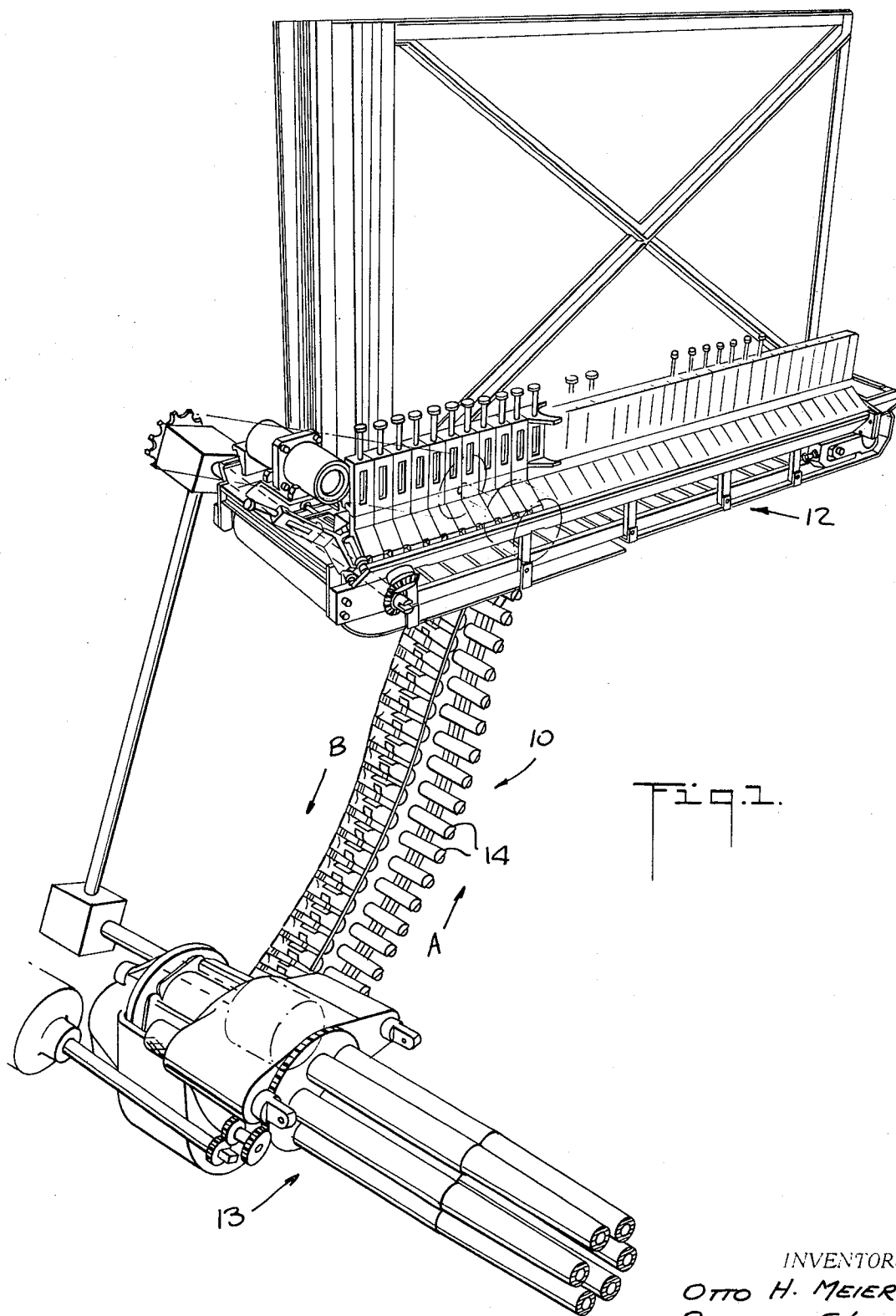
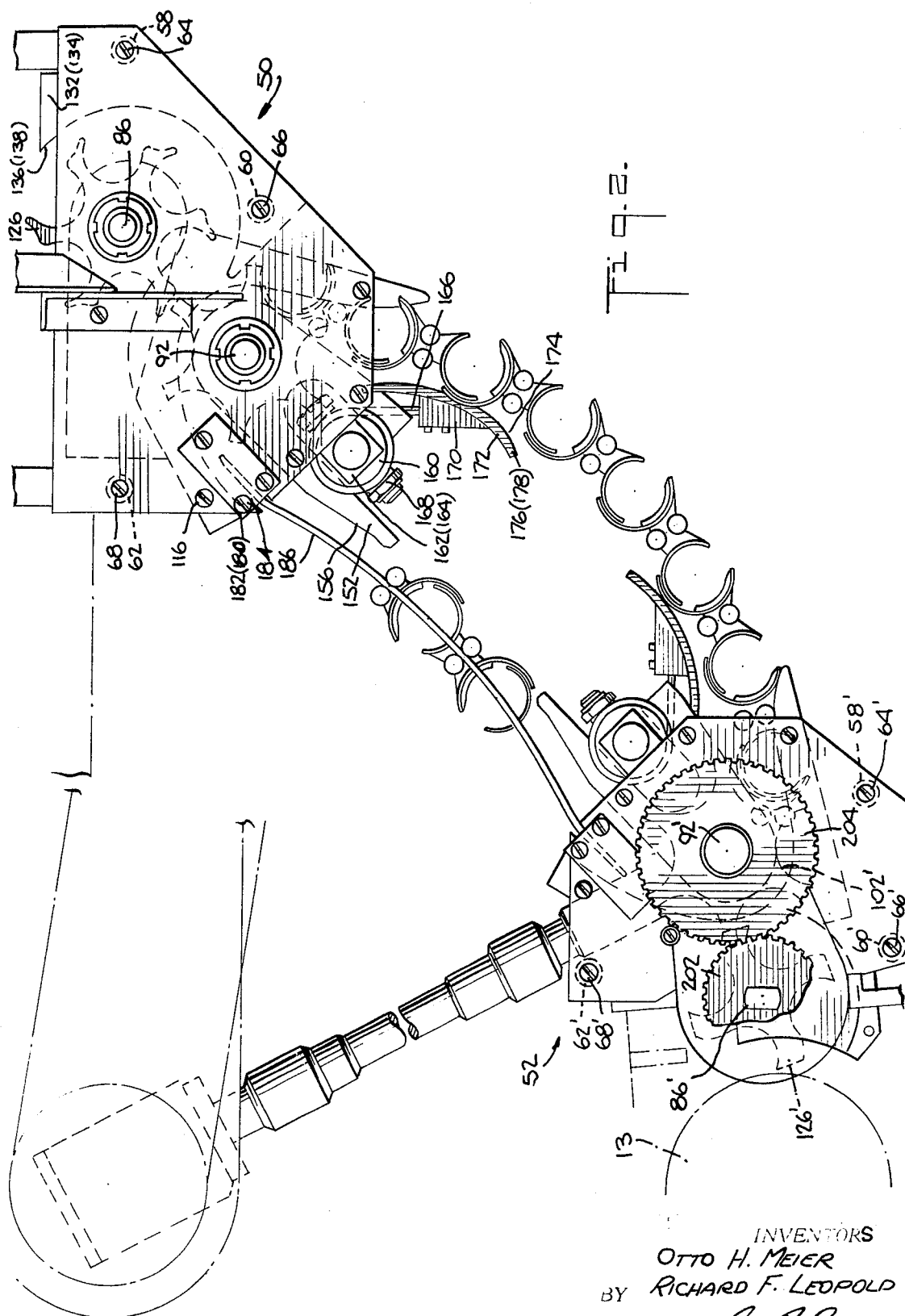


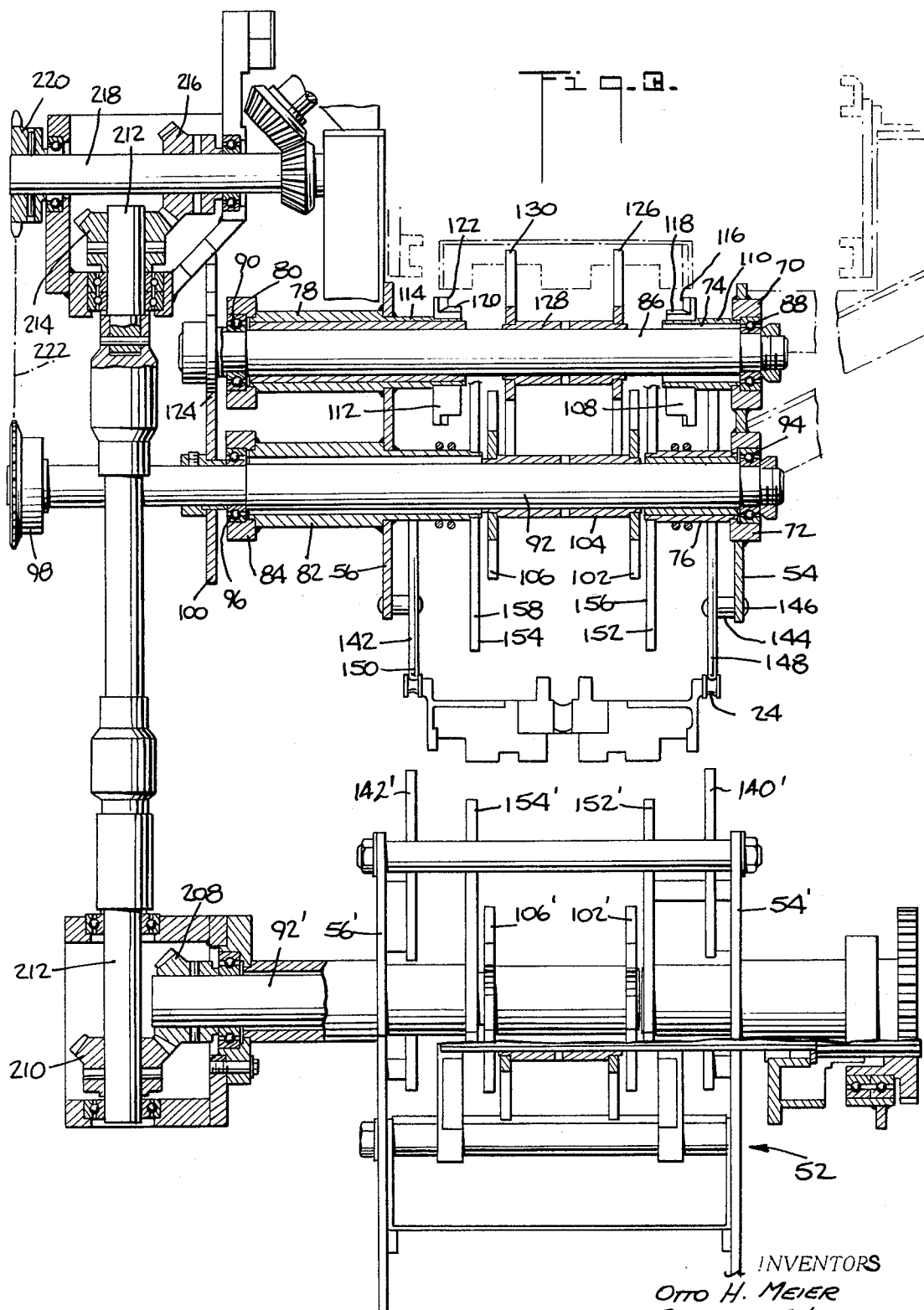
Fig. 1.

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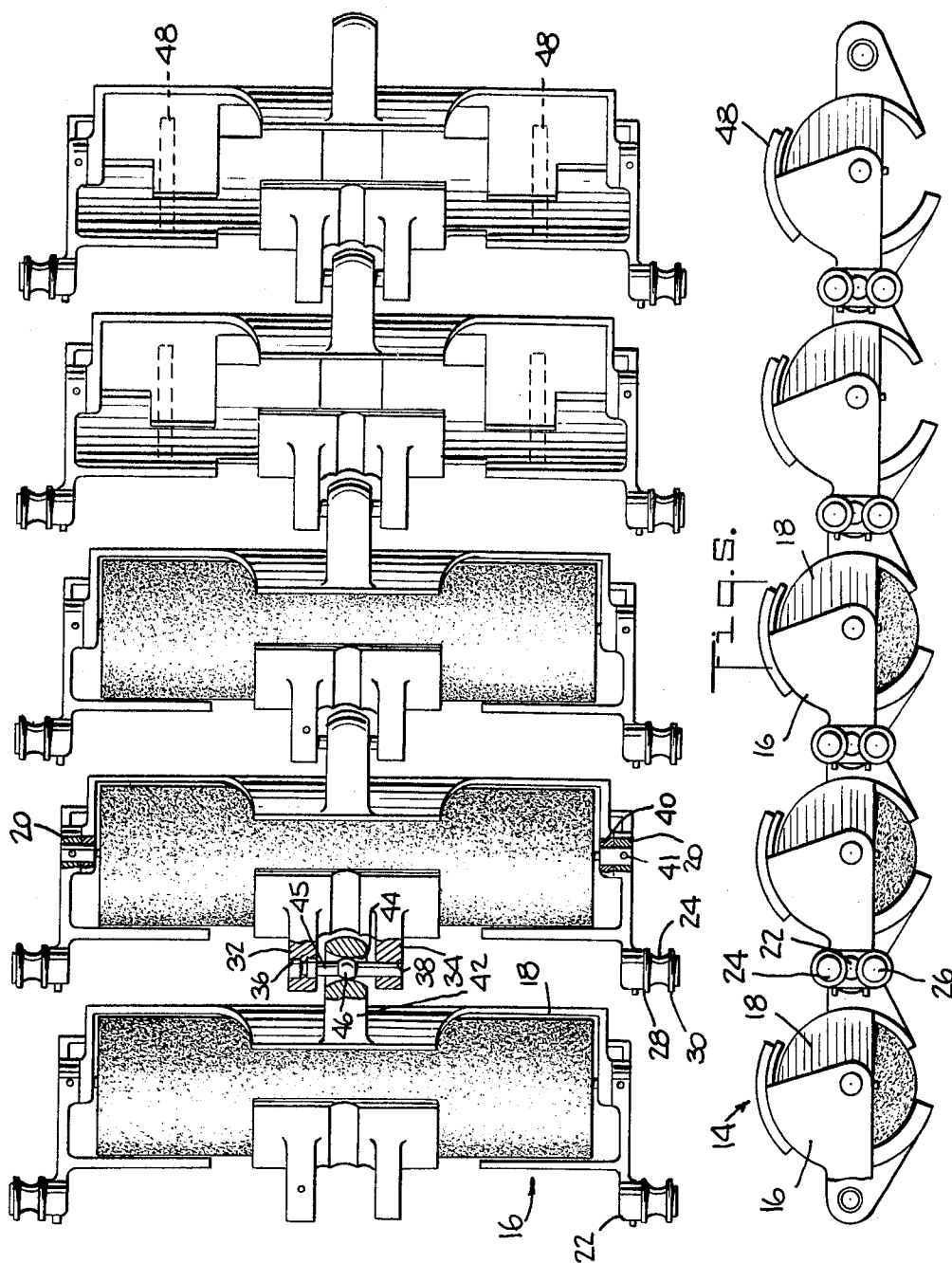
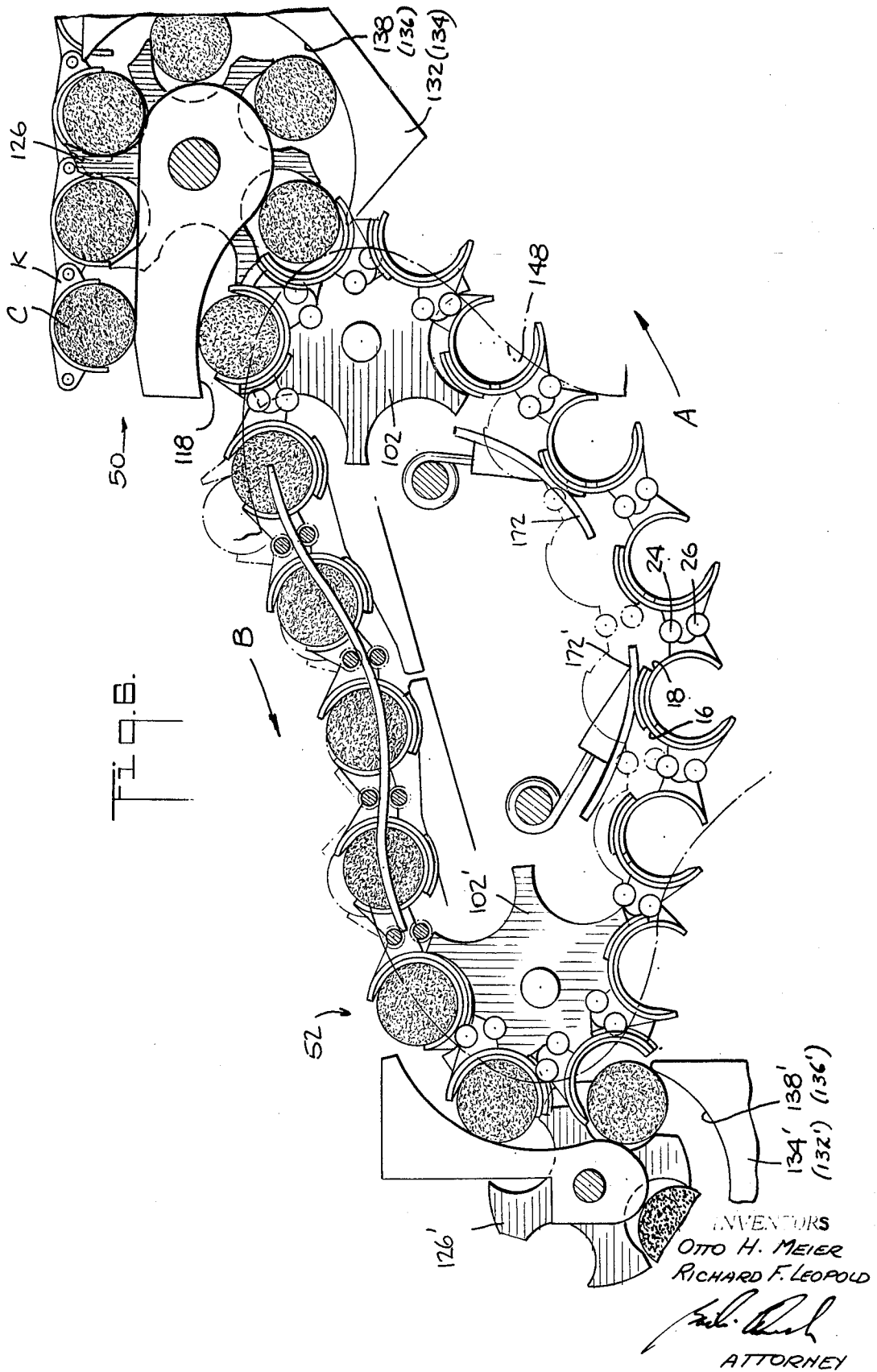


FIG. 4.

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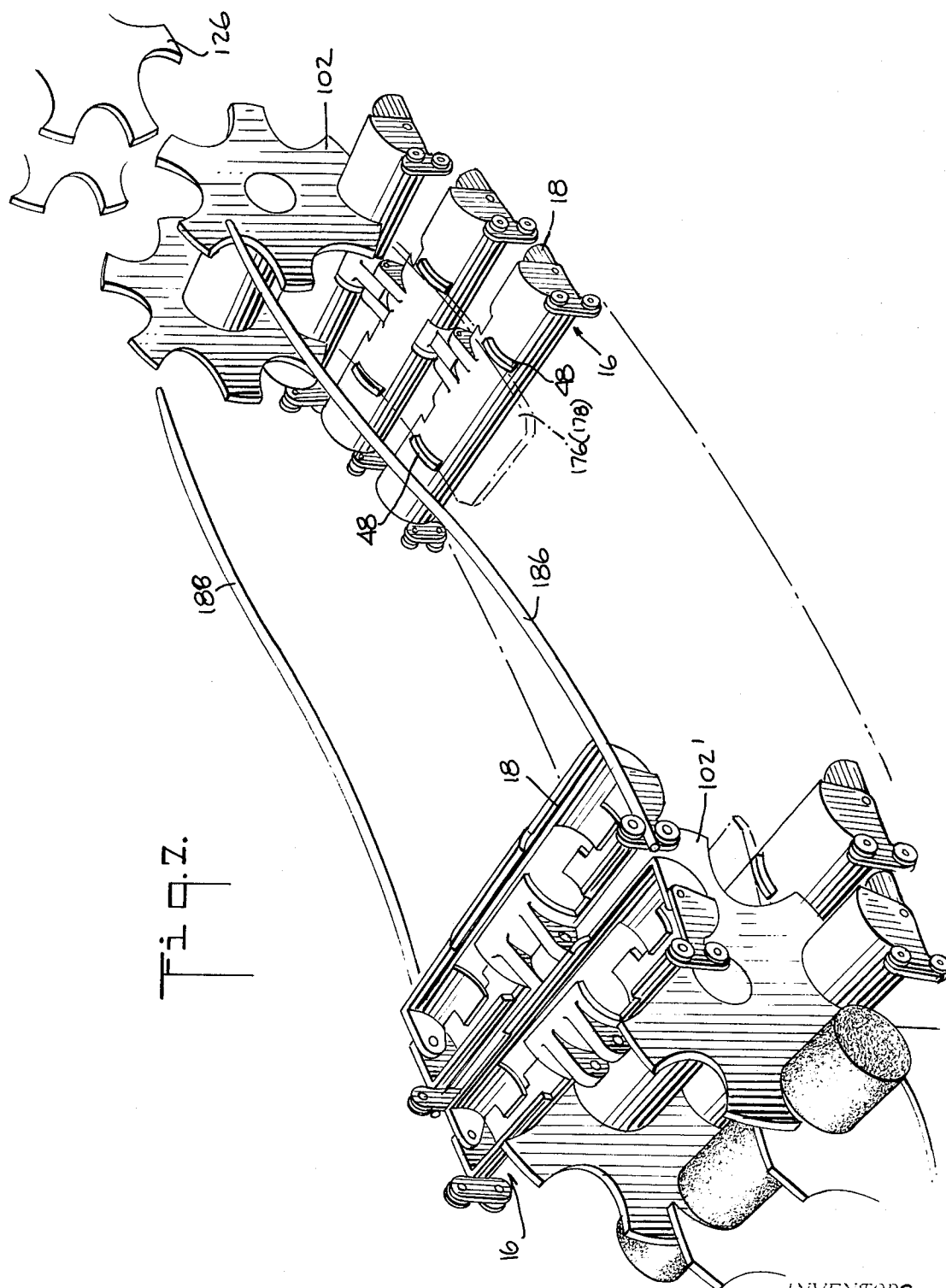


FIG. 7.

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## ENDLESS CONVEYOR SYSTEM

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

This invention relates to endless conveyor systems, and particularly to such systems for supplying cartridges to automatic guns.

#### 2. Background of the Invention

Aircraft armament now requires extremely high rates of fire, e.g. 6,000 to 12,000 shots per minute, in short or sustained bursts. While the modern Gatling type weapon disclosed by H. McC. Otto in U.S. Pat. No. 2,849,921, issued Sept. 2, 1958 and by R.E. Chiabrandy et al in U.S. Pat. No. 3,380,343, issued Apr. 30, 1968 is admirably suited to this task, the supplying of cartridges to the weapon becomes a more critical limitation as the individual mass and total number of cartridges to be accelerated and conveyed from the ammunition storage device to the weapon increases. J. M. Trumper in U.S. Pat. No. 3,437,005, issued Apr. 8, 1969; and R.G. Kirkpatrick in U.S. Pat. No. 3,429,221, issued Feb. 25, 1969 show systems suited to this purpose for conveying cased cartridges. These systems require the cartridges to have a wear resistant surface, since their surfaces suffer friction engagement.

E. Ashley et al in U.S. Patent Application No. (Attorney's Docket 52-AR-1673), filed Mar. 10, 1970, disclose a Gatling type weapon utilizing caseless cartridges. Those cartridges are moulded out of the propellant powder in a cylindrical shape. The surface of the cartridge is relatively fragile. Further, the weapon is movable with respect to its ammunition storage device.

### SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide an endless conveyor system which will transport cartridges at a rapid rate from a storage device to a weapon without abrading the surfaces of the cartridges.

It is another object of this invention to provide such a system which is flexible and will accommodate fan, roll and twist routing of the conveyor path.

A feature of this invention is a flexible conveyor assembly including an endless chain of "clam shell" units linked together. Each unit includes two unit halves formed as longitudinally-sectioned, closed-ended, hollow cylinders. These units have interlocking joints which hold the halves together, and allow the halves to rotate concentrically with respect to each other, thus allowing the unit to "clam shell" around a cartridge. Each unit assembly is attached to the next adjacent unit by a spherical double-tapered sleeve joint which holds a set pitch to pitch length while allowing roll, fan and twist misalignment between the units. At each end of the element assembly are double pin guides which fit around flexible rod guide rails.

### BRIEF DESCRIPTION OF THE DRAWING

These and other objects, features and advantages will be apparent from the following specification of the invention taken in conjunction with the accompanying drawing on which:

FIG. 1 is a perspective view of a total weapon system including a Gatling type weapon and a cartridge storage device interconnected by a conveyor system embodying this invention;

FIG. 2 is a front view in elevation of the conveyor system of FIG. 1;

FIG. 3 is an end view in elevation of the conveyor system of FIG. 2;

FIG. 4 is a top view of a train of "clam shell" units;

FIG. 5 is a front view of the train of units of FIG. 4;

FIG. 6 is a front view similar to FIG. 2 showing the movement of cartridges into, through and out of the conveyor system; and

FIG. 7 is a perspective view similar to FIG. 6.

The conveyor system 10 shown in FIG. 1 is utilized to transport caseless cartridges from a stationary cartridge storage

device 12 such as is shown in U.S. Patent Application No. (Attorney's Docket No. 52-AR-1639) to a movable Gatling type weapon 13 such as is shown in U.S. Patent Application No. (Attorney's Docket No. 52-AR-1643).

The conveyor system 10 includes an endless chain of linked together "clam shell" units 14. Each unit includes a first outer half 16 and a second inner half 18, each is shaped generally as a longitudinally-sectioned, closed end cylinder. The outer half 16 has at each end wall a longitudinal pivot bearing 20 and a radial arm 22. Two spaced apart rollers 24, 26 are journaled to the arm 22. Each roller has two spaced apart flanges 28, 30. Each outer half 16 also has two spaced apart radial lugs 32, 34 extending from the middle portion of the side wall. Each lug has a respective bore 36, 38 therethrough. The inner half 18 has at each end wall a longitudinal pivot bearing 40. A shaft 41 is disposed through the bearings 40 and 20 to interlock the two halves 16 and 18, for mutual concentric rotation. Each inner half 18 also has a radial lug 42 with a double tapered bore 44 therethrough. A shaft 45 with a central ball portion 46 is disposed through the bore 44 and through the bores 36, 38 of the lugs 32, 34 of the next adjacent outer half 16. This coupling arrangement ensures uniform spacing between mid points of adjacent "clam shell" units, and yet permits relative fan, twist and roll between adjacent elements. Additionally, each outer half 16 has two spaced apart ribs 48 for providing lateral constraint during cartridge handling operations.

The conveyor system also includes an entrance assembly 50 and an exit assembly 52.

The entrance assembly includes a front plate 54 and a rear plate 56 which are secured in a spaced apart, parallel relation by three spacer tubes 58, 60, 62 respectively fixed by three bolt assemblies 64, 66, 68. The front plate has an upper front bearing housing 70 and a lower front bearing housing 72 fixed thereto, which in turn have an upper extension tube 74 and a lower extension tube 76 respectively fixed thereto. The rear plate has an upper extension plate 78 with an upper bearing housing 80 fixed thereto, and a lower extension plate 82 with a lower bearing housing 84. An upper shaft 86 is journaled through and between upper bearings 88, 90 and a lower shaft 92 is journaled through and between lower bearings 94, 96. A sprocket wheel 98 is pinned to the aft end of the lower shaft 92, and a spur gear 100 is pinned to the shaft aft of the aft bearing. A lower sprocket assembly comprising a forward sprocket 102, a spacer tube 104, and an aft sprocket 106 is also pinned to the lower shaft. A forward loading tray bar 108 is fixed by a spacer tube 110 to the housing 70 and a spacer tube to the forward plate 54. An aft loading tray bar 112 is similarly fixed by a spacer tube 114 to the housing 80 and by another spacer tube to the aft plate 56. The bars in conjunction have a forward transverse surface 116, a forward longitudinal surface 118, an aft longitudinal surface 120, and an aft transverse surface 122 to receive and guide cartridges C delivered by a conveyor K of the stationary storage device 12, as shown in FIG. 6. A spur gear 124 is pinned to the aft end of the shaft 86 and is meshed with the gear 100. An upper sprocket assembly comprising a forward sprocket 126, a spacer tube 128 and an aft sprocket 130 is also pinned to the upper shaft. Two guide plates 132, 134 are respectively spaced from and fixed to the plates 54, 56, in alignment with the sprockets 126, 130, by suitable spacer tubes and bolt assemblies, and have respective guide surfaces 136, 138, spaced from the longitudinal surfaces 118, 120 by a distance equal to the diameter of the cartridges. Thus, briefly, as seen in FIG. 6, cartridges are delivered by the conveyor K onto the surfaces 118, 120, between the surfaces 116, 122; are engaged by the sprockets 126, 130; and are carried around by the sprockets, between the surfaces 118, 138 and 120, 136, while between the transverse surfaces 116, 122, for disposition into the units 14. As seen in FIGS. 2 and 3, two guide plates 140, 142 are respectively spaced from and fixed to the plates 54, 56 in alignment with the rollers 24 by suitable spacer tubes 144 and bolt assemblies 146, and have respective guide surfaces 148, 150 which serve as tracks for the rollers 24 as the cam ele-

ments are carried around the lower sprocket assembly. Two additional guide plates 152, 154 are respectively spaced from and fixed to the plates 54, 56 by the spacer tubes 76, 82 respectively and by other suitable spacer tubes and bolt assemblies, and have guide surfaces 156, 158 for bearing against the outer halves 16. A rod 160 is fixed between two pads 162, 164 which are respectively fixed to plates 54, 56. A coil spring 166 is fixed about the rod 160 by a nut 168 and has two ends which are fixed in two pads 170 which is fixed to a curved shoe plate 172. The shoe plate has an under surface 174 which bears against and biases the outer halves 16, and provides tension in the train of elements, and has two guide surfaces 176, 178 which pass between the ribs 48 for aligning the outer halves before their rollers 24 engage the guide surfaces 148, 150. Two pads 180, 182 are respectively secured to the plates 54, 56, over cutouts therein by machine screws 184, and have respectively welded thereto two rods 186, 188 which are in alignment with the surfaces 148, 150 and the rollers 24. As shown in FIG. 6, the "clam shell" units 14 return empty from the weapon in the direction of arrow A towards the entrance assembly 50. Each unit is aligned by the shoe 172 passing between the ribs 48, and then its rollers 26 ride onto the guide surfaces 148, 150 and the unit is then captured by the lower sprockets 102, 106 and carried around towards the upper sprockets 126, 130. As each unit is carried around the gap between the surfaces 148, 150 and the valleys of the sprockets 102, 106, taken along a line which is radial to the longitudinal axis of the sprockets, progressively decreases. Compressive forces generated by the sprocket valley surfaces pressing against the trailing rollers 26 carried by that outer half and the leading rollers 26 coupled to the mating inner half, cause relative concentric movement of the two halves, resulting in an opening up of the "clam shell" unit to receive a cartridge. After the cartridge has been received, the unit comes around and out of the sprockets with relative concentric movement of the halves, to close the element about the cartridge, and continue in the direction of the arrow B. Before the rollers 24 leave the surfaces 148, 150, the rollers 24, 26 straddle the rods 186, 188, which serve as guide rails and which maintain the units in a closed disposition.

The exit assembly 52 is quite similar to the entrance assembly 50 and has a front plate 54' and a rear plate 56' which are secured in a spaced apart, parallel relation by three spacer tubes 58', 60', 62' respectively fixed by three bolt assemblies 64', 66', 68'. Also provided are conveyor sprockets 102', 106' and hand-off sprockets 126', 130'. The hand-off sprockets 126', 130' may also serve as the feeder sprockets of the weapon 13 which hand the cartridges into the rotary feed tray of the weapon. Also provided are shafts 92', 86', guide plates 132', 134', with guide surfaces 136', 138', guide plates 140', 142', with guide surfaces 148', 150', guide plates 152', 154', with guide surfaces 156', 158', rod 160' supported by pads 162', 164', with a coil spring 166', pads 170' and a curved shoe plate 172', and pads 180', 182' welded to the other ends of the rods 186, 188. For the purpose of illustrating a functional conveyor system, shafts 86' and 92' are shown permanently synchronized by meshed spur gears 202 and 204 respectively fixed thereto. However, if the sprocket 126' is actually the feeder sprocket in the weapon, the synchronization is provided by synchronized clutch as described in the previously mentioned application. Power input to the conveyor is provided at shaft 92' by a source which is not shown, but which is provided by gear take off from the weapon as indicated in the previously mentioned application.

The aft end of the shaft 92' is fixed to a miter gear 208, which is meshed with a miter gear 210, which is fixed to one end of a shaft 212. The other end of the shaft 212 is fixed to a miter gear 214, which is meshed with a miter gear 216, which is fixed to a shaft 218. Power may be taken from the shaft 218, as shown in FIG. 1, to synchronously drive the stationary storage device 12. A sprocket 220 is fixed to the shaft 218, and a drive-chain 222 intercouple the sprockets 220 and 98. The shaft 212 is essentially a torsion spring and serves to ab-

sorb some of the momentum of the loaded units of the conveyor system when the shaft 92', which is directly driven by the weapon, is halted at the end of a firing burst. Although the exit sprockets 102', 106' are halted, the entrance sprockets 102, 106 are still free to turn, and the loaded units continue to advance in the direction B, enlarging the delivery run by clam shelling the units about their respective pivots 41 and flexing the rods 186, 188, which are normally concave bowed, and contracting the return run against the bias of the shoe plates 172, 172'.

It will be appreciated that the entrance and exit assemblies have been made symmetrical to permit the conveyor system to be run in reverse and thus utilized to load the stationary storage device. If this option is omitted, then the shoe plate 172' and its spring system may be deleted.

While there have been shown and described the preferred embodiments of the invention, it will be understood that the invention may be embodied otherwise than as herein specifically illustrated or described, and that certain changes in the form and arrangement of parts and in the specific manner of practicing the invention may be made without departing from the underlying idea or principles of this invention within the scope of the appended claims.

We claim

1. A flexible conveyor assembly comprising:

an endless chain of conveyor units each unit including:

a first unit half portion formed as a longitudinally-sectioned, hollow cylinder having first and second end walls;

each of said first half portions having a first pair of transversely spaced apart, longitudinally journaled rollers mounted to a first means extending transversely from said first end wall, and a second pair of transversely spaced apart, longitudinally journaled rollers mounted to a second means extending transversely from said second end wall;

a second unit half portion formed as a longitudinally-sectioned, hollow cylinder having first and second end walls;

said first and second half portions being journaled for mutual coaxial rotation by a first pivotal connection between said respective first end walls and a second pivotal connection between said respective second end walls;

the first half portion of each unit being journaled to the second half portion of the next adjacent unit by a pivotal connection providing relative movement at least about an axis transverse to the path of movement of said chain;

a first transfer station for receiving each unit in sequence and for providing relative movement between the respective first and second half portions to thereby initially open and subsequently close a lateral passageway into said unit;

a second transfer station for receiving each unit in sequence and for providing relative movement between the respective first and second half portions to thereby initially open and subsequently close said lateral passageway into said unit; and

guide means disposed at least in part between said first and second stations for engaging each unit as it passes between said first and second stations for positively maintaining said respective lateral passageway of each such unit closed;

said guide means including a rail extending between said first and second transfer stations, said first pair of rollers of each unit being adapted to straddle and ride on said first rail, and a second rail extending between said first and second transfer stations, said second pair of rollers of each unit being adapted to straddle and ride on said second rail.

2. A conveyor assembly according to claim 1 wherein:

each said transfer station includes

a sprocket for receiving each unit in sequence, and

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first and second guide surfaces for camming against said first and second pairs of rollers of each received unit for thereby causing relative pivotal movement of the respective first and second half portions.

3. A conveyor assembly according to claim 1 wherein: said pivotal connection between adjacent units is effectively spherical permitting fanning and twist between adjacent units.

4. A conveyor assembly according to claim 3 wherein: said first and second rails are resilient and adapted for movement relative to each other, thereby accomodating

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fanning and twist between adjacent units while maintaining the respective lateral passageways closed.

5. A conveyor assembly according to claim 4 further including:

first spring means adjacent said first transfer station bearing centrifugally against the return run of said endless chain of units; and

second spring means adjacent said second transfer station bearing centrifugally against the return run of said endless chain of units.

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