AMMUNITION HANDLING SYSTEM

Inventors: Newton C. Garland; James D. Scanlon, both of Burlington; Otto H. Meier, Shelburne; Douglas P. Tassie, Burton P. Clark, both of St. George; Lester F. Backus, Charlotte, all of Vt.


Filed: Oct. 13, 1971

Appl. No.: 188,831

References Cited

UNITED STATES PATENTS
2,993,415 7/1961 Panicci..................89/33 D

Primary Examiner—Edward A. Sroka
Attorney—Bailin L. Kuch et al.

ABSTRACT

A cartridge storage and feed system is provided including a magazine having a plurality of channels in a planar array, each channel for storing a column of cartridges, and an annular scoop for withdrawing the leading cartridge from each of said channels seriatim for providing a train of cartridges.

21 Claims, 9 Drawing Figures
AMMUNITION HANDLING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention
This invention relates to 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 weapons disclosed by H. McC. Otto in U.S. Pat. No. 2,849,921 on Sept. 2, 1958 and by R. E. Chiabrando et al in U.S. Pat. No. 3,380,343 on Apr. 30, 1968 are 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 cartridge source to the weapon increases.

The original Gatling gun utilized an on-the-gun gravity-feed hopper. Subsequently J.G. Accles in U.S. Pat. No. 290,622 on Dec. 18, 1883 disclosed a positive, helical magazine feed for the Gatling gun. Thereafter, under the lead of F. Bailey and H.P. Maxim, belt feeds, either continuous or link, became the mode. See "The Machine Gun Belt," by Col. Jim Crossman, in The American Rifleman, Dec. 1966, pp. 46-49. Departing from the belt approach, A. Miclaus, Jr., in U.S. Pat. No. 1,136,695 on Apr. 10, 1915 proposed a linear, linkless feed system. The magazine had a plurality of vertical storage channels, each containing a column of cartridges under downward spring bias. An endless conveyor belt below the magazine emptied each channel completely, starting from the most remote channel, and serially conveyed the train of cartridges to the weapon. To supply a Gatling gun of the Otto type, B. Dorsie and R.H. Casler, in U.S. Pat. No. 1,935,914 on May 10, 1960 disclosed a linkless, positive, helical magazine feed, of drum shape, in the spirit of Accles. A feed chute permits the magazine to be spaced from the weapon. This type of magazine becomes quite complex, and the drum shape is frequently uneconomical in its use of aircraft interior space. Recently, E. Ashley and D.P. Tassie, in U.S. Pat. Application, Ser. No. 826,814 filed May 22, 1969 disclosed a linkless, positive magazine of rectangular solid shape including a magazine having a plurality of side by side channels, each channel for storing a column of cartridges, and an endless stripping conveyor for cyclically withdrawing the leading cartridge from each of said channels serially to provide a train of cartridges to an endless conveyor of the type disclosed by R.G. Kirkpatrick in U.S. Pat. No. 3,429,221 issued Feb. 25, 1969 for feeding to a weapon. The ammunition may be fed by an endless conveyor such as is disclosed by O.H. Meier and R.F. Leopold in U.S. Pat. Application Ser. No. 24, 198 filed Mar. 31, 1970 now U.S. Pat. No. 3,670,863.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide an improved cartridge storage and feed system of minimized complexity and volume, and maximized storage density.

A feature of the invention is the provision of a cartridge storage and feed system including a magazine having a plurality of channels in a planar array, each channel for storing a column of cartridges, and an annular scoop for withdrawing the leading cartridge from each of said channels seriatim for providing a train of cartridges. Several planar arrays, e.g., three, may be stacked, and the output trains may be merged into a single train of cartridges.

BRIEF DESCRIPTION OF THE DRAWING

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

FIG. 1 is a side view in elevation in cross-section taken along plane I—I of FIG. 2 of a first embodiment of this invention showing one of the three planar arrays of the storage and feed system, having a scoop wheel with one scoop;

FIG. 2 is a top plan view of the system of FIG. 1;

FIG. 3 is an end view in elevation in cross-section taken along plane III—III of FIG. 2;

FIG. 4 is a perspective view of a second embodiment of this invention showing the three planar arrays of the storage and feed system, each array having a scoop wheel with three scoops;

FIG. 5 is a side view in elevation in cross-section taken along plane V—V of FIG. 4 showing one of the three planar arrays of FIG. 4;

FIG. 6 is an end view in elevation in cross-section taken along plane VI—VI of FIG. 4;

FIG. 7 is a top plan view of the shuttle-accelerator-conveyor of FIG. 4;

FIG. 8 is a side view in elevation in cross-section taken along the plane VIII—VIII of FIG. 4; and

FIG. 9 is a flow chart of the acceleration — converging procedure.

DESCRIPTION OF THE FIRST EMBODIMENT

The ammunition storage and feed system shown in FIGS. 1, 2 and 3 includes three planar modules, each having a cartridge storage array 10, a scoop wheel assembly 12 and a cartridge conveyor assembly 14; and a merging cam assembly 16. Each scoop wheel in sequence scoops a burst of cartridges from its respective array, into its respective conveyor assembly, and these bursts of cartridges are merged in sequence by the merging cam assembly to provide a single train of cartridges which is handed off to an intermediate conveyor assembly 18 which may be of the type shown in U.S. Pat. No. 3,429,221, supra, here shown, or Ser. No. 24, 198 supra.

The three storage arrays 10A, 10B, 10C are defined by two outer side plates 20 and two intermediate side plates 22, and two end plates 24. Two additional outer side plates 26 are respectively fixed on the plates 20 and two additional intermediate plates 28 are fixed on the plates 22. A split shaft 30 is journaled at 32 to and between the plates 26. Each array has a plurality of spaced apart partitions 32 fixed to each side plate and extending inwardly. The partitions are parallel except adjacent the shaft 30 whereat they meld into a curved relationship. These partitions define cartridge receiving compartments, which engage the two ends of the cartridge 34, here shown as a caseless cylinder. A respective pusher bar assembly 36 is disposed in each array between the partitions. Each pusher bar assembly includes a beam 40 and a contoured superstructure 42.
fixed thereon to which includes a plurality of flexible pusher subassemblies formed of links 44 and rollers 46. Two sheaves 48 are journaled to and below the distal ends of the bar. A respective cable 50 is fixed at one end to a transverse tube 52 passing through the side walls, passes around the two sheaves 48, and is wound up on a capstan 54 fixed to a transverse tube 56. When the array has been fully loaded with cartridges, the pusher bar is at the bottom of the array with the cartridges in columns thereabove. As the capstan shortens the cable it raises the pusher bar which pushes the column of cartridges upwardly through the compartments. The capstan is driven by the splined shaft 30 by means of sprocket wheels and a chain drive, not shown, to synchronize the rise of the pusher bar assembly with the rotation of the splined shaft.

Each cartridge conveyor assembly 14 includes a double sprocket 60 journaled at 62 on the splined shaft 30, and journaled at 64 to a double fixed internal ring gear 66. A double planetary gear 68 is fixed on a shaft 70 which is journaled to and between a double pillow block 72 which is fixed to the splined shaft 30. The double planetary gear 68 is meshed with both the double fixed internal ring gear 66, and with a double external ring gear 66, and with a double external ring gear 74 which is integral with the double sprocket 60. A guide assembly 76 overlies and extends from between the double outer ring gear, and at its distal end journals a shaft 78 to which is fixed a double sprocket 80. The top portion of the guide assembly includes a center-T-rail 82 and two spaced apart side rails 84. An endless conveyor chain 86 of linked cartridges 88 is carried around the large double sprocket 60, the guide assembly 76, and the small double sprocket 80. Each cradle has two bifurcated lugs 90 forward, and two lugs 90 aft which are pivotally coupled at 94 to the respective bifurcated lugs of the next successive cradle. Each cradle has a T-shaped cut-out 96, in the underside thereof, which mates with the T-shaped rail 82, while the distal under surface portions of the cradle ride on the side rails 84.

Each scoop wheel assembly 12 includes a left scoop disk 100 and a right scoop disk 102 respectively fixed to the splined shaft 30. Each disk includes a hub 104, a main side plate 106, a spiral outer, inwardly directed, rigid flange sector 108, and an annular, outer, inwardly directed, resilient and preferably elastomeric, flange sector 110 mounted to the plate 106 by a plurality of spring fingers 112. Each main side plate has one spiral slot or hook-like flanged opening 114 therein, adjacent said flange sector 108, providing a scoop cam surface 116 having a leading edge 118. The scoop cam surface of the three scoop wheel assemblies of the respective three modules are mutually 120° out of phase. As the cam surfaces of a respective scoop wheel assembly pass the upper ends of the cartridge receiving compartments, they scoop or peel off the top-most cartridge in each compartment, and guide and accelerate it spirally inwardly between the flange sectors 108 and the endless conveyor chain 86, as it passes around the large double sprocket 60, each such round being seated in a respective cradle 88. As each cradle comes around the double sprocket and crosses the resilient flange sector it snaps the cartridge out from between the resilient flange sector 110. In the embodiment shown in FIG. 1, the angular velocity of the endless conveyor is three times as fast as the angular velocity of the scoop wheel assembly. The pitch of the endless conveyor is one-sixteenth, while the pitch of the 16 cartridge compartments presented to the scoop wheel assembly is one thirty-second. In one revolution of the splined shaft, i.e., of all three scoop wheel assemblies, a total of 48 cartridges are scooped. Each endless conveyor has 28 cradles, and as it runs from the sprocket 60, contains a group of sixteen successive cradles which respectively carry cartridges and a group of 12 successive cradles which are empty. As the three endless conveyors respectively run from the large double sprocket 60 towards the distal double sprocket 80, they are in phase, i.e., they are in cross-wise alignment, with one conveyor having a first group of 16 filled cradles and the two other conveyors having their respective cross-wise aligned cradles empty; then another conveyor having a second group of 16 filled cradles, and the remaining conveyor having a third group of 16 filled cradles.

The merging cam assembly 16 is fixed across the three conveyor assemblies, and includes a transverse cover plate portion 120 and two symmetrical depending side portions 122 having inner cam walls 124 which initially, upstream, encompass all three endless conveyors, then diagonally overlie and traverse the outer two conveyors and finally, adjacent the distal sprocket 80, encompass the middle conveyor only. The cam walls serve to shift any cartridge lying in a cradle in an outer conveyor to a respective empty transverse cradle in the middle conveyor. Two symmetrical trap-door deceleration cam assemblies 126 are pivotally mounted in respective apertures in the cover plate portion 120, and are spring biased downwardly so that their respective cover plate portions 128 are aligned with the main portion 120. Each assembly 126 has a depending wall portion 130 with a concave inner cam surface 134 and a 45° aft cam surface 136. Cartridges which are carried by the middle conveyor from the middle module ride straight under the cover plate portion, engage the aft cam surfaces 136 of both trap-door cams, deflecting these cams up and out of the way, and continue in the middle conveyor to the distal sprocket 80 whereat they are handled off to the intermediate conveyor assembly 18. Cartridges which are carried by the left conveyor from the left module ride under the cover plate portion, engage the left inner cam wall 124 and are progressively driven transversely rightwardly from their respective cradles in the left conveyor into the respective, transversely aligned, initially empty, cradles in the middle conveyor. As each such cartridge moves forwardly and rightwardly, it’s right end engages the aft cam surface 136 of the left trapdoor cam, deflecting it up and out of the way, and continues rightwardly until its right end engages the interior cam surface 134 of the right trap door cam, limiting further free rightward movement, and precisely locating the cartridge in the cradle in the middle conveyor. The shifted cartridge continues in the middle conveyor to the distal sprocket 80 whereat it is handed off to the intermediate conveyor assembly 18. Similarly, cartridges on the right conveyor are shifted leftwardly onto the middle conveyor, push the right trap door cam up out of the way and are decelerated and located by the left trap door cam in the respective cradles of the middle conveyor, to be handed off to the intermediate conveyor assembly 18.
DESCRIPTION OF THE SECOND EMBODIMENT

The ammunition storage and feed system shown in FIGS. 4 through 9 includes three planar modules, each having a cartridge storage array 200, a scoop wheel assembly 202, a cartridge conveyor assembly 204, and a single accelerator-merge assembly 206. Each scoop wheel assembly continually scoops cartridges 207 from its respective array into its respective conveyor assembly. The accelerator-merge assembly accelerates each of the cartridges from its conveyor, thereby increasing the pitch distance between cartridge and inter-leaves the three trains of cartridges into a single train to be handed off to an intermediate conveyor assembly.

As in the first embodiment, the three storage arrays 200 are defined by side plates 208, and the cartridge receiving compartments are defined by partitions 210. A respective pusher bar assembly 212 is disposed in each array to raise the rows of cartridges towards the respective scoop wheel assembly 202, and is operated by a capstan 214 winding the distal end of a cable 216 about sheaves 218 and which is driven by an endless chain 220 and sprockets from the main shaft 222. The main shaft is journaled through the three arrays. Each scoop wheel assembly 202 includes a pair of spaced disks 224, each having a hub 226 fixed to the main shaft 222, a main side plate 228 and three spiral, inwardly directed, rigid flange sectors 230. Each main side plate 228 has three spiral slots or hook-like flanged openings 229 therein, mutually spaced 120° apart, defining the sectors 230 and providing three scoop cam surfaces 232 having respective leading edges 234. Three scoop cam extensions 236, having respective tails 238, are respectively pivotally mounted at 240 to the flange sectors, and have respective cam followers 242 which ride in a cam slot 244 in the side plate 208 of the array 200. When a respective cam surface 232 is scooping cartridges from the compartments the respective scoop extension tail 238 is pivoted centripetally to provide a continuation of the cam surface and admit cartridges through the hook-like opening 229 into the interior of the scoop wheel assembly. When the respective cam surface is not scooping cartridges the respective scoop extension tail is pivoted annularly to clear the cartridges which have been scooped by the succeeding cam surfaces and being carried by the conveyor assembly, and to retain these cartridges within the interior of the scoop wheel assembly and prevent their centrifugal passage through the hook-like opening.

Each cartridge conveyor assembly 204 includes a stationary hub 246 which is journaled on the main shaft 222 by a pair of bearings 248. A web 250 is fixed to the stationary hub 246, which in turn is fixed to a track support 252 which carries a track 254 having two inwardly turned edges 256 serving as rack rails. A double sprocket 258 is fixed to a shaft 260 which is journaled by bearings 262 to the web 250. A spur gear 264 is fixed to the shaft 260 and is meshed with an internal ring gear 266 which is fixed to the side plate 228 of the scoop wheel assembly. A distal double sprocket 268 is fixed to a shaft 270 which is journaled in the accelerator-merge assembly and which interrupts the tracks 254. An endless conveyor chain of linked cradles 274 is engaged with and carried by the track 254 around the interior of the scoop wheel assembly and around the distal sprocket 268. Each cradle has a single bifurcated lug 276, and a lug 278 forward which is pivotally coupled at 279 to the respective bifurcated lug of the next successive cradle. The lug assembly is quasi-spherical to permit some twist between successive cradles. Each cradle has a pair of depending and outwardly directed feet 280 which mate with the rails.

The track 254, and, therefore, the cradles supported thereon, is generally parallel to the main shaft 222, except where the upper run crosses out past the flange sectors 230 of the scoop disks; here the track and the supported cradles are tilted to permit the cartridges carried by these cradles to clear the scoop disk flange sectors. The cartridges are retained in the tilted cradles by suitable guide surfaces. The distal sprocket 268 engages and pulls the upper run of the cradles of the conveyor, while the scoop sprocket engages and pulls the lower run of the cradles, and ensures their proper phase relationship to the cam surfaces 232.

The endless chain of conveyors has an angular velocity about the main shaft which is three times as fast as the scoop wheel. As each cartridge is scooped from the top of a column it is accelerated by the cam surface and disposed in a cradle in the conveyor assembly. The scoop assemblies and the respective conveyor assemblies are 40° out of phase between arrays and thus the cartridges arrive at their respective distal sprockets 120° out of phase with respect to pitch between arrays for handling by the accelerator-merge assembly.

The accelerator-merge assembly straddles the three arrays and receives the respective distal sprockets and the turn-arounds of the respective conveyor assemblies. The assembly includes two side plates 282, a bottom plate 284, a top plate 286, and a merge cylindrical housing 288 having a longitudinal opening 289. The distal sprocket shaft 270 is journaled to and between the side walls 282 by a pair of bearings 290. An accelerator shaft 292 is journaled to and between the side walls 282 by a pair of bearings 294. Three diametral l-shaped slots 296, mutually 120° out of phase, are provided in the accelerator shaft, respectively aligned with the three distal sprockets 268. Three, l-shaped, accelerator shuttles 298 are respectively disposed in the l-shaped slots. Each shuttle includes two, distally transversely elongated, portions 300 connected by a diametral web portion 302. Each end portion has a semi-cylindrical concavity 304 closed by an end wall 306 which has a distal cam follower portion 308. A respective internal cardiodi cam surface 310 in a cam plate 312 encircles each end wall and at least one cam follower portion 308 rides on a respective cam surface 310 at all times. The shaft 292 is eccentric to the cam surface 310, which causes the shuttle to shift within the respective slot 296 as the shaft and the shuttle rotate. A combiner shaft 314 is journaled to and between the side walls 282 by a pair of bearings 316. A combiner rotor 318 is fixed on the shaft and has six longitudinal cut outs 320 therein providing six longitudinal lands 322. Six middle track guides 324 are respectively fixed to the six lands 322, as by machine screws 326, in alignment with the middle distal sprocket 268 and the middle shuttle 298. Four left track guides 328 are diametrically spaced apart and fixed to four respective lands in alignment with the left distal sprocket 268 and the left shuttle 298. Four right track guides 330 are diametri-
cally spaced apart and fixed to four respective lands, 120° out of phase with the left track guides, in alignment with the right distal sprocket and the right shuttle 298. Two diametrically spaced apart left cartridge carriers 332, each having a cartridge receiving, longitudinally extending, concavity 334, two track receiving, longitudinally extending rabbets 336, and an end post 338 with a cam follower roller 340, are disposed in diametrically spaced apart cut outs 320, and engaged with the left track guides 328. The roller 340 is engaged with a double U-shaped cam track 342 in the housing which serves to reciprocate each left shuttle between alignment with the left distal sprocket and the middle distal sprocket once during each rotation of the rotor. Similarly, two right cartridge carriers 332R are provided which shuttle between alignment with the right distal sprocket and the middle distal sprocket once during each rotation of the rotor. Two middle cartridge carriers 332M omit the cam follower and are fixed in alignment with the middle distal sprocket. Thus the carriers are disposed around the rotor in the following sequence, left, middle, right, left, middle, right. The housing also has a middle transverse slot 344 in alignment with the middle carriers, and the left and right carriers when they are in their respective shifted to middle disposition. The sprocket 346 of an intermediate conveyor assembly extends in part in this slot. Six lower cartridge guides 348 are fixed to the lower plate 284 and have respective guide surfaces 350. Six upper cartridge guides 352 are fixed to the upper plate 286 and have respective guide surfaces 354. The shafts 314, 292, 270 and 222 are interconnected by suitable spur gears and chain and sprockets, as shown.

In use, the three cartridge conveyor assemblies are 120° or one-third pitch out of phase. Each of the scoop wheel assemblies continually and serially scoops the upper most cartridge from the compartments of its respective array and hands each cartridge aft to the respective conveyor assembly, serially filling each cartridge therein, at a relatively low rate, e.g., 2000 cartridges per minute. Each cartridge is carried out of the respective scoop wheel assembly, along the upper run of the respective conveyor assembly, around the respective distal sprocket 268, between the respective guide surfaces 350 and 354 and handed off into the semi-cylindrical concavities 304 of the respective shuttle 298, accelerated by the shuttle in one-half revolution thereof, and handed off to a respective carrier 332 in the combiner. In one-half rotation of the combiner the cartridge is either shifted to, or maintained at the center of the combiner and handed off to the intermediate conveyor assembly at three times the original scoop rate, e.g., 6,000 cartridges per minute.

While two embodiments of the invention have been described, 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 principles of the invention within the scope of the appended claims.

What is claimed is:

1. An article storage and feed system, comprising:

   a plurality of magazine assemblies, each assembly having a plurality of channels, each channel for storing a column of articles;

   a like plurality of stripping conveyor assemblies, one for each magazine assembly respectively, each including means for individually engaging, accelerating and withdrawing the leading article from the discharge end of a first one of said plurality of channels; and next, individually engaging, accelerating and withdrawing the leading article from the discharge end of a second one of said plurality of channels; and next individually engaging, accelerating and withdrawing the leading article from the discharge end of a third one of said plurality of channels; and so on in sequence to individually engaging accelerating and withdrawing the leading article from the last one of said plurality of channels, and thereby providing a train of articles, one from each channel, seriatim; and combining means coupled to each of said conveyor assemblies for combining the like plurality of respective trains of articles into a single train of articles.

2. A system according to claim 1 wherein:
   the number of magazine assemblies = n;
   the number of channels in each magazine assembly = c; and
   each of said stripping conveyor assemblies provides a train of uniform pitch spacing of articles each having the sequential format of one group of c pitch spaces, each space containing an article; and (n-1) groups of c pitch spaces, each space omitting an article.

3. A system according to claim 2 wherein:
   the pitch spacing of all of said conveyor assemblies are transversely in phase; and
   taken transversely, only one pitch space in any of said conveyor assemblies contains an article.

4. A system according to claim 3 wherein:
   said combining means sequentially shifts all of said articles transversely from (n-1) conveyor assemblies to one conveyor assembly.

5. A system according to claim 3 wherein:
   said combining means sequentially shifts all of said articles transversely from (n-1) trains to one train.

6. A system according to claim 4 wherein:
   the number of magazine assemblies = n; and
   each of said stripping conveyor assemblies provides a train of articles of uniform linear pitch spacing = s.

7. A system according to claim 6 wherein:
   the pitch spacing of all of said conveyor assemblies are, taken sequentially — transversely, 1/n out of phase; and
   each pitch space in each conveyor assembly contains an article.

8. A system according to claim 7 wherein:
   said combining means sequentially increases the linear pitch spacing of each train to (s)(n), and sequentially shifts all of said articles transversely from (n-1) trains to one train.

9. A system according to claim 8 wherein:
   each said stripping conveyor assembly includes an endless train of elements for carrying articles, stripping means for displacing each leading article from its respective column to a respective element in said endless train.
10. A system according to claim 1 wherein:
each of said stripping conveyor assembly includes
a respective cam surface rotating about an axis,
said cam surface sequentially riding under the
leading article in each channel and displacing said article from said channel along said cam surface.
11. A system according to claim 10 wherein:
each said stripping conveyor assembly further includes
a respective article conveyor means for capturing each article in sequence as it is displaced along said cam surface and transporting such article away from said cam surface.
12. A system according to claim 11 wherein:
said article conveyor means also rotates about said axis.
13. A system according to claim 12 wherein:
said article conveyor means rotates about said axis at a higher velocity than said cam surface.
14. A system according to claim 13 wherein:
the number of magazine assemblies = n; and
said angular velocity of said article conveyor means = (n) velocity of said cam means.
15. A system according to claim 14 wherein:
each stripping conveyor assembly has (n) respective cam surfaces, uniformly angularly spaced apart.
16. A system according to claim 10 wherein:
said cam surface is provided on a spiral slot in a disk.

17. A system according to claim 10 wherein:
said cam surface is provided in part on a first spiral slot in a first disk and in part on a second spiral slot in a second disk longitudinally spaced therefrom.
18. A system according to claim 17 wherein:
each said slot has an additional surface spaced from said cam surface for constraining centrifugal movement of a stripped cartridge.
19. A system according to claim 18 wherein:
each said additional surface includes a resilient portion adapted to be distorted to release such stripped cartridges for displacement from said disks.
20. An accelerator for a train of articles comprising:
a first article conveyor conveying articles at a first velocity = v₁;
a second article conveyor for conveying articles at a second velocity = v₂;
an intermediate article carrier journaled for rectilinear movement in a guide which is journaled for rotation about an intermediate axis; and means coupled to said carrier and to said guide for causing said guide to rotate about said intermediate axis and said carrier to move rectilinearly in said guide.
21. An accelerator according to claim 20 wherein said intermediate axis is eccentric between said first and second conveyors by the ratio of V₁:V₂.