June 16, 1959 M. D. AUMANN 2,890,779

FLEXIBLE CONVEYER CHUTE

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Fig. 1

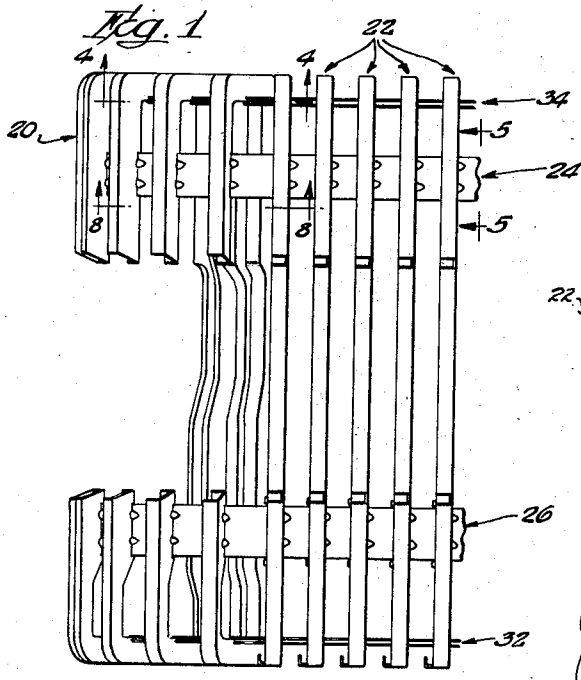


Fig. 4

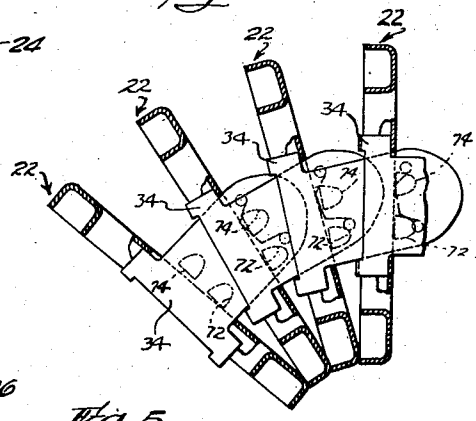


Fig. 5

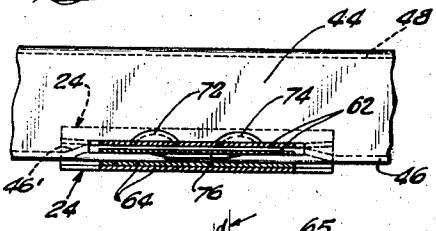


Fig. 2

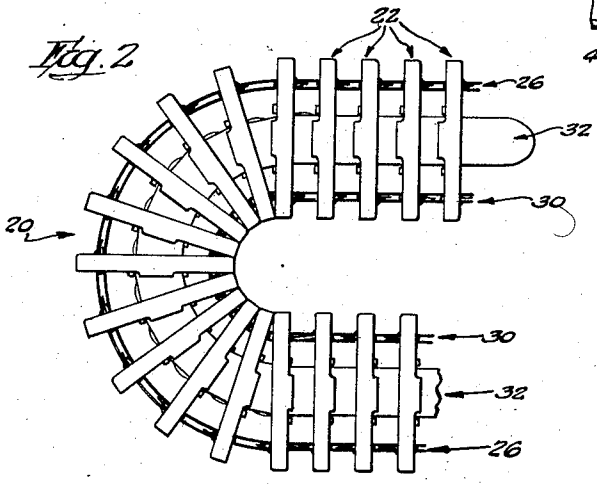


Fig. 6

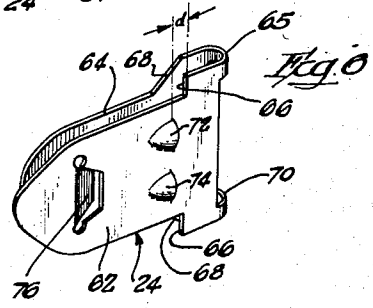


Fig. 6a

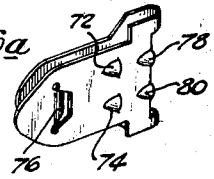
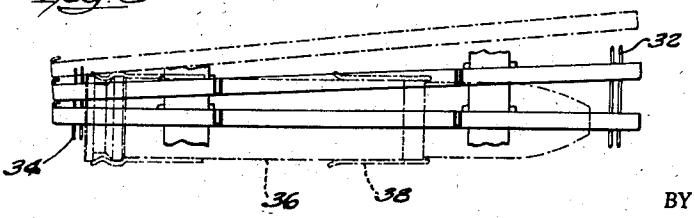


Fig. 3



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Fig. 7

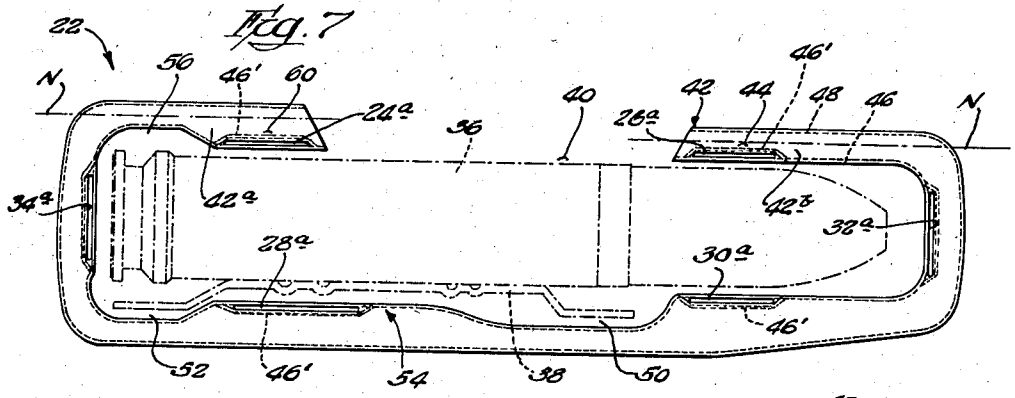


Fig. 8

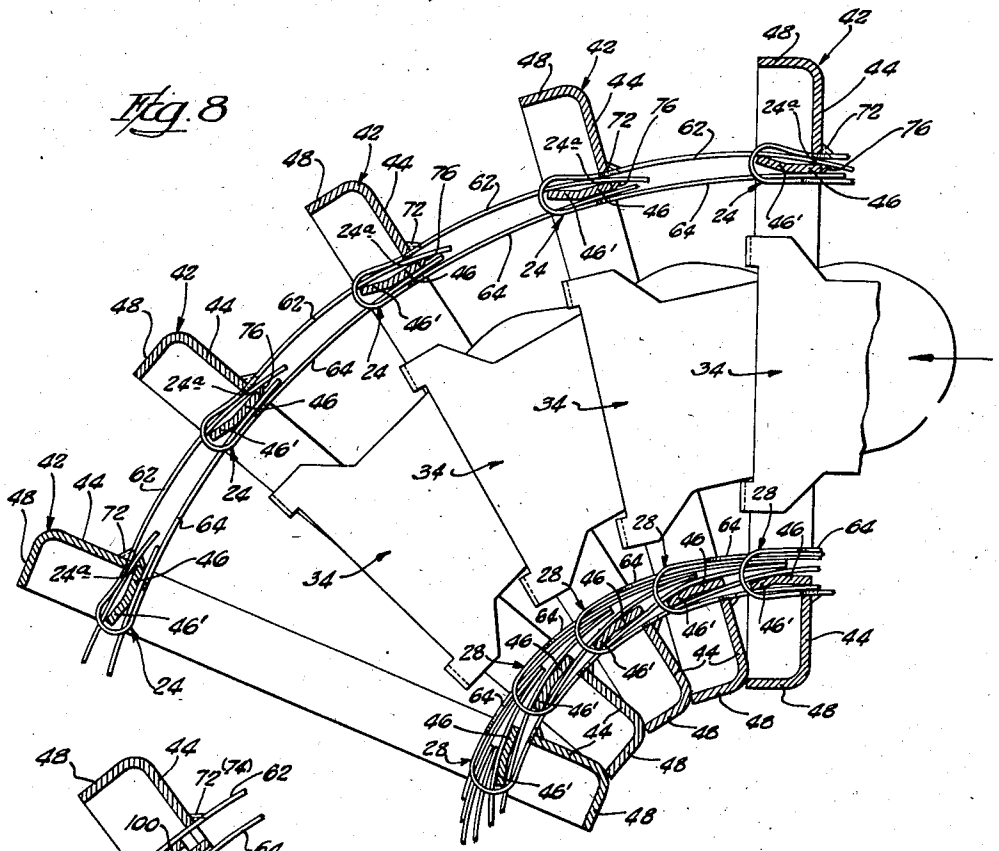
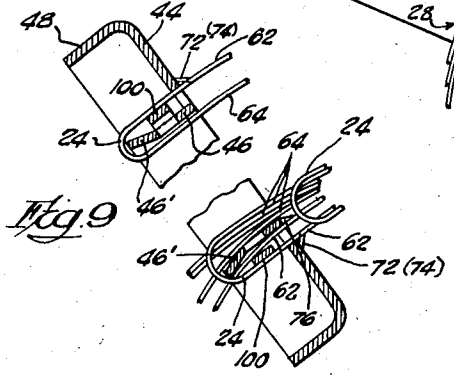


Fig. 9



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Fig. 10

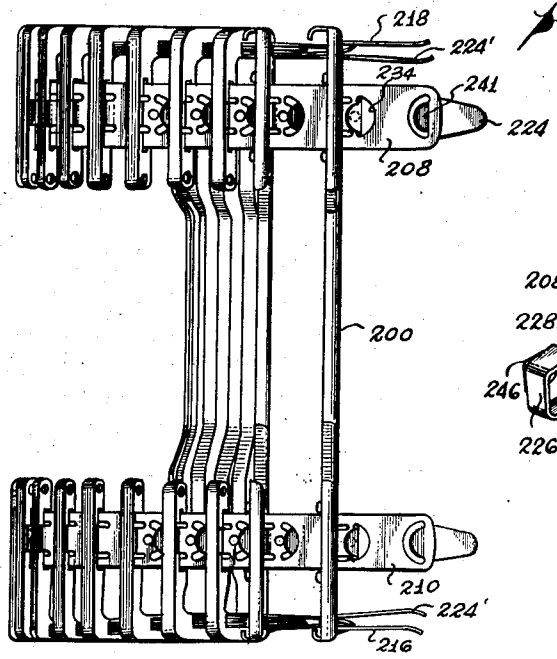


Fig. 12

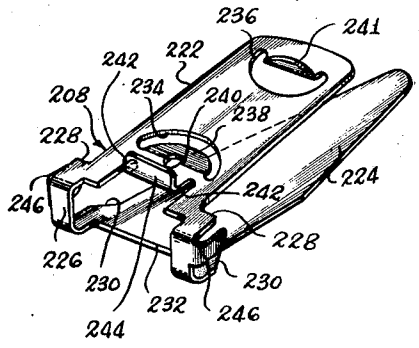


Fig. 11

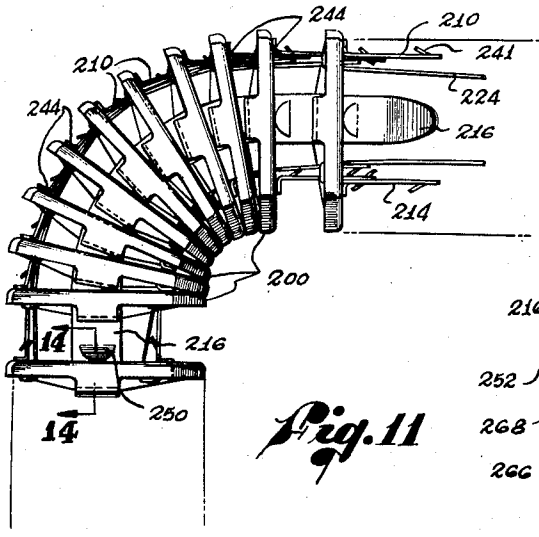


Fig. 13

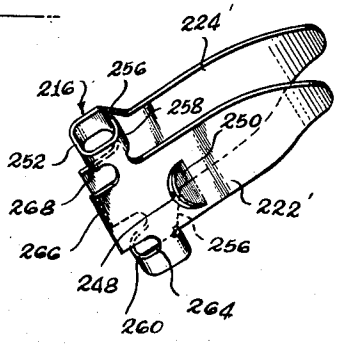
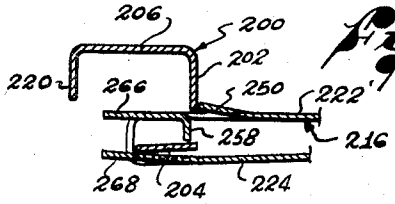


Fig. 14



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Fig. 15

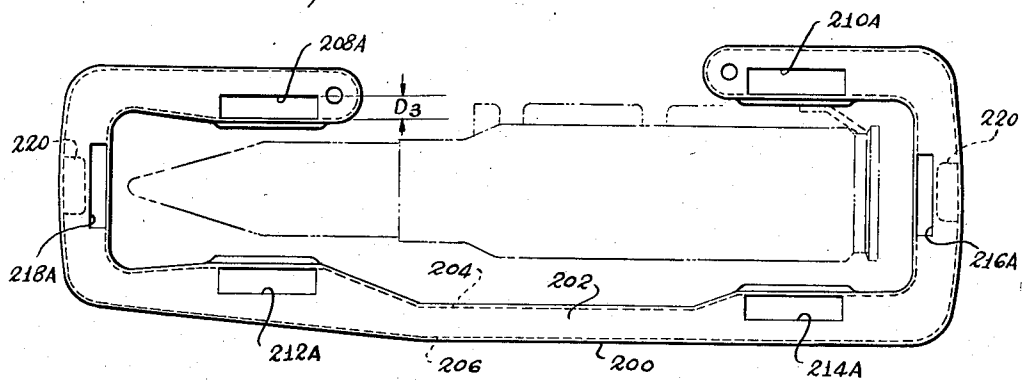


Fig. 16

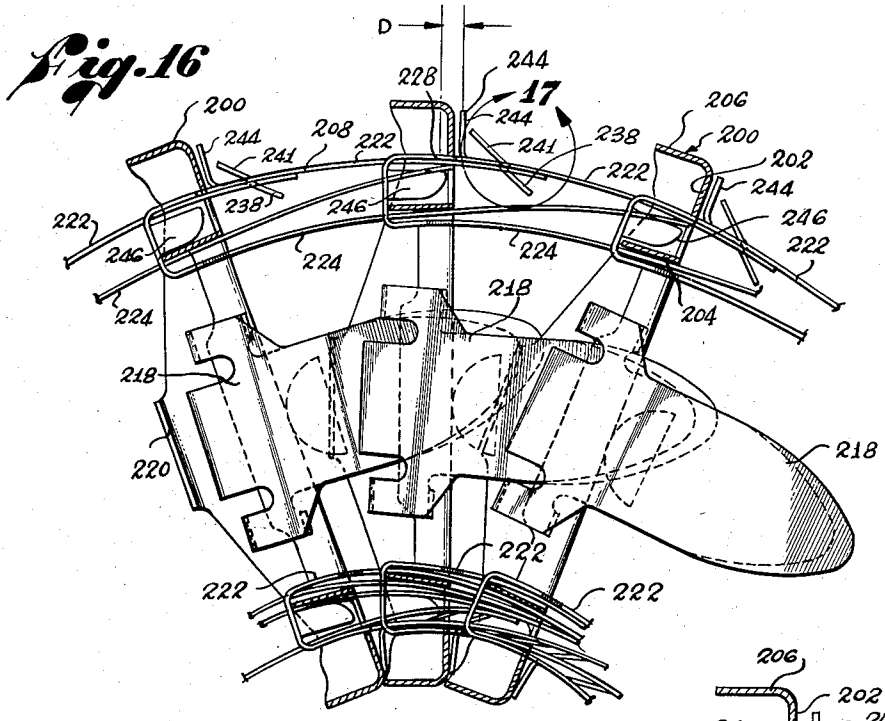


Fig. 16a

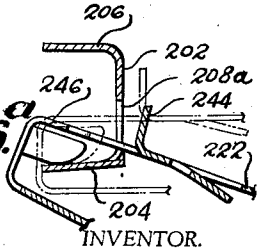


Fig. 17

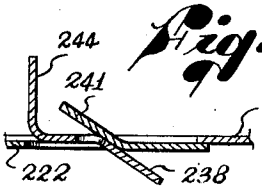
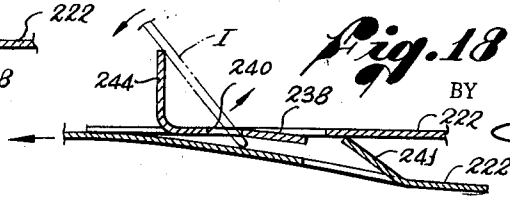


Fig. 18



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FLEXIBLE CONVEYER CHUTE

Mark D. Aumann, Fullerton, Calif., assignor to Townsend Engineered Products Incorporated, Santa Ana, Calif., a corporation of California

Application March 7, 1958, Serial No. 719,976

28 Claims. (Cl. 193—25)

This invention relates to conveyer chutes, and particularly to a flexible conveyer chute of simplified construction.

This application is a continuation-in-part of my copending application, Serial No. 608,477, filed September 7, 1956, and entitled Flexible Conveyer Chute.

Numerous different forms of flexible conveyer chutes have been devised, and while capable of satisfactorily performing their intended function of guiding articles to be conveyed along a defined path, these existing chutes possess certain inherent deficiencies which pose problems in the manufacture and application of the chutes.

In general, flexible conveyer chutes comprise a series of generally identical articulated links which permit flexing of the chute to a desired configuration. In the past each of these several links have comprised a frame composed of a multiplicity of elements which were riveted or otherwise secured together. This assembly of the elements to form the individual frames was accomplished in one or more subassembly operations, and the several frames thus formed were interconnected in a final assembly operation to form the conveyer chute.

These subassembly operations, obviously, were time consuming and added to the complexity and cost of manufacture of the conveyer chute. Moreover, owing to the relatively large number of individual elements comprising in most cases each of the link frames, and the subassembly operations necessary to assemble these elements to form the individual frames, a relatively large number of tools, such as dies, assembly jigs, and the like, were required. Often, this tooling was complex and costly owing to the complex configurations of the elements. It is also evident that such complex tooling required substantial skill and training of the personnel using the same and a relatively large number of personnel to accomplish the manufacture of a given chute.

In order that conveyer chutes be capable of satisfactorily and efficiently performing their intended function of conveying articles from one point to another, it is essential, obviously, that the frames comprising the links of the chute possess substantial rigidity against excessive inward or outward deflection or bending to constrict or enlarge the passage through the chute. In most cases, the conveyer chute must, of necessity, be relatively restricted in size. Accordingly, to provide the necessary rigidity, the link frames have, in the past, been constructed of relatively heavy gage metal and/or auxiliary reinforcing means have been employed. The use of heavy gage metal, of course, not only adds considerably to the weight of the chute, which is extremely objectionable in various applications, such as aircraft applications, but also complicates the various manufacturing steps, such as punching and forming, involved.

In certain types of conveyer chutes, rigidity of the link frames is especially essential. Thus, in flexible conveyor chutes for conveying linked rounds of ammunition from a supply to an automatic weapon, the individual

link frames are generally of open construction. This construction provides along the chute a longitudinal opening through which access may be had to a belt of ammunition in the chute for manually moving the belt along the chute during loading of the conveyer system. The ends of the frames, defining therebetween this access opening, are unsupported, and if not suitably reinforced are prone to deflection in transverse planes of the guideway. Inward deflection of these ends constricts the guideway through the chute and, if excessive, prevents free movement of the rounds through the chute.

Outward deflection of these ends under the internal loads imposed thereon by the rounds being conveyed, on the other hand, enlarge the guideway through the chute. Excessive outward deflection of these ends is most likely to occur in chutes employed with a booster device for assisting the weapon in moving the ammunition belt. In such cases the guideway may become so enlarged as to allow the ammunition belt to pyramid with resultant jamming of the chute.

In view of the foregoing remarks, a general object of this invention may be stated as being the provision of a flexible conveyer chute of simplified construction.

Another object of the invention is the provision of a flexible conveyer chute possessing a minimum number of parts and requiring minimum tooling of simple design in its fabrication.

Yet another object of the invention is the provision of a flexible conveyer chute which requires a minimum of assembly operations and wherein the fabrication of the chute involves only the steps of forming the individual components and final assembly of the components into a flexible chute.

A further object of the invention is the provision of a flexible conveyer chute wherein final assembly of the components into a flexible chute is accomplished by simple clipping of the components together without the need of spot welds or other auxiliary fastening means.

A still further object of the invention is the provision of a flexible conveyer chute wherein the individual link frames are so constructed as to possess minimum weight and maximum rigidity against deflection to constrict or enlarge the chute guideway.

Yet a further object of the invention is the provision of a flexible conveyer chute of the character described wherein the individual links may be quickly and easily detached.

A still further object of the invention is the provision of a flexible conveyer chute which is relatively simple in construction, inexpensive to manufacture, and otherwise especially well suited to its intended purposes.

Briefly, the foregoing and other objects of the invention are achieved, in the illustrative embodiment of the invention, by the provisions of a series of identical link frames which are slotted for receipt of interconnecting runners extending from one frame to the next. These runners are of generally U-shaped configuration and fabricated of flexible spring steel so as to accommodate relative articulation of the link frames of the chute.

In assembled condition, the leaves or legs of these runners extend through the slots in respective adjacent frames and are interleaved between the leaves or legs of the runners on the adjacent frames. This interleaving is accommodated by slots in the runners themselves. Rapid and simple assembly of the frames and runners to form a chute is accomplished by insertion of the lanced runner legs through the slots of adjacent frames, both legs of each runner being inserted through the slot in an adjacent runner so that adjacent runner legs overlap to provide a relatively smooth guide surface in the chute.

In one form of the invention, one of the legs of each

runner is lanced to provide extending louvers and a tab which abut the respective adjacent frames to prevent extraction of the runners from the slots in the frames and limit extension of the chute. In an alternative form of the chute, one leg of each runner is formed with a pair of inclined tabs which extend to opposite sides of the leg and are engageable with the tabs on the overlapping legs of adjacent runners to limit extension of the chute.

To achieve maximum rigidity with minimum weight, the link frames are of generally channel-shaped cross-section with the channel of the frame opening longitudinally rather than transversely of the chute as in most existing conveyer chutes of which I am aware. This construction of the frames places the flanges of the channels so as to obtain greatest rigidity of the frames against flexing to enlarge or constrict the chute guideway.

Other objects and advantages of the invention will become readily apparent to those skilled in the art from the following detailed description taken in conjunction with the annexed drawings, wherein:

Fig. 1 is a top plan view of one form of the present conveyer chute, the latter being illustrated as flexed in roll;

Fig. 2 is a side elevation of the conveyer chute of Fig. 1;

Fig. 3 illustrates a series of links of the conveyer chute of Fig. 1 flexed in flat fan;

Fig. 4 is a section taken along line 4—4 of Fig. 1;

Fig. 5 is an enlarged section taken along line 5—5 of Fig. 1;

Fig. 6 is an enlarged view in perspective of one of the novel runners which interconnect adjacent links of the conveyer chute of Fig. 1;

Fig. 6*a* is a perspective view of a modified runner;

Fig. 7 is an enlarged view in elevation of one of the links comprising the chute of Fig. 1;

Fig. 8 is an enlarged section taken along line 8—8 of Fig. 1;

Fig. 9 illustrates a modified form of the invention;

Fig. 10 is a view of a still further modified form of the present chute shown as flexed in roll attitude;

Fig. 11 is a side elevation of the chute of Fig. 10;

Fig. 12 is an enlarged perspective of a modified runner embodied in the chute of Fig. 10;

Fig. 13 is an enlarged perspective of another modified runner embodied in the chute of Fig. 10;

Fig. 14 is an enlarged section taken along the line 14—14 of Fig. 11;

Fig. 15 is an enlarged side view of one of the link frames embodied in the chute of Fig. 10;

Fig. 16 is an enlarged longitudinal section through the chute of Fig. 10;

Fig. 16*a* illustrates the manner of joining the runners and frames of the chute;

Fig. 17 is an enlargement of the area encircled by the arrow 17 in Fig. 16; and

Fig. 18 illustrates the manner of detaching links from the chute.

In Figs. 1–8 of the attached drawings there is illustrated a flexible conveyer chute **20** constructed in accordance with the invention and comprising a series of identical link assemblies including links **22** which are flexibly interconnected by a series of runners **24** through **34**. The illustrative embodiment of the present conveyer chute is especially designed for conveying rounds **36** of ammunition joined by a series of interengaging links **38** into a belt. Accordingly, the several links **22** of the present conveyer chute are contoured to provide in the latter a guideway **40** conforming, generally, to the shape of the rounds **36**. It will become apparent, however, as the description proceeds that the features of this invention may be incorporated into flexible conveyer chutes for conveying articles other than rounds of ammunition. The invention, therefore, should not be thought of as limited to flexible ammunition conveyer chutes as herein disclosed for illustrative purposes.

As indicated above, the several links **22** are identical and, accordingly, only one of these links will be described in detail, it being understood that the following description will apply equally well to any one or all of the several links **22**. Each of the links **22** comprises a frame **42** of channel section defined by a web **44** and flanges **46** and **48** extending perpendicular to the web **44**. For reasons preliminarily indicated and hereinafter more fully discussed, web **44** extends in a plane normal to the longitudinal axis of the guideway **40** while the flanges **46** and **48** extend in planes parallel to such axis.

To accommodate the conveying of belted or linked ammunition, the web **44** and the flanges **46** and **48** are contoured, as shown most clearly in Fig. 7, so that there are formed along the normally lower lateral leg of the frame a pair of spaced depressions **50** and **52** separated by a relatively raised section **54**. The upper left hand leg of the frame, as viewed in Fig. 7, is contoured to provide an outer recessed portion **56** and an inner raised portion **60**. The frame **42**, at the depression **50** is reduced as much as is practical to provide flexibility to the frame in twist attitude. As shown, the depressed portions **50** and **52** on the lower leg of the frame also provide clearance spaces for opposite, downwardly inclined ends of the links **38** of the belt of ammunition while the upper recessed portion **56** merely provides clearance for the butt ends of the rounds **36**.

To accommodate interconnection of the several frames **42** into a unitary conveyer chute by means of the runners **24–34**, the web **44** of each frame is formed with a series of slots designated by numerals **24***a*–**34***a* so as to correspond to the numerals applied to the runners which are received in those slots, as described below. Slots **24***a*, **26***a*, **30***a*, **32***a* and **34***a* are shown to be of the same length while slot **28***a* is shown as being somewhat longer. The widths of all of the slots **24***a*–**34***a* are the same and of a dimension somewhat greater than twice the thickness of the material from which the runners are formed so that the legs of two runners are adapted to be freely received within each of the slots.

As shown most clearly in Fig. 8, the inner flanges **46** of the frame have portions **46'** thereof bent at an angle toward the outer flanges **48** for a length substantially equal to that of the adjacent slot **24***a*–**34***a* and aligned with the adjacent slot.

The runners **24–34** are all substantially identical and differ only in the greater lateral dimension of runner **28** and the lesser length of the end runners **32** and **34**. Runner **28** is preferably, though not necessarily, wider than the other runners so as to be engageable by the links **38** of the ammunition belt. This is done to limit rocking of the links about the axes of the rounds **36**.

Owing to their similar construction, only one of these runners, namely, runner **24**, will be described in detail, it being understood that such detailed description will apply equally well to the remainder of the runners except, as noted, to dimension. Runner **24** (Fig. 6) is fabricated from a strip of spring steel, or the like, which is sheared to the configuration shown and folded about a center line to form a pair of flexible legs **62** and **64**. Leg **62** is somewhat longer than leg **64** to facilitate their separation for ease of assembly. The curved connecting portion **65** of the runner bridging the legs **62** and **64** conforms substantially to a semi-circle as shown. The width of leg **62** is somewhat less than the length of the slot **24***a* while both legs **62** and **64** are enlarged adjacent the curved connecting portion **65** to form a pair of right angle shoulders **66** at opposite sides of leg **62** and a pair of inclined shoulders **68** at opposite sides of leg **64**.

The rounded portion **65** of the runner is centrally slotted at **70** for receiving the legs **62** and **64** of an adjacent runner in the assembled condition of the links, as

described below. Leg 62 is lanced along a line spaced a distance *d* from the shoulders 66 and formed with upstanding louvers 72 and 74. Distance *d* is somewhat greater than the thickness of the material from which link frames 42 are made.

Runner leg 62 is also lanced and bent outwardly adjacent its tip to form an upstanding tab 76. As shown, louvers 72 and 74 project from the side of runner leg 62 remote from leg 64 while tab 76 projects toward the latter leg. The outer surfaces of louvers 72 and 74 and tab 76 slope toward the surface of leg 62 in the direction of the tip of the latter.

Runner leg 62 may, if desired, be formed with a second pair of louvers 78 and 80 at the edge of slot 70 in the runner, as shown in Fig. 6*a*. These latter louvers may be provided to afford relief for and next the louvers 72 and 74 on the preceding aligned runner in tight roll. Also, while two louvers 72 and 74 have been shown, one louver spaced a somewhat greater distance *d* from shoulder 66 may be employed in some cases to permit increased angulation of the runners with respect to their frames 42. Such increased angulation might be necessary for example, to a smaller minimum roll radius.

As indicated above, the remainder of the runners are substantially identical to that just described and differ from the latter only in dimensions. Accordingly, no description of these other runners is deemed necessary. For facility in the description of the assembly of the links and runners, set forth below, the lanced legs of all the runners are identified by the numeral 62 and the other legs of the runners by the numeral 64 as in the case of runner 24.

In assembly of the links and runners, the lanced leg 62 of each of the runners 24–34 is inserted first through its respective slot in one of the frames 42, then through the slot 70 in the aligned runner on the adjacent frame, and finally through its respective slot in the web of the adjacent frame. The legs 62 are thus inserted to position louvers 72 and 74 beyond the web 44 of the one frame and the web 76 beyond the web of the adjacent frame, as shown most clearly in Fig. 8. The resiliency of the material from which the runners are made accommodate slight inward flexing of the louvers and tab during insertion of the runner legs through their respective slots. After movement of the louvers and tab beyond the webs of the frames, they return to their normal condition wherein they limit movement of the runner legs in their respective slots.

In final assembled condition of the several frames and runners, illustrated most clearly in Fig. 8, the leg 62 of one runner extends through the slot 70 in the curved connecting portion 65 of the adjacent runner and through the aligned slot in the web of the adjacent frame and is interleaved between the leg 62 of the latter runner and the outer surface of the inner flange 46 on the latter frame. As described above, louvers 72 and 74 and tab 76 on the interleaved leg 62 are positioned beyond the webs 44 of the frames, in the manner illustrated, so that the frames are secured against separation. The other leg 64 of each runner extends through the slot 70 in the curved connecting portion 65 of the adjacent runner and is then interleaved between the leg 64 of the latter runner and inner surface of the inner flange 46 on the adjacent frame.

As shown in Fig. 8, the resilient flexibility of the runners 24, 26, 28 and 30 accommodates articulation of the conveyer chute in roll, the minimum roll radius being fixed by abutment of the inner edges of adjacent frames 42 and the maximum extension of adjacent frames at their outer edges. The maximum extension is, in turn, determined by abutment of the tabs 76 and shoulders 66 on the outer runners 24, 26 or 28, 30, as the case may be (namely, runners 24 and 26 for the direction of roll illustrated in Fig. 8), with the webs 44 of their adjacent frames. During such articulation of the conveyer chute in roll, the end runners 32 and 34 remain unflexed and are angulated in their plane, as illustrated in Fig. 8.

Similarly, articulation of the frames in fan (Fig. 3) and the minimum fan radius are limited by abutment of the inner edges of the frames and extension of the outer edges of the frames, to their limit. This extension is determined by abutment of the tabs 76 and shoulders 66 on the outer end runners 32 and 34, as the case may be (runners 32 for the direction of fan shown in Fig. 3), with the webs 44 of their adjacent frames. During such articulation of the chute in fan, the end runners 32 and 34 are flexed while the top and bottom runners 24–30 remain unflexed and are angulated in their planes in the same manner as were the end runners 32 and 34 during articulation of the chute in roll.

A slightly modified link frame for the link is illustrated in Fig. 9, wherein the inner flanges 46 are lanced and offset toward the outer flanges 48 in alignment with each of the slots 24*a*–34*a*. The resulting offset portions 100 are arranged to bear on the outer legs 62 of the runners, as shown, to assure engagement of the louvers 72 and 74 on the outer runner legs 62 with the webs 44 of the frames. In assembled condition of these latter frames, the outer legs 62 of the runners on one frame extend through the slots 70 in the curved connecting portions of the runners on adjacent frames and are then interleaved between the inner flanges 46 of the adjacent frames and the offset portions 100.

As will be noted in Fig. 8, when the frames are compressed to their limit, as are the inner edges of the frames in roll, the ends of the runner legs associated with one frame extend completely beyond the adjacent frame and the alternate frame. The inner inclined edges 46' of the inner flanges 46 act as camming surfaces to cam the inner runner legs 64 inwardly of the inner flanges 46 on the alternate frames.

Movement of the articles through the conveyer chute is in the direction indicated by the arrow in Fig. 8, so that the overlapping inner runner legs 64 provide a series of longitudinally extending guiding surfaces spaced about the chute guideway 40.

It will be apparent from Fig. 7 that the upper inwardly extending lateral legs 42*a* and 42*b* of the frame 42 are unsupported and if not suitably reinforced, would be subject to deflection inwardly of the chute guideway 40. If such inward deflection is excessive, the guideway or passage 40 through the chute may be restricted to such an extent as to preclude passage of the articles therethrough. Also, as preliminarily noted, excessive outward deflection of these unsupported legs enlarges the guideway and renders the chute subject to jamming especially when a booster device is used.

It will be noted that the neutral axis of the legs in such deflection is at a position somewhat as indicated at N and that the flanges 46 and 48 of the legs extend normal to the plane of this deflection. The web 44 is in the plane of this deflection, owing to the opening of the channel of the frame in a longitudinal direction of the chute. This arrangement places the two flanges 46 and 48 of the frame at maximum distances from the neutral axis during bending of the legs 42*a* and 42*b* in a direction to restrict or enlarge the guideway 40 so that maximum resistance to such bending is offered. Accordingly, the frames 42, and especially the unsupported legs 42*a* and 42*b*, have maximum stiffness and rigidity against deflection in the plane normal to the guideway. The possibility of bending of the frame to excessively constrict or enlarge the guideway 40 through the chute is, therefore, substantially reduced without increasing the weight of the frames by the use of heavy gauge metal or auxiliary reinforcing means. Obviously, a closed rectangular frame construction might be used in some cases to eliminate the unsupported frame legs.

Figs. 10–18 illustrate a conveyer chute similar to those described above, but incorporating a still further modi-

fied form of flexible runner. This modified runner is especially designed to facilitate detachment and assembly of the individual links or frames and reduce the resistance to flexing of the chute, as well as resistance to passage of articles through the chute.

Referring to these figures, the modified conveyer chute will be seen to comprise a series of link frames **200** which are substantially identical to the link frames **42** of Figs. 1 through 8. Thus, each of the link frames **200** is of open, generally rectangular configuration and has a channel section defined by a web **202** in the plane of the link and inner and outer flanges **204** and **206** along opposite edges of the web **202**. Each link frame **200**, as viewed in Fig. 15, is substantially identical in configuration to the previously described link frame **42**, as viewed in Fig. 7, so as to accommodate the conveying of linked rounds of ammunition.

Opening through the web **202** of each of the link frames **200** are a series of slots **208A** to **216A** for receiving the modified runners referred to above and to be presently described. The link frames **200** of Figs. 10–18 differ from the link frames **42** of Figs. 1 through 8, in that the portions of the inner flanges **204** aligned with the slots **208** through **216** in the webs **202** of the former links are planar and incline slightly inwardly of the chute passage rather than being bent outwardly in the manner illustrated at **46'** in Figs. 1 through 8. Also, each of the link frames **200** has a pair of abutment lips **220** extending inwardly of the frame from the edges of the outer flanges **206** at the ends of the frame. These lips **220** abut adjacent frames when the chute is compressed or flexed in tight fan attitude.

The several link frames **200**, comprising the chute of Figs. 10–18, are flexibly interconnected by a series of flexible runners designated by the numerals **208** through **218** so as to correspond to the numerals applied to the frame slots **208A** to **218A** which receive the legs of the respective runners as hereinafter described. The runners **208** through **214** are generally similar as are the two end runners **216** and **218**, so that only one of each of these two groups of runners, namely, runner **208** and runner **216**, will be described in detail, it being understood that such detailed description will also apply to the other runners or runner in the respective groups.

Runners **208** and **216** are similar, one to the other, and to the runners of Figs. 1 through 8, in that each is fabricated from a strip of spring steel or the like which is sheared to the configuration shown, and folded about a center line to form on each runner a pair of flexible legs **222** and **224** (Figs. 12 and 13) and a connecting portion **226**. The runner legs **222** are hereinafter referred to as the outer legs, while the runner legs **224** are hereinafter referred to as the inner legs, inasmuch as in the assembled condition of the runners and link frames **200**, the legs **222** extend through the frame slots **208A** through **218A**, as the case may be, outwardly of the inner frame flanges **204**, while the runner legs **224** extend inwardly of such flanges.

As shown most clearly in Fig. 12, the inner runner leg **224** of runner **208** is somewhat longer than the outer runner leg **222** and has its free end tapered and rounded, as illustrated, to facilitate assembly of the runners and link frames. The outer runner leg **222** has a generally rectangular configuration and a width substantially equal to the width of the inner runner leg **224** at the base of the latter. The runner is enlarged adjacent the connecting portion **226** to form a pair of right angle shoulders **228** at opposite sides of the outer leg **222** and a pair of inclined shoulders **230** at opposite sides of the inner leg **224**. The connecting portion **226** is formed with a slot, or notch, **232**, having a length measured transversely of the runner legs **222** and **224**, which is slightly greater than the width of the legs.

The outer runner leg **222** is semi-circularly lanced adjacent its base and tip, as indicated at **234** and **236**. As shown, the lances **234** and **236** curve toward one another. The generally semi-circular tab **238** defined by the base lance **234** is bent inwardly, as shown most clearly in Fig. 12, at an acute angle to the plane of the upper runner leg **222**. This tab **238** is formed with a perforation **240** designed to receive a slender, rod-like instrument I (Fig. 18) for flexing the tab **238** from its normal position of Fig. 17 to its position of Fig. 18. The tab **238** is thus flexed to facilitate detachment of the individual frames **200** of the chute, as will be presently described.

The generally semi-circular tab **241**, defined by the tip lance **236**, is bent outwardly at an acute angle to the plane of the upper runner leg **222**, as shown. The upper runner leg **222**, at its base, is formed with a pair of longitudinal lances **242** opening through the edge of the notch **232** in the connecting portion **226** of the runner. The rectangular tab **244**, defined by these longitudinal lances **242**, is bent upwardly into substantially perpendicular relationship to the plane of the upper runner leg **222**. As may be observed most clearly in Fig. 16, the plane of the perpendicular tab **244** is spaced a distance D, toward the tip of the upper runner leg **222**, from the right angular shoulders **228** at the base of the latter leg.

Extending longitudinally of the runner legs **222** and **224** and toward the tips of the latter, at opposite ends of the curved connecting portion **226**, are a pair of tongues **246**. These lips terminate just short of the right angular runner shoulders **228**. The inner edges of these tongues **246**, that is, the edges proximate to and substantially paralleling the inner runner legs **224**, are spaced from the latter a distance which is substantially greater than the thickness of the material from which the frames **200** are fabricated.

Referring now to Fig. 13, the outer and inner legs **222'** and **224'**, respectively, of the end runner **216**, which, as indicated, is identical to the other end runner **218**, will be seen to be of substantially the same length and be tapered and rounded at their tips. These rounded, tapered tips of the runner legs are outwardly curved slightly, as shown. The outer runner leg **222'** adjacent its base is semi-circularly lanced at **248**. The generally semi-circular tab **250** defined by the lance **248** is bent outwardly at an acute angle to the plane of the outer runner leg **222'**.

As in the runner **208** of Fig. 12, the connecting portion **252** of the runner **216** is somewhat enlarged relative to the width of the runner legs, so as to form at the base of the inner runner leg **224'** inclined shoulders **256**. Perpendicular shoulders are defined by inwardly bent lips **258** on the enlarged, connecting portion **252** at opposite sides of the outer runner leg **222'**.

The connecting portion **252** of the runner is formed with a notch or slot **260** and with longitudinally extending lances **264** opening through the edge of this slot **260**. The lances **264** define therebetween enlarged outer and inner tabs **266** and **268**, respectively.

The outer tab **266** extends in the plane of the outer runner leg **222'**, while the inner, enlarged tab **268** is bent slightly toward the outer tab **266**.

In assembly of the link frames and runners, the lanced, outer leg **222** or **222'** of each of the runners **208** through **218** is inserted first through its respective slot **208A** through **218A** in one of the frames **200**, then through the slot **232** or **260**, as the case may be, in the connecting portion of the aligned runner on the adjacent frame, and finally through the aligned slot **208A** through **218A** in the adjacent frame. The outer runner legs **222** are thus inserted through their respective frame slots to position the perpendicular tabs **244** on the runners **208** through **214**, beyond the web **202** of the one frame and the outwardly inclined tip tab **241** on that runner leg beyond the web **202** of the adjacent frame, as well as beyond the downwardly extending base tab **238** on the runner which extends from the latter frame, as may be observed most clearly in Fig. 16.

In this respect, it will be observed in Fig. 16*a* that the

tabs 244 are proportioned to pass through the frame slots when the runners are inclined to the frames, as shown in solid lines in the latter figure. The illustrated rounded inner edges of the tongues 246 enable the runners to be thus inclined. After the tabs on the runners have been inserted through the slots, the runners are rocked to their dotted line position and the outer runner leg is inserted through the aligned slot on the adjacent frame.

In the assembled condition of the runners and frames, engagement of the runner tongues 246 with the adjacent inner frame flanges 204 retains the runner tabs 244 in position behind the frame webs 202 and thereby prevents accidental separation of the runners and frames.

The outer legs 222' of the end runners 216 and 218 are similarly inserted through the end slots 216A and 218A of the frame until the outwardly inclined tabs 250 on the outer runner legs are located beyond the webs 202 of their respective frames, as shown most clearly in Fig. 10. The tip of the outer runner legs 222' extend through the slot 260 in the connecting portion of the aligned end runner on the adjacent link and through the aligned slot 216A or 218A, as the case may be, in the web of the adjacent frame.

The inner runner legs 224 of the runners 208 through 218 extend along the inner sides of the flanges 204 of their respective frame 200 and through the slot in the connecting portion of the aligned runner on the adjacent frame so as to have their tip portions received between the inner runner leg on the adjacent frame and the inner surface of the inner flange 204 on the adjacent frame, as shown in the drawings. The interleaved, overlapping disposition of the runner legs 222 and 224 of the runners 208 through 218 is, therefore, thus far substantially identical to the interleaved, overlapping disposition of the runner legs in the conveyer chute of Figs. 1 through 8. In the chute of Figs. 10–16, however, the tips of the inner runner legs extend on the outer side of the third or alternate link frames, as shown in Fig. 16. When the links are compressed, therefore, the inner runner legs extend through the aligned frame slots 208A–218A in the alternate frames, as shown in the lower portion of Fig. 16. The aforedescribed slight inward inclination of the inner flanges 204 act to "lead" the inner runner legs to the outside of the flanges in the alternate frames. It will be apparent that only two inner runner legs overlap within the chute passage at all points along the latter. There is, therefore, no reduction in the cross-sectional dimensions of the chute passage when the chute is compressed, as occurs in the chute of Figs. 1–8 due to the increased number of runner legs which overlap within the passage when the latter chute is compressed. In the chute of Figs. 10–18, accordingly, there is less resistance to movement of articles through the passage when the chute is compressed. This reduces the resistance to compression, and, therefore, flexing of the chute.

As in the case of the conveyer chute of Figs. 1 through 8, the resilient flexibility of the runners 208 through 214 accommodates articulation of the conveyer chute in roll, the minimum roll radius being fixed by abutment of the inner edges of adjacent frames 200 and the maximum extension of adjacent frames at their outer edges. In the case of the conveyer chute of Figs. 10–18, this maximum extension is, in turn, determined by interengagement of the inclined base and tip tabs 238 and 241 on the overlapping, outer legs 222 of the runners 208 through 214, in the manner shown in Fig. 17.

Articulation of the chute in fan and the minimum fan radius are limited by abutment of the inner edges of the frames 200 and extension of the outer edges of the frames to their limit. This extension, in the conveyer chute of Figs. 10–18, is determined again by the interengagement of the tabs 238 and 241 on the outer runner legs 222, as in the case of roll, rather than by interengagement of tabs on the end runners 216 and 218, as was true in the conveyer chute of Figs. 1 through 8. During articulation of the chute and fan, the end runners 216 and 218 are flexed while the top and bottom runners 208 through 214 are merely angulated in their plane.

It will be observed that axial tension on the chute in the illustrated condition of maximum roll, as well as in minimum fan radius and maximum extension of the chute, is taken up entirely through the outer runner legs 222. Thus, this tension is transmitted from one runner leg directly to the adjacent leg through the interengaging tabs 238 and 241, rather than through the link frames as was the case in the conveyer chute of Figs. 1 through 8. This permits the maximum extension of the chute and the minimum fan and roll radii to be more accurately controlled than in the case of the conveyer chute of Figs. 1 through 8, by providing an accurate spacing between the base and tip tabs 238 and 241 on the runner legs 222.

A unique advantage of the present flexible chute design is that the runners can overlap a greater distance than in existing chutes employing conventional hook and eye or loop arrangements for interconnecting adjacent link frames. The present chute design, therefore, enables a greater degree of chute articulation, extension and compression than existing chutes of the type mentioned.

From the foregoing description, it will be apparent that fabrication of the present conveyer chute involves merely the forming of the several link frames and flexible runners and final assembly thereof into an integral conveyer chute. It will be seen, therefore, that there has been described and illustrated a conveyer chute which is fully capable of obtaining the objects and advantages preliminarily set forth while certain preferred embodiments of the invention have been described and illustrated for illustrative purposes, it will be evident that numerous modifications in design and arrangement of parts is possible within the scope of the following claims.

I claim:

1. A flexible conveyer chute having a longitudinal passage through which articles to be conveyed are adapted to move, said chute comprising: a series of link assemblies arranged lengthwise of said passage each including a frame extending about the passage and a plurality of coupling means joining the frames of adjacent assemblies for relative articulation and relative extensible and contractile movement longitudinally of the passage, the several frames having a plurality of similarly located openings spaced about and opening through the frames lengthwise of said passage; each of said coupling means comprising a flexible runner extending slidably through one of said openings in the frame of its respective assembly and the corresponding opening in the frame of an adjacent assembly, means for limiting movement of the runner in opposite directions in said one opening, abutment means on said runner, cooperating abutment means on said adjacent assembly engageable with said runner abutment means to limit separation of the assemblies, one of said abutment means being flexible to clear the other abutment means and said runner abutment means being movable through said corresponding opening in the adjacent assembly whereby to permit separation of said assemblies.

2. The subject matter of claim 1 wherein said openings are slots in said frames and said runners comprise flexible leaves loosely received in said slots.

3. The subject matter of claim 1 wherein said runner abutment means are flexible, and said cooperating abutment means comprise said frame of the adjacent assembly.

4. The subject matter of claim 1 wherein said cooperating abutment means are on the runners of said adjacent assembly, the longitudinally aligned runners of adjacent assemblies overlapping.

5. A flexible conveyer chute having a longitudinal passage through which articles to be conveyed are adapted to move, said chute comprising: a series of link assemblies arranged lengthwise of said passage each including a frame extending about the passage and a plurality of

coupling means joining the frames of adjacent assemblies for relative articulation and relative extensible and contractile movement longitudinally of the passage, the several frames having a plurality of similarly located openings spaced about and extending through the frames lengthwise of the passage; each of said coupling means comprising a generally U-shaped runner including a pair of spaced, substantially parallel legs and a connecting portion joining the legs at one end; one leg of each runner extending slidably through corresponding openings in the frames of adjacent assemblies and the other leg of each runner extending longitudinally of the passage within the latter and forming an article guiding surface within said passage; and said assemblies including cooperating abutment means for limiting relative longitudinal movement of said runners and frames.

6. The subject matter of claim 5 wherein said frames comprise flanges paralleling said passage and straddled by said runner legs.

7. The subject matter of claim 5 wherein said connecting portions of the runners are slotted for receiving the legs of adjacent runners whereby said runner legs are disposed in overlapping fashion.

8. The subject matter of claim 7 wherein said frames comprise flanges straddled by said runner legs, one leg of each runner extending from one frame to an adjacent frame and having its free end slidably disposed between said flange of the adjacent frame and said one leg of the corresponding runner extending from said adjacent frame to the next following frame.

9. The subject matter of claim 1 wherein each of said frames includes a wall in a transverse plane of said passage and having said openings therein.

10. The subject matter of claim 9 wherein each of said frames includes flanges at inner and outer edges of said wall, said flanges extending substantially perpendicular to said wall and substantially parallel to the passage whereby said frames possess maximum rigidity against bending in said plane.

11. A flexible conveyer chute having a longitudinal passage through which articles to be conveyed are adapted to move, said chute comprising: a series of link assemblies spaced lengthwise of the passage each including a frame extending about the passage, the several frames having similarly located slots in zones spaced about said passage and opening through the frames longitudinally of the passage, and coupling means joining adjacent frames for relative articulation and relative extensible and contractile movement longitudinally of the passage; said coupling means comprising generally U-shaped runners of flexible material each including a pair of flexible leaves as legs thereof and a connecting portion joining the leaves at one end, each pair of corresponding slots in adjacent frames having one leaf of a runner extending slideably therethrough longitudinally of the passage and the other leaves of the runners extending longitudinally of the passage within the latter and forming guiding surfaces for the articles conveyed, the length of said leaves being such as to accommodate limited relative movement of adjacent frames longitudinally of the passage, and cooperating abutment means on adjacent assemblies for limiting longitudinal separation thereof.

12. The subject matter of claim 11 wherein said connecting portions of the runners are slotted and receive therethrough the leaves of adjacent runners whereby said runner leaves are arranged in overlapping fashion.

13. The subject matter of claim 12 wherein said one leaf of each runner extending from a given frame to an adjacent frame passes through the slot in the connecting portion of the corresponding runner extending from said latter frame to the next frame and then through the slot in the wall of said latter adjacent frame, the other leaf of each runner passing through the slot in said corresponding runner and being interleaved between said other leaf of the latter runner and said latter adjacent frame.

14. The subject matter of claim 11 wherein said abutment means comprise shoulder means adjacent said connecting portion of each runner engageable with said frame of the respective assembly to limit separation of each runner and its respective frame, detent means adjacent the free end of said one leaf of each runner, and means on the adjacent assembly engageable with said detent means to limit separation of each runner and the adjacent frame.

15. The subject matter of claim 14 wherein said shoulder and detent means are punched from said one leaf of each runner.

16. The subject matter of claim 15 wherein said detent means are flexible whereby to permit separation of the runners and frames.

17. The subject matter of claim 11 wherein each of said frames are channel-shaped in cross-section with the web of the channel disposed in a transverse plane of said passage, said web being flanged along its inner and outer edges parallel to said passage whereby said channel opens longitudinally of the passage and said frames present maximum rigidity to bending in said plane.

18. The subject matter of claim 17 wherein said slots are formed in said web of each frame.

19. The subject matter of claim 11 wherein each frame includes a wall in a transverse plane of said passage which is formed with said slots and flanged along its inner edges parallel to the passage, the leaves of the runners in each assembly straddling said flanges on the frame of the respective assembly, the connecting portions of the runners being slotted, and the leaves of each runner passing through the slot in the corresponding runner of an adjacent assembly, said other leaves of the runners of each assembly being interleaved between said other leaves of the runners in an adjacent assembly and said flange on said frame of the latter assembly, and said flanges being outwardly inclined in portions thereof aligned with said slots whereby said other leaves on the runners are cammed inwardly of the flanges when the frames are compressed.

20. The subject matter of claim 19 wherein the free ends of said one leaf of the runners are inwardly inclined whereby said one leaf of the runners extending from one assembly through a slot in the frame of an adjacent assembly is cammed inwardly of the flange on the frame of the next following assembly when the frames are compressed.

21. The subject matter of claim 11 wherein each frame includes a wall in a transverse plane of said passage and having said slots formed therein, said abutment means comprising shoulder means on said one leaf of each runner adjacent said connecting portion of the latter and detent means adjacent the free end of said one leaf of each runner engageable with opposite sides of said walls of respective adjacent frames.

22. The subject matter of claim 21 wherein said one leaf of corresponding runners are disposed in overlapping fashion, and said cooperating abutment means are on said overlapping leaves.

23. A flexible conveyer chute having a longitudinal passage through which articles to be conveyed are adapted to move, said chute comprising: a series of links spaced lengthwise of the passage, each link comprising a frame extending about said passage and including a wall in a transverse plane of and extending about the passage, said walls of the several frames having similarly located slots therethrough in zones spaced about said passage and disposed in planes substantially paralleling said passage, and coupling means joining adjacent frames for relative articulation and relative extensible and contractile movement longitudinally of the passage, said coupling means comprising generally U-shaped runners of flexible material each having a pair of flexible leaves as legs thereof and a connecting portion joining the leaves at one end, each pair of corresponding slots in adjacent frames having one leaf of a runner extending slideably therethrough longitudinally of the passage and the other leaf of each runner

extending longitudinally of the passage within the latter and forming guiding surfaces for the articles conveyed, the length of said leaves being such as to accommodate limited relative movement of adjacent frames longitudinally of the passage, and abutment means on said one leaf of each runner engageable with adjacent frames for limiting longitudinal separation thereof.

24. A flexible conveyer chute having a longitudinal passage through which articles to be conveyed are adapted to move, said chute comprising: a series of links spaced lengthwise of the passage, each link comprising a frame extending about said passage and including a wall in a transverse plane of and extending about the passage, said walls of the several frames having similarly located slots therethrough in zones spaced about said passage and disposed in planes substantially paralleling said passage, and coupling means joining adjacent frames for relative articulation and relative extensible and contractile movement longitudinally of the passage, said coupling means comprising generally U-shaped runners of flexible material each having a pair of flexible leaves as legs thereof and a connecting portion joining the leaves at one end, each pair of corresponding slots in adjacent frames having one leaf of a runner extending slideably therethrough longitudinally of the passage and the other leaf of each runner extending longitudinally of the passage within the latter and forming guiding surfaces for the articles conveyed, the length of said leaves being such as to accommodate limited relative movement of adjacent frames longitudinally of the passage, first abutment means on said one leaf of said runners engageable with said frames for limiting separation of the runners and frames, and second abutment means on said one leaf of said runners, said second abutment means on adjacent longitudinally aligned runners being engageable to limit separation of adjacent frames.

25. A flexible ammunition chute having a passage through which articles of ammunition are adapted to be conveyed, comprising a series of links spaced lengthwise of the passage and each comprising a generally rectangular frame extending about said passage, each frame having a wall coextensive therewith and in a transverse plane of the passage, said walls of the frames having a series of similarly located slots therethrough, there being at least one slot in each leg of the frames and the slots extending parallel to the respective legs, and coupling means joining adjacent frames for relative articulation and relative movement longitudinally of the passage, said coupling means comprising a series of generally U-shaped runners extending between adjacent links, each runner having a pair of substantially parallel flexible leaves forming the legs of the runner and a connecting portion connecting said legs at one end, said connecting portion being slotted, each pair of corresponding slots in adjacent frames having one leaf of a runner extending loosely therethrough longitudinally of the passage, the other leaves of said runners extending in said passage, the runner leaves extending from one frame to an adjacent frame passing through the slots in the connecting portions of the corresponding runners extending from said adjacent frame to the next following frame, whereby the runner leaves are arranged in overlapping fashion, said other runner leaves within said passage forming guiding surfaces for the articles conveyed, and cooperating abutment means on the leaves and frames for limiting separation of the frames.

26. The subject matter of claim 25 wherein each of said frames comprises a channel member, said wall forming the web of the channel, and flanges formed along the inner and outer edges of said wall parallel to said passage whereby said frames possess maximum resistance to bending in said transverse planes, said runner leaves straddling the inner flanges of the frames.

27. A link for a conveyer chute of the class described, comprising a frame defining a central opening through which articles conveyed are adapted to move along a given direction line, said frame including a wall coextensive with the frame and in the plane of said opening, and flanges along the inner and outer edges of said wall extending normal to said plane whereby the frame possesses maximum resistance to bending in said plane.

28. A runner for a conveyer chute of the class described, comprising a strip of thin, flexible material bent into a generally U-shaped configuration to form a pair of substantially parallel, flexible leaves and a connecting portion connecting said leaves at one end, said connecting portion having a slot of a length slightly greater than the width of said leaves, one of said leaves having shoulders adjacent said connecting portion and facing the free ends of the leaves, and said one leaf having spaced projecting abutments.

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