

LOADING SYSTEM FOR LINKLESS AMMUNITION

DESCRIPTION

5 TECHNICAL FIELD

The present invention relates to an installation provided with a linkless ammunition loading system, in particular for artillery installations.

TECHNICAL BACKGROUND

10 Installations are known in the industry which are provided with linkless ammunition loading systems; in this respect, it would be desirable to make available further installations including loading systems differing from those currently known in the art.

15 US 1,332,060 A describes an installation having the technical features mentioned in the preamble of the independent claim.

SUMMARY OF THE INVENTION

It is one object of the present invention to realize an
20 installation provided with an improved loading system capable of overcoming the drawbacks of the techniques currently available on the market.

According to the present invention, this and other objects are achieved through an installation provided with
25 a loading system having the technical features set out in the appended independent claim.

It is understood that the appended claims are an integral part of the technical teachings provided in the following detailed description of the present invention. In
30 particular, the appended dependent claims define some preferred embodiments of the present invention that include some optional technical features.

In particular, the installation provided with the loading system offers the following advantages, which are in particular due to some preferred, though not essential, aspects of the present invention:

- 5 - loading of linkless ammunitions;
- heightwise and widthwise compact automatic loading, resulting in reduced turret volumes;
- smaller front area to be protected because, due to the fact that ammunition storage is moved to the traversing mass,
- 10 the turret geometry is reduced and the inertia variation caused by the movements of the ammunitions in the elevating mass is cancelled;
- since there are no links connecting the ammunitions, the typical ballistic window for discharging such links is
- 15 eliminated;
- possibility of loading the firearm with different ammunition types per feeding branch;
- possibility of replenishment of two separate magazines in the traversing mass directly from the crew space, which is
- 20 situated within the hull under the turret base plane and is therefore separated from the rest of the vehicle by a ballistic protection; this facilitates the replenishment operation, while at the same time improving crew safety, since it is not necessary to climb up into the turret space.

25 Further features and advantages of the present invention will become apparent in light of the following detailed description, provided herein merely as a non-limiting example and referring, in particular, to the annexed drawings as summarized below.

30 BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1 and 1a show, respectively, a perspective front top view and a partially transparent perspective rear top

view, both of which concern a turret whereon an installation comprising a loading system according to the present invention has been mounted.

Figure 2 shows a block diagram of an installation
5 comprising a loading system obtained in accordance with an exemplary embodiment of the present invention.

Figure 3 shows a partial perspective rear top view of the installation comprising the loading system shown in the preceding figures.

10 Figure 4 shows a partially transparent perspective view, magnified compared with Figure 3, of an ammunition feeding assembly for the installation shown in the preceding figures.

Figure 5 shows a perspective view, further magnified
15 compared with Figure 3, concerning an ammunition transfer device for the feeding assembly shown in Figure 4.

Figure 6 shows a partially transparent perspective view, further magnified compared with Figure 3, concerning an ammunition conveying guide of the feeding assembly shown
20 in Figure 4.

Figures 7 and 8 show, respectively, side views and perspective of the feeding mechanism of the feeding assembly shown in the preceding figures, which includes a chain. These figures also show ammunition pushing members.

25 Figure 8a is a schematic view that shows how the chain is guided along its path, in particular by rollers of the chain itself, shown in the preceding figures.

Figures 8b and 8c are views similar to those of Figures 7 and 8, which show an implementation variant of the
30 previously shown chain.

Figures 8d and 8e are views showing one possible and illustrative linking method that can be adopted for the links

of the chain shown in Figures 7, 8 and 8a and respectively,
of the one shown in Figures 8b and 8c.

Figure 9 is a side view of an ammunition loading guide
of the feeding assembly, which allows the transfer of
5 ammunitions from the last section of the chain to the firearm
inlet.

For completeness' sake, the following is a list of
alphanumerical references and names used herein to identify
parts, elements and components illustrated in the above-
10 summarized drawings.

- Z. Traversing axis
- Y. Elevating axis
- x1. Mounting axis
- x2. Thrust axis
- 15 W. Star element rotation axis
- P0. Magazine path
- P1. Conveying path
- P2. Loading path
- A. Ammunitions
- 20 1. Turret
- 10. Artillery installation
- 12. Traversing mass
- 14. Elevating mass
- 16. Firearm assembly
- 25 18. Barrel
- 20. Magazine
- 22. Feeding assembly
- 24. Transfer device
- 25. Inlet of the feeding assembly and conveying guide
- 30 26. Conveying guide
- 27. Star element
- 28. Conveying mechanism

- 29. Crank
- 30. Sliding structure
- 30a. Lateral rail portion
- 30b. Central rail portion
- 5 32. Conveying chain
- 34. Pushing members
- 35. Lever
- 36. Chain links
- 36a. Horizontal chain links
- 10 36b. Vertical chain links
- 37. Thrust spring
- 38. Sliding pins
- 38a. Lateral sliding pins
- 38b. Central sliding pins
- 15 39. C-shaped bodies
- 39a. Horizontal C-shaped bodies
- 39b. Vertical C-shaped bodies
- 40. Rollers
- 41. Through bores
- 20 41a. (First) through bores
- 41b. (Second) through bores
- 42. Gear wheels
- 46. Loading guide
- 48. Loading mechanism
- 25 50. Loading star elements

DETAILED DESCRIPTION OF THE INVENTION

With reference to Figures 1 and 1a, numeral 1 designates as a whole a turret equipped with an artillery installation 10.

- 30 Installation 10 is particularly suitable for installation on terrestrial vehicles, e.g. armoured vehicles such as tanks. Nevertheless, it may be used for other

applications as well, e.g. aircraft, ships or fixed installations.

With reference to Figure 2, installation 10 is represented by means of a block diagram, whereas in Figure 3 the construction details of such installation 10 are shown in a perspective rear view. In a *per se* known manner, artillery installation 10 comprises a traversing portion or mass 12, an elevating portion or mass 14, and a firearm assembly 16.

10 Traversing mass 12 is configured to be rotatably mounted and supported on a stationary support structure (not numbered), so as to rotate about a substantially vertical traversing (or azimuthal) axis Z.

Elevating mass 14 is rotatably supported by traversing mass 12 about an elevating axis Y, which is substantially horizontal and perpendicular to vertical axis Z. In particular, when viewing Figure 2, elevating axis Y substantially corresponds to an axis entering perpendicularly through the sheet plane. In a *per se* known manner, typically traversing mass 12 and elevating mass 14 are mutually assembled by means of a pair of cheeks (details not shown) fixed to traversing mass 12, whereon elevation bearings are mounted, particularly at elevating axis Y).

20 A firearm assembly 16 is in turn supported by elevating mass 14. Moreover, firearm assembly 16 comprises a barrel 18 configured to fire ammunitions A. In the embodiment illustrated herein, barrel 18 is a cannon, e.g. having a calibre of 30mm.

Installation 10 comprises also a magazine 20 configured to contain a plurality of ammunitions A to be fed to barrel 18. In particular, magazine 20 is configured to automatically move the plurality of ammunitions A. Furthermore,

ammunitions A contained in the magazine are of the type not mutually connected by links -also referred to as linkless ammunitions.

Magazine 20 is carried by traversing mass 12 and is
5 operatively integral therewith; in particular, as will be further explained hereinafter, magazine 20 is separate and distinct from elevating mass 14.

In the embodiment illustrated herein, magazine 20 has, at its outlet, a star-element conveyor of a *per se* known
10 type (not numbered), which dispenses ammunitions A out of itself.

Artillery installation 10 further comprises a feeding assembly 22 configured to transfer ammunitions A coming from magazine 20 to barrel 18, for such ammunitions A to be fired
15 through the latter.

In the embodiment illustrated herein, feeding assembly 22 is carried by elevating mass 14 and is operatively integral therewith; in particular, unlike magazine 20, feeding assembly 22 is separate and distinct from traversing
20 mass 12.

Furthermore, artillery installation 10 comprises a transfer device (or "exchanger") 24 configured to transfer ammunitions A from magazine 20 to feeding assembly 22.

In particular, transfer device 24 is mounted on
25 traversing mass 12.

The following will describe further technical features of this exemplary embodiment of the present invention.

In the implementation example illustrated herein, transfer device 24 is mounted in proximity to the elevating
30 axis Y.

As will be described in more detail below, also with reference to some preferred and optional technical features

of the present invention, due to this arrangement of transfer device 24 the mutual arrangement between transfer device 24, carried by traversing mass 12, and inlet 25 of feeding assembly 22, carried by elevating mass 14, always remains substantially the same for any angle of elevation assumed by elevating mass 14 relative to traversing mass 12 about elevating axis Y; therefore, ammunitions A can be conveyed from magazine 20 to barrel 18 (through feeding assembly 22) in any mutual operating condition of traversing mass 12 and elevating mass 14 of artillery installation 10.

With particular reference to Figure 4, there is shown a magnified view of feeding assembly 22 visible in the preceding figures.

Feeding assembly 22 comprises a conveying guide 26 mounted on elevating mass 14 and defining a path for transporting ammunitions A from transfer device 24 towards barrel 18. In the illustrated embodiment, the inlet of feeding assembly 22 substantially coincides with the inlet of conveying guide 26, and both are designated by the same reference numeral 25.

In particular, inlet 25 of conveying guide 26, whereat ammunitions A coming from magazine 20 are made to arrive via a star element, e.g. a three-lobed one (not numbered in Figure 4), is situated in the vicinity of the elevating axis Y. Ammunitions A are intended to enter - and subsequently slide - therein with their side facing conveying duct 26. As will be further described below, conveying guide 26 is advantageously provided as a rigid conduit.

With particular reference to Figures 4 and 6, conveying guide 26 defines an open path, in particular a path shaped as a whole as a horizontally turned J. Moreover, the path defined by conveying guide 26 extends in three dimensions in

space and, being compact, makes it possible to reduce the total transversal and lateral dimensions of feeding assembly 22.

The rigid conduit formed by conveying guide 26 is, for example, implemented as an open channel in which ammunitions A can slide. In particular, such rigid conduit has a substantially rectangular cross-section, suitable for receiving ammunitions A with their side facing forwards and for directing them towards barrel 18. Furthermore, said conveying conduit or channel is rigid.

Transfer device 24 is configured to pick up ammunitions A as they exit magazine 20 and supply them to inlet 25 of conveying guide 26.

In Figures 5 and 6, for completeness' sake, arrows schematically indicate the path followed by ammunitions A between magazine 20 and conveying guide 26. In particular, the arrow designated as P0 indicates the magazine path initially followed by ammunitions A exiting magazine 20, which are then picked up by transfer device 24. The arrow designated as P1 indicates the conveyance path followed by ammunitions A going through conveying guide 26. As shown more clearly in Figure 6, conveyance path P1 is substantially curvilinear and bends upwards, rotating by about 180°, thus "overturning" the ammunitions from their previous orientation at inlet 25 of conveying guide 26.

Transfer device 24 additionally comprises a star element 27, in particular a three-lobed one, rotatably supported about a rotation axis W situated in proximity to the elevating axis Y. In the implementation example illustrated herein, star element 27 is aligned with feeding assembly 22.

Multi-lobed star element 27 is configured to rotate and

pick up ammunitions A exiting magazine 20 and supply them to inlet 25 of feeding assembly 22, and in particular to the conduit formed by conveying guide 26, for moving them towards barrel 18. As can be seen, ammunitions A are picked up
5 laterally by star element 27 from the outlet of magazine 20, and are then delivered to inlet 25 of conveying guide 26 (in particular, to the inlet of the rigid conduit defined by the latter).

Inlet 25 of conveying guide 26 (e.g. the inlet of the
10 rigid conduit defined by the latter) is located at the elevating axis Y, being in particular crossed transversally by the latter.

Preferably, rotation axis W is substantially parallel to elevating axis Y; in the embodiment illustrated herein,
15 the distance between rotation axis W and elevating axis Y is such that, in at least a part of the rotation path of star element 27, the centre of ammunition A to be picked up by star element 27 lies substantially on elevating axis Y.

In particular, the rotation axis W is spaced apart
20 vertically (i.e. along the direction of the traversing axis Z) from elevating axis Y.

According to a further embodiment, transfer device 24 may advantageously be driven by a motor, e.g. via a gear transmission that controls the rotation of star element 27
25 about rotation axis W.

Feeding assembly 22 further comprises a conveying mechanism 28 configured to push ammunitions A along conveying guide 26. In particular, conveying mechanism 28 may be driven by means of a motor (not shown) and/or manually, e.g. by
30 means of a crank 29.

According to one possible embodiment of the present invention, the transmission of the motion from conveying

mechanism 28 in elevating mass 14 to transfer device 24 in traversing mass 12 may occur through a mechanical connection consisting of a differential gear (not shown in the drawing) that ensures synchronized motion.

5 Conveying mechanism 28 comprises a hollow sliding structure 30 and a conveying chain 32 sliding in the cavity defined by sliding structure 30. Some exemplary technical features of conveying chain 32 are visible in more detail in Figures 7, 8 and 8a.

10 Conveying mechanism 28 comprises also a plurality of pushing members 34 sliding in conveying guide 26 and carried by conveying chain 32. Each one of pushing members 34 is configured for pushing a respective ammunition A adjacent thereto, which is guided by conveying guide 26.

15 Sliding structure 30 extends substantially parallel to conveying guide 26. In particular, sliding structure 30 is fixed to conveying guide 26, e.g. being surrounded along at least a part of its extension by conveying guide 26.

 Furthermore, as will be described more in detail
20 hereinafter, preferably sliding structure 30 is essentially a rail in which conveying chain 32 slides and from/by which pushing members 34 are suspended and/or supported, which then extend and slide in conveying guide 26. In particular, the rail comprises a plurality of rail portions 30a, 30b,
25 extending parallel to and facing each other.

 Conveying chain 32 forms a closed loop and is configured to transmit a forward motion to pushing members 34 mounted thereon. Also, conveying chain 32 comprises a plurality of chain links 36 mutually connected in an articulated manner.
30 More in detail, chain links 36 can move, in particular by rotating in different planes, in order to follow the path delimited by conveying guide 26.

In the embodiment illustrated herein, each one of pushing members 34 is shaped substantially as a widened fork, the neck of which - which protrudes and is supported by respective chain link 36 - branches off laterally into two arms.

In the embodiment illustrated herein, each one of chain links 36 substantially defines a closed-loop shape (e.g. wherein the closed loop forms a substantially rectangular or square shape).

As shown in detail in Figures 7 and 8, each closed loop defined by each chain link 36 lies in a plane perpendicular to the plane in which the previous and/or next chain link 36 lies. In this regard, by way of example, in Figure 7, reference number 36a and 36b designate two adjacent chain links. As it becomes particularly apparent when viewing Figure 7, the link 36a is joined to link 36b by means of a connection that - as will be described in more detail below - provides such two components with three degrees of freedom, thus differing from a traditional chain (e.g. a bicycle chain).

In particular, pushing members 34 are arranged along conveying chain 32 spaced out by a predetermined distance, so that between two pushing members 34 a corresponding ammunition A can be housed, which must be guidedly transported along conveying guide 26. In particular, each one of pushing members 34 is mounted on a respective chain link 36 at predetermined intervals (e.g. at regular and periodic intervals) along conveying chain 32. More particularly, each one of pushing members 34 is mounted after a predefined number of successive chain links 36, depending on the diameter or calibre of the ammunition A to be conveyed.

Furthermore, each pushing member 34 is fixedly mounted to the respective chain link 36 along a mounting axis x1 substantially perpendicular to conveying chain 32.

As it will be further described below, chain links 36
5 carry respective sliding pins 38 on their sides.

In particular, sliding pins 38 rotatably support rollers 40 around themselves. Sliding pins 38 slide, preferably via rollers 40, within sliding structure 30, which, as aforementioned, substantially defines a rail along
10 which conveying chain 32 is configured to slide and/or by which it is configured to be supported.

In particular, each roller 40 carried by the respective sliding pin 38 engages into a respective rail portion 30a, 30b that contributes to defining the sliding structure 30.
15 In the embodiment illustrated herein, chain links 36 to which pushing members 34 are mounted have no associated sliding pin (and roller).

As illustrated in Figure 8a, each one of rail portions 30a, 30b has a C-shape capable of receiving rollers 40
20 preferably carried by respective sliding pins 38 protruding from chain links 36, so as to guide and support conveying chain 32 as it moves in space.

More in detail, still with reference to the embodiment illustrated by way of example in Figures 7 and 8, each one
25 of the horizontal chain links 36a has a lateral sliding pin 38a that protrudes from laterally opposite sides. The ends of lateral sliding pin 38a engage, under the sliding action of rollers 40, into corresponding lateral rail portions 30a of sliding structure 30.

30 Conversely, each vertical chain link 36b (e.g. when it lacks and does not support an associated pushing member 34) has respective central sliding pin 38b protruding from

conveying chain 32 on the side axially opposite to the side from which pushing members 34 extend. The end of central sliding pin 38b slidably engages into a corresponding central rail portion 30b of sliding structure 30.

5 In the embodiment illustrated herein, each pushing member 34 is supported along its mounting axis x1 through the interposition of an additional roller 40 between it and chain link 36. In particular, at one end roller 40 is rotatably mounted to chain link 36, while at the other end
10 it is rotatably integral with pushing member 34.

With reference to Figures 8b and 8c, there is shown a further implementation variant of conveying chain 32. Compared with the conveying chain illustrated in Figures 7, 8 and 8a, a lever 35 is associated with each pushing member
15 34. In particular, lever 35 is mounted to pushing member 34 and is elastically stressed so that it abuts against ammunition A. In this manner, considering that when viewing Figures 8b and 8c the ammunition feeding direction is from right to left, each ammunition A is pushed against the
20 previous pushing member 34 by lever 35 mounted to the next pushing member 34.

Moreover, lever 35 is moved angularly away from pushing member 34 about a thrust axis x2, e.g. substantially perpendicular to mounting axis x1. In particular, a thrust
25 spring 37 is provided, which is mounted between pushing member 34 and lever 35. Thrust spring 37 abuts on pushing member 34 at one end and on lever 35 at the other end. In the implementation variant illustrated herein, thrust spring 37 is, advantageously, a torsion spring.

30 With reference to Figures 8d and 8e, there is shown an exemplary way of linking chain links 36. In the embodiment illustrated herein, chain links 36 consist of a C-shaped

body 39 whose ends are crossed by a respective sliding pin 38; in other words, the closed-loop shape of each chain link 36 is defined by C-shaped body 39 and by a respective sliding pin 38.

5 In addition, still with reference to Figures 8d and 8e, each chain link 36 is connected to adjacent chain link 36 by means of respective sliding pin 38, which fits through a through bore 41 formed in the intermediate portion of C-shaped body 39 belonging to adjacent chain link 36, situated
10 between the ends of chain link 36. For example, each vertical link 36b is connected to adjacent horizontal link 36a by means of central sliding pin 38b that fits through the (first) through bore 41a formed in the intermediate portion of horizontal C-shaped body 39a. Vice versa, each horizontal
15 link 36a is connected to adjacent vertical link 36b by means of lateral sliding pin 38a that fits through the (second) through bore 41b formed in the intermediate portion of vertical C-shaped body 39b.

With particular reference to Figures 6 and 9, conveying
20 mechanism 28 further comprises a pair of gear wheels 42 co-operating with conveying chain 32 in order to move it along sliding structure 30. In particular, at gear wheels 42 sliding structure 30 is interrupted and allows sliding pins 38 of chain links 36 to engage with the crown formed by each
25 one of gear wheels 42 in order to achieve the movement of conveying chain 32. More particularly, lateral sliding pins 38a are engaged between successive teeth of gear wheels 42. Even more particularly, central sliding pins 38b are engaged into an annular groove (not visible in the drawings) provided
30 on each gear wheel 42; this limits the lateral displacement of chain links 36.

With particular reference to Figure 9, feeding assembly

22 comprises also a loading guide 46 situated between conveying guide 26 and barrel 18. More in detail, loading guide 46 is adjacent to the outlet of conveying guide 26 at one end and adjacent to the inlet of barrel 18 at the other end.

In the embodiment illustrated herein, loading guide 46 defines a substantially straight and ascending loading path P2 for the ammunitions coming from conveying guide 26 and directed towards barrel 18.

Feeding assembly 22 further comprises a loading mechanism 48 configured to push the ammunitions A along loading guide 46 and towards the inlet of barrel 18. In particular, loading mechanism 48 comprises a plurality of loading star elements 50 arranged in series and mutually adjacent. Loading star elements 50 are configured to rotate and engage in succession ammunitions A which have come sideways from conveying guide 26 and which have arrived - still with a lateral orientation - at loading guide 46, so as to cause them to advance up to the inlet of barrel 18.

In particular, loading mechanism 48 is rigidly connected to firearm assembly 16, so that the actuation of the whole feeding assembly is regulated by firearm assembly 16 itself.

Of course, without prejudice to the principle of the invention, the forms of embodiment and the implementation details may be extensively varied from those described and illustrated herein by way of non-limiting example, without however departing from the scope of the invention as set out in the appended claims.

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CLAIMS

1. Linkless ammunition loading installation (10) comprising:
- a traversing portion (12) configured to be rotatably mounted and supported on a stationary support structure, so as to rotate about a traversing axis (Z),
 - an elevating portion (14) rotatably supported by said traversing portion (12) about an elevating axis (Y) substantially perpendicular to the traversing axis (Z),
 - a firearm assembly (16) supported by the elevating portion (14) and comprising a barrel (18) configured to fire ammunitions (A) through itself,
 - a magazine (20) carried by said traversing portion (12) and configured to contain a plurality of linkless ammunitions (A) to be fed to said barrel (18),
 - a feeding assembly (22) configured to transfer the linkless ammunitions (A) from said magazine (20) to said barrel (18) for firing said linkless ammunitions (A), said feeding assembly (22) being carried by said elevating portion (14), and
 - a transfer device (24) configured to transfer said linkless ammunitions (A) from said magazine (20) to said feeding assembly (22);
- said installation being characterized in that said magazine (20) is separate and distinct from said elevating portion (14), and said feeding assembly (22) is separate and distinct from said traversing portion (12); and
- in that said transfer device (24) is mounted on said traversing portion (12).
2. Installation according to claim 1, wherein said transfer device (24) is mounted in proximity to said elevating axis (Y).

3. Installation according to claim 2, wherein said transfer device (24) comprises a star element (27) rotatably supported about a rotation axis (W) situated in proximity to the elevating axis (Y).

5 4. Installation according to claim 3, wherein said star element (27) is aligned with the feeding assembly (22) for rotating and picking up said linkless ammunitions (A) exiting said magazine (20) and supplying them to the inlet (25) of said feeding assembly (22).

10 5. Installation according to any one of the preceding claims, wherein said feeding assembly (22) comprises a conveying guide (26) mounted on said elevating portion (14) and defining a path for transporting said linkless ammunitions (A) from said transfer device (24) towards said
15 barrel (18).

6. Installation according to claim 5, wherein said feeding assembly (22) further comprises a conveying mechanism (28) configured to push said linkless ammunitions (A) along said conveying guide (26).

20 7. Installation according to claim 6, wherein said conveying mechanism (28) comprises:

- a hollow sliding structure (30),
- a conveying chain (32) sliding in the cavity defined by said sliding structure (30), and
- 25 - a plurality of pushing members (34) sliding in said conveying guide (26) and carried by the conveying chain (32), each one of said pushing members (34) being configured for pushing a respective linkless ammunition (A) adjacent thereto.

30 8. Installation according to claim 7, wherein said sliding structure (30) comprises a guide (30a, 30b) in which said conveying chain (32) slides and from/by which said pushing

members (34) are suspended and/or supported.

9. Installation according to any one of claims 5 to 8,
wherein said feeding assembly (22) further comprises a
loading guide (46) situated between said conveying guide
5 (26) and said barrel (18).

10. Installation according to claim 9, wherein said feeding
assembly (22) further comprises a loading mechanism (48)
configured to push said linkless ammunitions (A) along said
loading guide (46) towards the inlet of said barrel (18).

10