

DESCRIPTION

Title of the Invention: WORKPIECE EJECTION DEVICE AND WORKPIECE
SUPPLY DEVICE PROVIDED WITH SAME

Technical Field

[0001] The present invention relates to a workpiece ejection device that is used when, from a magazine, i.e., a container for storing a plurality of plate-like workpieces in an arrayed state with a certain spacing held between the plate-like workpieces, the workpieces are supplied to a processing apparatus one by one. The present invention further relates to a workpiece supply device provided with the workpiece ejection device.

Background Art

[0002] When plate-like workpieces, e.g., printed boards or lead frames, are handled by an automatic machine in manufacturing of electric and electronic products, a container for storing plural plate-like workpieces in an arrayed state with a certain spacing held between the plate-like workpieces is employed in many cases. Such a container is generally called a “magazine”.

When some type of processing, e.g., coating of an adhesive to mount components or a test for determining whether finished processing has been normally performed, is executed on workpieces, operations are carried out in a manner of supplying, from the magazine storing not-yet-processed workpieces, those workpieces to the processing apparatus one by one, and after the end of the processing, storing the processed workpieces into the same magazine or another magazine. Of those operations, in the operation of supplying the workpieces from the magazine to the processing apparatus one by one, an ejection device is

used to push the workpiece from an end surface of the magazine on the side oppositely away from the processing apparatus.

[0003] In a workpiece ejection device that is simplest and is used generally, as illustrated in Fig. 16, a workpiece 85 is pushed out by driving a driver 86, which includes a rod 87 provided with a workpiece contact member 88 at its leading end, by the action of pneumatic pressure, for example. To reliably push out the workpiece 85 from a magazine 84, a stroke of the rod 87 is usually almost equal to the width (or depth) of the magazine 84. When such a prior-art ejection device is arranged in series with respect to the magazine, a problem arises in that a space corresponding to twice the magazine width is occupied. In view of such a problem, various proposals have been made so far with intent to reduce the space occupied by the ejection device.

[0004] For example, Patent Document 1 discloses a device for letting out a lead frame or a printed board, wherein a bracket member disposed laterally of an elevator stage includes a vertical guide groove extending in an up-and-down direction and a horizontal guide groove extending in a horizontal direction to be connected to an upper end of the vertical guide groove through an arc-shaped guide groove, a pushing member formed in the shape of a strip having an arch-like cross-section by employing a leaf spring is inserted in the vertical guide groove and the horizontal guide groove to be freely movable over both the guide grooves in a lengthwise direction thereof, and a lower end of the pushing member is fixed to a head moving up and down reciprocally along the vertical guide groove, the letting-out device being characterized in that the horizontal guide groove is disposed to incline obliquely downwards from a horizontal plane toward the magazine rack, and a pressing roller for pressing an intermediate

portion of the pushing member downwards toward the horizontal guide groove is disposed in a state adjustable in the up-and-down direction.

[0005] Patent Document 2 discloses a pusher comprising a leaf spring, driving means that grips the leaf spring to advance and retract the leaf spring in a lengthwise direction, to thereby push a pushing target located in opposing relation to a leading end of the leaf spring, a direction turning section that bends a tailing end side of the leaf spring, which is advanced and retracted, relative to a leading end side thereof to deviate from a pushing direction such that an advancing and retracting direction of the leaf spring is turned, and guide means for guiding the leading end side and the tailing end side of the leaf spring in the advancing and retracting direction, the end sides of the leaf spring being positioned on both sides of the direction turning section as a boundary, wherein the leaf spring has a shape curved in a widthwise direction, and each of the respective guide means for the leading end side and the tailing end side includes at least one set of a non-cylindrical roller pair in combination of a concave roller and a convex roller, which are adapted for the curved shape of the leaf spring in the widthwise direction.

List of Prior-Art Documents

Patent Documents

[0006] Patent Document 1: Japanese Patent No. 3238786 (Japanese Patent Laid-Open Publication No. H6-275660)

Patent Document 2: Japanese Patent No. 4742400 (Japanese Patent Laid-Open Publication No. 2001-206510)

Summary of the Invention

Problems to be Solved by the Invention

[0007] The device disclosed in Patent Document 1 accompanies with the

following problems, for example. Because a height position of the leading end of the pushing member is adjusted by pressing and deforming the pushing member with the pressing roller, a difficulty occurs in keeping the height of the leading end constant (namely, a constant horizontal force cannot be applied to the workpiece to be pushed), and the leading end of the pushing member may contact with a position other than the workpiece to be pushed (e.g., with a bottom surface of the workpiece in an upper stage). Those problems are more significant as a distance through which the pushing member is pushed increases. In addition, because the pushing member is forcibly elastically deformed, there is another problem that, when the device is used for a long term, the pushing member cannot be fully returned to the original state to which it has to be returned by elasticity after being deformed.

Moreover, in the case of pushing not a light workpiece such as a lead frame, but a heavy workpiece such as a printed board including mounted components, a problem occurs in that the pushing member is elastically deformed, and the workpiece cannot be pushed accurately.

[0008] The device disclosed in Patent Document 2 accompanies with the following problem. Because the leaf spring is bent to turn its direction and is elastically deformed from a curved state to a flat state for advancement and retraction, elasticity of the leaf spring is lost and the leaf spring cannot be advanced to a proper position relative to the workpiece when the device is used for a long term. That problem is more significant as a distance through which the pushing member is advanced increases. Furthermore, because of the arrangement in which the leaf spring is disposed upright in the vertical direction, a difficulty occurs in reducing a width of the leaf spring in the up-and-down direction, an interval between

the workpieces arrayed in multiple stages in the magazine needs to be set to a certain or more value. Another problem is that, in the case of pushing a heavy workpiece such as a printed board including mounted components, the pushing member is elastically deformed, and the workpiece cannot be pushed accurately.

In addition, because the workpiece is pushed at one point by an end surface of the upright leaf spring, it is sometimes difficult to push out the workpiece in the same posture with high accuracy.

[0009] Accordingly, an object of the present invention is to provide a workpiece ejection device capable of solving the above-described problems.

Means for Solving the Problems

[0010] According to the present invention, there is provided a workpiece ejection device comprising an ejection member and a driving unit that pushes the ejection member in a first direction, the ejection member pushing a workpiece in a second direction that is different from the first direction, wherein the ejection member includes a plurality of connecting pieces and an expandable and contractible string-like member that interconnects the plural connecting pieces in a bendable fashion, and a direction turning section is provided to turn an advancing direction of the ejection member to the second direction.

The above-described workpiece ejection device according to the present invention may be characterized in that the ejection member includes a lateral side plate surrounding respective two opposing lateral surfaces of the plural connecting pieces that are interconnected, and the lateral side plate is formed of a thin plate having flexibility.

The above-described workpiece ejection device according to the

present invention may be characterized in that the connecting pieces have insertion holes penetrating therethrough in the same direction as a direction in which the connecting pieces are interconnected, and the string-like member is inserted through the insertion holes.

The above-described workpiece ejection device according to the present invention may be characterized in that the connecting pieces are each a plate-like member having a projection and a recess, and are interconnected in a state that the projection of each connecting piece is engaged in the recess of another adjacent connecting piece. Here, the plate-like member has a thickness of, e.g., several mm to several tens mm and preferably 3 mm to 10 mm.

[0011] In the above-described workpiece ejection device according to the present invention, in which the connecting pieces are each a plate-like member having a projection and a recess, and are interconnected in a state that the projection of each connecting piece is engaged in the recess of another adjacent connecting piece, the workpiece ejection device may be characterized in that the projection and the recess have a thickness equal to or less than a half of a thickness of the connecting piece, and are arranged substantially in point symmetric relation with respect to a center of a lateral surface of the connecting piece.

In the above-described workpiece ejection device according to the present invention, in which the connecting pieces are each a plate-like member having a projection and a recess, and are interconnected in a state that the projection of each connecting piece is engaged in the recess of another adjacent connecting piece, the workpiece ejection device may be characterized in that the projection and the recess have a thickness equal to or less than a half of a thickness of the connecting piece, and are

arranged substantially in line symmetric relation with respect to a vertical center line in a lateral surface of the connecting piece. Here, preferably, the connecting piece has a projection, a recess arranged above the projection, a projection, and a recess arranged under the latter projection, the latter projection and recess being provided in opposing relation to the former recess and projection, on inner peripheral side when the connecting pieces are in a bent posture, while the connecting piece has a projection and a recess provided in opposing relation to the projection on outer peripheral side when the connecting pieces are in the bent posture. Furthermore, preferably, the connecting piece includes connecting holes formed in the two projections provided on the inner peripheral side when the connecting pieces are in the bent posture, and a string latching hole formed in the connecting piece. Moreover, preferably, the string-like member is stretched in a state coupling one of the connecting holes and the string latching hole and coupling the string latching hole and the other connecting hole.

[0012] The above-described workpiece ejection device according to the present invention may be characterized in that the driving unit includes a driver for reciprocally moving a moving body to which the ejection member is coupled directly or indirectly, and a sensor for detecting application of an overload to the moving body, and the driver is stopped upon detection of the overload by the sensor.

The above-described workpiece ejection device according to the present invention may be characterized in that the direction turning section includes one or more rollers, which are disposed on inner peripheral side when the ejection member is in a bent posture, and which are in contact with one lateral surface of the ejection member, and one or

more rollers, which are disposed on outer peripheral side when the ejection member is in the bent posture, and which are in contact with the other lateral surface of the ejection member.

The above-described workpiece ejection device according to the present invention may be characterized in further including a support roller that supports, from below, the connecting piece of which direction has been turned to the second direction.

A workpiece supply device according to the present invention comprises the workpiece ejection device described above, a magazine placement unit, and an elevator that moves the magazine placement unit up and down.

Advantageous Effects of the Invention

[0013] With the present invention, the following advantageous effects can be obtained while a width of the ejection device in an ejection direction is held small.

(1) Flexure of the ejection member is small even when a distance through which the ejection member is advanced is long.

(2) The height of the leading end of the ejection member can be maintained constant when the ejection member is operated to advance and retract.

(3) A long service life is ensured because main members are not elastically deformed to turn the direction of the ejection member.

(4) Since the ejection member can be formed in a smaller thickness, the interval between the workpieces arranged in the magazine in a stacked state can be reduced.

Brief Description of the Drawings

[0014] [Fig. 1] Fig. 1 is a plan view of an ejection device according to

an embodiment of the present invention.

[Fig. 2] Fig. 2 is a view taken in a direction denoted by an arrow A in Fig. 1, namely, a side view of the ejection device according to the embodiment.

[Fig. 3] Fig. 3 is a view taken along a line B-B in a direction denoted by an arrow in Fig. 1, namely, a partly sectioned front view of the ejection device according to the embodiment.

[Fig. 4] Fig. 4 is an enlarged perspective view of a connecting piece used in the ejection device according to the embodiment.

[Fig. 5] Fig. 5 is a perspective view to explain a lateral side plate (in a bent posture) used in the ejection device according to the embodiment. Specifically, Fig. 5(a) represents the case where a folded portion is formed on the upper surface side, and Fig. 5(b) represents the case where the folded portion is formed on the lower surface side.

[Fig. 6] Fig. 6 is an explanatory view to explain an overload detection mechanism provided in the ejection device according to the embodiment. Specifically, Fig. 6(a) represents a state where a driving unit is stopped, Fig. 6(b) represents a state where the driving unit is operated, and Fig. 6(c) represents a state where an overload is detected.

[Fig. 7] Fig. 7 is a plan view illustrating a state where an ejection member of the ejection device according to the embodiment is advanced.

[Fig. 8] Fig. 8 is a perspective view of a loader according to Example 1, the view partly illustrating the interior of the loader in a seeing-through way.

[Fig. 9] Fig. 9 is a schematic perspective view to explain a connecting piece according to Example 2.

[Fig. 10] Fig. 10 is a schematic perspective view to explain a

connecting piece according to Example 3.

[Fig. 11] Fig. 11 is an explanatory view to explain one of methods for inserting a connecting string according to Example 3, i.e., (a) a method of linearly stretching a plurality of connecting strings.

[Fig. 12] Fig. 12 is an explanatory view to explain another one of the methods for inserting the connecting string according to Example 3, i.e., (b) a method of stretching the connecting string in a zigzag way.

[Fig. 13] Fig. 13 is an explanatory view to explain still another one of the methods for inserting the connecting string according to Example 3, i.e., (c) a method of linearly stretching one connecting string.

[Fig. 14] Fig. 14 is a schematic perspective view to explain a connecting piece according to Example 4.

[Fig. 15] Fig. 15 is an explanatory view to explain a method of fixing the lateral side plate according to Example 5.

[Fig. 16] Fig. 16 is an explanatory view to explain a workpiece ejection device of prior art.

Mode for Carrying out the Invention

[0015] One embodiment of the mode for carrying out the present invention will be described below.

<Constitution>

Fig. 1 is a plan view of an ejection device 1 according to the embodiment of the present invention, Fig. 2 is a view taken in a direction denoted by an arrow A in Fig. 1, namely, a side view of the ejection device 1 according to the embodiment, and Fig. 3 is a view taken along a line B-B in a direction denoted by an arrow in Fig. 1, namely, a partly sectioned front view of the ejection device 1 according to the embodiment. The ejection device 1 according to the embodiment will be described below

with reference to Figs. 1 to 3. In the following, for convenience of explanation, the lower side in Fig. 1 is called “front”, the upper side is called “rear”, the right side is called “right”, and the left side is called “left”. Furthermore, the right side in Fig. 2 and the upper side in Fig. 3 are called “upper”, and the left side in Fig. 2 and the lower side in Fig. 3 are called “lower”.

[0016] The ejection device 1 according to the embodiment includes, as main components, (1) an ejection member 2, (2) a driving unit 23, and (3) a direction turning section 41. Those components are described in detail below.

[0017] (1) Ejection Member

As illustrated in Fig. 1, the ejection member 2 in the embodiment is constituted by ten connecting pieces 3 that are interconnected into a series of pieces by a string-like member (connecting string 12), a leading end side termination piece 13, a tailing end side termination piece 14, and a lateral side plate 15 that surrounds most part of lateral surfaces of the above-mentioned pieces. The number of the connecting pieces 3 is not limited to ten in the illustrated example, and it may be changed as appropriate depending on the length of a workpiece. Thus, the number of the connecting pieces 3 may be smaller than 10 in some cases, and 11 or more in other cases.

Each of the connecting pieces 3 is a plate-like member, and it has a first projection 6, a second projection 7, a first recess 8, and a second recess 9. As illustrated in Fig. 4, the connecting piece 3 has the projections (6, 7) and the recesses (8, 9) that are formed respectively at a pair of end surfaces (contact surfaces 4), i.e., lateral surfaces defining opposite ends in the lengthwise direction thereof. The connecting piece 3

further has an insertion hole 5 extending to connect respective centers of the pair of end surfaces 4. The plural connecting pieces 3 are interconnected when used. For example, the connecting pieces 3 in number six or more, preferably eight or more, are interconnected into a series of pieces by the connecting string 12 in use. Each of the projections (6, 7) of the connecting piece 3 has a semicircular (circular arc) shape. A thickness, denoted by 10, of each of the projections (6, 7) is about a half that of a body of the connecting piece 3, and a width, denoted by 11, thereof is smaller than that of the body of the connecting piece 3, for example, about 1/3 in the embodiment. The recesses (8, 9) have semicircular shapes allowing them to be tightly fitted with the projections (6, 7). The projections (6, 7) and the recesses (8, 9) are provided to be positioned out of interference with the insertion hole 5. While, in Fig. 4, the projections (6, 7) and the recesses (8, 9) are provided on the upper surface side of the connecting piece 3, their locations are not limited to the upper surface side. The projections (6, 7) and the recesses (8, 9) may be provided at a center in the up-and-down direction or on the lower surface side.

[0018] The first projection 6 and the first recesses 8 of one connecting piece 3 are fitted respectively with the second recess 9 and the second projection 7 of another connecting piece 3 that is adjacent to one end of the one connecting piece 3. The second projection 7 and the second recesses 9 of the one connecting piece 3 are fitted respectively with the first recess 8 and the first projection 6 of still another connecting piece 3 that is adjacent to the other end of the one connecting piece 3. The semicircular shapes of the projections (6, 7) and the recesses (8, 9) allow the ejection member 2 to easily turn its direction. Furthermore, in the

illustrated example, the projections (6, 7) and the recesses (8, 9) are formed in an upper half of the connecting piece 3 to provide a smooth surface on the lower surface side where any recesses and projections are not exposed (i.e., free from bottom surfaces of the projections and upper surfaces of the recesses). As a result, the connecting piece 3 is slidably supported such that the direction turning of the connecting piece 3 is not impeded. Supporting of the projections (6, 7) by the recesses (8, 9) also contributes to preventing flexure of the ejection member 2. A material of the connecting piece 3 is preferably a slippery resin, e.g., a polyacetal resin (POM), a polyamide resin (nylon), or a fluorocarbon resin (PTFE). By employing the slippery resin, the connecting piece 3 can smoothly move and turn its direction.

[0019] The connecting string 12 is a string-like member for interconnecting the above-described plural connecting pieces 3. The connecting string 12 can be made of a resin-based expandable and contractible material. The connecting string 12 involves a string made of multiple filaments, a stranded string, and a braided string. For example, a fishing line made of nylon or a fluorocarbon resin fiber (polyvinylidene fluoride) is used in this embodiment.

In this embodiment, as illustrated in Fig. 1, one connecting string 12 is inserted through respective insertion holes 5 of the connecting pieces 3, and opposite ends of the connecting string 12 are connected respectively to the leading end side termination piece 13 and the tailing end side termination piece 14. The connecting string 12 and each of the termination pieces 13 and 14 may be connected in a manner providing a certain level of strength through, e.g., bonding or clamping.

[0020] A length of the connecting string 12 is set such that the

connecting string 12 is stretched without slacking from one end to the other end in a state where the recesses and the projections of the plural connecting pieces 3, the leading end side termination piece 13, and the tailing end side termination piece 14 are fitted with each other, and in a posture where the contact surfaces 4 are contacted with each other, i.e., in a posture where the connecting pieces, etc. are arranged linearly. In other words, the length of the connecting string 12 is set such that the connecting string 12 is stretched without slacking when a length of the ejection member 2 is shortest, and such that the connecting string 12 is caused to extend when the ejection member 2 is in a bent posture. An expandable and contractible synthetic fiber string is preferably used as the connecting string 12. The reason is that, because the string is expandable and contractible in itself, the connecting pieces can be avoided from separating from each other and can be held in the state interconnecting into a series of pieces even when a gap is formed between the connecting pieces in a later-described stage of direction turning. Furthermore, because the connecting string has the shortest length in the above-described state and is expandable and contractible, a force is exerted on the connecting string to bring it into a linear posture, whereby the connecting string can hold the linear posture even after the direction turning.

[0021] The lateral side plate 15 is a member that is formed of a flexible thin plate, and that surrounds substantially the entirety of respective lateral surfaces of the plural connecting pieces 3, the leading end side termination piece 13, and the tailing end side termination piece 14. A width (height) of the lateral side plate 15 in the vertical direction is substantially the same as that of the connecting pieces 3. When the

ejection member 2 is in a bent posture, the lateral side plate 15 is also bent as illustrated in Fig. 5. The lateral side plate 15 is formed by folding one plate into a shape embracing the plural connecting pieces 3, the leading end side termination piece 13, and the tailing end side termination piece 14. At a rear end of the lateral side plate 15, lateral- side plate folded portions 15a and 15b are formed by folding ends of the lateral side plate 15 to extend as horizontal plates at mutually shifted positions to be not overlapped with each other. The lateral-side plate folded portions 15a and 15b may be formed on the upper surface side as illustrated in Fig. 5(a), or on the lower surface side as illustrated in Fig. 5(b). Elongate holes are formed in the lateral side plate folded portions 15a and 15b at positions corresponding to elongate holes 20 that are formed in the tailing end side termination piece 14, and the lateral-side plate folded portions 15a and 15b are attached to the tailing end side termination piece 14 by fixing members 21.

[0022] The fore end side of the lateral side plate 15 is folded in match with the shape of a fore end of the leading end side termination piece 13. A fixation hole 16 is formed in shortest one of folded portions of the lateral side plate 15 at the fore end side, and the shortest folded portion is fixed to the leading end side termination piece 13 by fixing member (not illustrated). The hole 16 is provided as, e.g., one or plural threaded holes for fixation by screwing through a workpiece contact member 17 described later. The lateral side plate 15 is fixed only at the tailing end side termination piece 14 and the leading end side termination piece 13, and it is not fixed to the lateral surfaces of the connecting pieces 3. With such a constitution, movements of the connecting pieces 3 are not restricted during the direction turning, and the connecting pieces 3 can smoothly

turn their directions. A metallic thin plate having flexibility and elasticity is preferably used as the lateral side plate 15. For example, stainless steel or brass is used. By disposing the above-described lateral side plate 15 to surround substantially the entire periphery of the connecting pieces 3 and both the termination pieces 13 and 14, the ejection member 2 can be made less apt to flex downwards in the vertical direction without needing any special support when the ejection member 2 is advanced.

[0023] The leading end side termination piece 13 is a plate-like member that constitutes a leading end portion of the ejection member 2. The recess and the projection are provided at a rear-end lateral surface of the leading end side connecting piece 13, but the recess and the projection are not provided at a fore-end lateral surface thereof. A not-illustrated hole (threaded hole) for fixation is formed in the fore-end lateral surface of the leading end side connecting piece 13 at a position corresponding to the above-mentioned hole 16. The workpiece contact member 17 is attached to the fore-end lateral surface of the leading end side connecting piece 13 with the lateral side plate 15 interposed between them. The workpiece contact member 17 preferably has a shape causing a workpiece 55 to be pushed at two or more contact points. The workpiece contact member 17 in this embodiment has a U-shape when viewed from above, and a groove 19 having a concave shape when viewed from side is formed in each of both projected ends 18 of the U-shape member 17 (see Fig. 3). A width (vertical gap) of the groove 19 is preferably set to be greater than a thickness of the workpiece 55 such that the workpiece 55 contacts with a deepest portion of the concave groove 19. The workpiece 55 is in the form of a small-sized thin plate, such as a printed board or a lead frame, and its shape is not limited to a rectangle.

[0024] The tailing end side termination piece 14 is a plate-like member that constitutes a tailing end portion of the ejection member 2. The recess and the projection are provided at a fore-end lateral surface of the tailing end side termination piece 14, but the recess and the projection are not provided at a rear-end lateral surface of the tailing end side termination piece 14. Elongate holes 20 for fixation are vertically formed in the tailing end side termination piece 14 at two positions. The fixing members 21, such as bolts, are inserted to the elongate holes 20, respectively, to fix the tailing end side termination piece 14 and the lateral side plate 15 to a driving block b 34 described later. Thus, the ejection member 2 is movable by the driving unit 23.

The tailing end side termination piece 14 is not necessarily constituted by one member, and it may be constituted by two members each having the elongate hole 20 formed at one position. Even when the tailing end side termination piece 14 is formed of two separate members, the tailing end side termination piece 14 can be fixed to the driving block b 34 described later. When the tailing end side termination piece 14 is separated into two members, tension of the lateral side plate 15 can be adjusted by adjusting respective positions of the two members in a back-and-forth direction (lengthwise direction of the elongate holes 20). A posture of the ejection member 2 after the direction turning can be further adjusted by adjusting the tension of the lateral side plate 15.

[0025] As described above, with the constitution that the ejection member 2 is divided into a plurality of small pieces, which are interconnected to a series of pieces by the connecting string 12, and the lateral side plate 15 having flexibility and elasticity is disposed to surround the lateral surfaces of the ejection member 2, a thickness of the ejection

member 2 can be reduced in its entirety (e.g., an average thickness of several mm to about 10 mm), and the ejection member 2 can be made less apt to flex downwards in the vertical direction without needing any special support. Furthermore, since the ejection member 2 is constituted by a plate-like member having a certain thickness and high rigidity, the ejection member 2 can push even a heavy workpiece, such as a printed board including mounted components, without causing elastic deformation.

[0026] (2) Driving Unit

As illustrated in Figs. 2 and 3, the driving unit 23 includes, as main components, a base plate 22, a driving-unit mount plate 24, a tube 25, a guide rail 29, a driving block a 33, and a driving block b 34.

The driving-unit mount plate 24 is vertically connected to the base plate 22. The tube 25 and the guide rail 29 arranged in parallel are attached to the driving-unit mount plate 24. The tube 25 and the guide rail 29 are coupled to each other by the driving block a 33 including a moving body 30.

[0027] In this embodiment, an air cylinder comprising the tube 25 and the moving body 30, which is linearly moved along the tube 25 by the action of compressed air, constitutes a driver. The compressed air is supplied and discharged through two pipes 27 that are coupled to opposite ends of the tube 25 through couplings 26, respectively. The couplings 26 are each provided with a flow rate adjusting thumb 28. A moving speed of the moving body 30 can be adjusted by operating the flow rate adjusting thumb 28 and adjusting a flow rate of the compressed air.

It is to be noted that, while the air cylinder is used as the driver in this embodiment, the driver is not limited to the air cylinder. Any other desired type of driver can also be used insofar as it is linearly operated.

For example, a ball screw or a belt may be driven by a motor.

[0028] Moving blocks a 31 and b 32 are movably mounted to the guide rail 29 to guide the driving blocks a 33 and b 34, respectively. Thus, the moving block a 31 fixed to the driving block a 33 and the moving block b 32 fixed to the driving block b 34 guide the corresponding driving blocks a 33 and b 34 when the driving blocks are linearly moved. Because the guide rail 29 aids linear movement of the driving blocks, it is possible to reduce a load exerted on the driving unit 23, and to cause the ejection member 2 to linearly move with high accuracy.

[0029] The driving block a 33 and the driving block b 34 have an L-shape when viewed from side, and they are arranged such that two inner surfaces of those driving blocks are contacted with each other. Here, the driving block a 33 and the driving block b 34 are coupled by a spring 37 (tension spring) to be able to move away from each other against an urging force of the spring 37. The spring 37 coupling the driving block a 33 and the driving block b 34 is preferably selected as one having such strength (spring constant) that the spring 37 does not extend under a load given by total weight W of the driving block b 34, the moving block b 32, the ejection member 2, and the workpiece 55. Stated in another way, the spring 37 is preferably a spring that starts to extend just when a force in excess of the load corresponding to the above-mentioned total weight W, i.e., a force not less than a force required to push out the workpiece 55, is exerted on the spring. The reason is that an overload exerted on the ejection member 2 can be detected with such an arrangement (details will be described below).

[0030] An upper end of the driving block b 34 (i.e., its end on the side oppositely away from a detection plate 39) is disposed to extend through

an elongate hole 35 for driving, which is formed in the base plate 22, and the tailing end side termination piece 14 (i.e., the ejection member 2) is fixed to the upper end of the driving block b 34 by the fixing member 21. The elongate hole 35 for driving is formed to extend over substantially the same length as a stroke of the moving body 30 parallel to the tube 25 and the guide rail 29. In other words, the tube 25, the guide rail 29, and the elongate hole 35 for driving are arranged on the same plane parallel to one another, and they have substantially the same length as the stroke of the moving body 30. It is to be noted that the shape of each of the driving blocks (33, 34) is not limited to the L-shape when viewed from side, and may be changed as appropriate.

[0031] The constitution of an overload detection mechanism 36 is now described. A sensor 38 is disposed on the driving block a 33, and the detection plate 39 is disposed on the driving block b 34, thereby constituting the overload detection mechanism 36. The sensor 38 used in this embodiment is a photosensor that is turned on when light is interrupted. However, the sensor 38 is not limited to that type of photosensor. Another type of sensor, such as a photosensor that is turned on with incidence of light, a fiber sensor, or a proximity sensor may be used instead.

[0032] The operation of the overload detection mechanism 36 is now described. Fig. 6 illustrates details of the operation of the overload detection mechanism 36. When the driving unit 23 is stopped, the overload detection mechanism 36 is in a state illustrated in Fig. 6(a). When the driving unit 23 is actuated to perform the operation of ejecting the workpiece, the driving block a 33 and the driving block b 34 are moved together in a direction denoted by an arrow, as illustrated in Fig. 6(b).

The driving block a 33 and the driving block b 34 are moved together because those two blocks are coupled to each other by the spring 37. In the ordinary ejection operation, as described above, the state of the overload detection mechanism 36 is shifted from Fig. 6(a) to Fig. 6(b).

[0033] Fig. 6(c) illustrates a state when an overload is detected. If a force in excess of the workpiece load (i.e., an overload) is exerted on the ejection member 2, for example, in the event of the workpiece 55 being caught in the magazine 54, the spring 37 is caused to extend, whereupon the driving block b 34 is moved away from the driving block a 33. In such a state, the detection plate 39 disposed on the driving block b 34 interrupts an optical axis 40 of the sensor 38 disposed on the driving block a 33, thus turning on the sensor 38. Upon the sensor 38 being turned on, a control unit (not illustrated) stops the operation of the driver (air cylinder) at once, and issues an alarm in the form of light or sounds to an operator. Thus, since the operation can be stopped quickly upon detection of the overload, it is possible to avoid damages of the workpiece 55 and the magazine 54, and to prevent failures or breakage of the driver (air cylinder) and the ejection member 2.

[0034] (3) Direction Turning Section

The direction turning section 41 is disposed on the base plate 22 and is constituted by a first direction turning roller 42, a second direction turning roller 43, and a third direction turning roller 44, which are disposed on both sides of the ejection member 2 in zigzag-sandwiching relation. The rollers 42 to 44 are each rotatable about a mount shaft to allow smooth movement of the ejection member 2 while a force is applied to the ejection member 2 from the roller. The roller arrangement is not limited to the illustrated one, and the above-mentioned rollers may be arranged

in opposing relation like later- described guide rollers 48. More stable direction turning is realized as the number of rollers increases. For that reason, three or more rollers are preferably disposed.

[0035] In this embodiment, the first direction turning roller 42 is arranged on the left side of the ejection member 2 near a position deviated forwards from a start point 45 of the direction turning through a distance corresponding to about a half of the connecting piece 3. Furthermore, a contact position between the first direction turning roller 42 and the ejection member 2 is shifted to the right from contact positions between three guide rollers 48 on the left side and the ejection member 2. With such an arrangement, a force acting to incline the ejection member 2 to the right is exerted so as to start the direction turning of the ejection member 2.

The second direction turning roller 43 is disposed on the right side of the ejection member 2 at a position near a midpoint 46 of a path of the direction turning. Furthermore, a contact position between the second direction turning roller 43 and the ejection member 2 is shifted to the right from contact positions between three guide rollers 48 on the right side and the ejection member 2. With such an arrangement, a force acting to push the ejection member 2 obliquely toward the front left side is exerted to deform the posture of the ejection member 2 into a circular arc shape such that the connecting piece 3 passing the roller 43 can smoothly turn its direction.

[0036] The third direction turning roller 44 is arranged on the forward side of the ejection member 2 (and on the same side as the roller 42) near a position deviated to the right from an end point 47 of the direction turning through a distance corresponding to about two connecting pieces 3.

The roller 44 applies a force acting to push the ejection member 2 rearwards (upwards in Fig. 1). Such a force is applied in consideration of the fact that, because the connecting string 12 is inserted through the ejection member 2, a force acting to restore the ejection member 2 toward a linear posture (i.e., a force acting to turn the ejection member 2 forwards about the direction turning start point 45 for restoration to an original posture) is exerted on the ejection member 2 due to expandable and contractible properties of the connecting string 12. With the provision of the third direction turning roller 44, the ejection member 2 can be maintained in a posture after having turned to a direction different from the direction in which the ejection member 2 is driven (i.e., a direction perpendicular to the driving direction in this embodiment).

In this embodiment, mount holes into which respective shafts of the rollers 42 to 44 are fitted are each formed as an elongate hole such that a roller position can be adjusted in a direction in which a force is applied to the ejection member 2 from the roller (see dotted lines in Fig. 1). The magnitude of the force applied to the ejection member 2 can be adjusted to desired strength by adjusting the position of each of the rollers 42 to 44 along the elongate hole and then fixing the roller with a fixing member.

[0037] By changing the positions and the number of the direction turning rollers, the ejection member 2 can be turned to a direction (leftward direction) that is reversed to the direction described above in this embodiment (i.e., the rightward direction). Furthermore, the ejection member 2 may be turned in its direction at a different angle from that described above in this embodiment. For example, when the turning angle is between 0 to 90 degrees, the direction turning of the ejection

member 2 can be realized with the constitution of the present invention without difficulty.

As described above, since the ejection member 2 can be turned in its direction and the driving unit 23 and the ejection member 2 are disposed on the same plane, an entire space occupied by the ejection device 1 can be reduced.

[0038] (4) Additional Constitutions

The ejection device 1 may further include the following features as additional constitutions.

In order to aid the linear movement of the ejection member 2, plural sets of guide rollers 48 are disposed in opposing relation along the elongate hole 35 for driving, which is formed in the base plate 22 (see Fig. 1). Similarly to the direction turning rollers 42 to 44, the guide rollers 48 are each rotatable about a mount shaft to allow smooth movement of the ejection member 2 while a force is applied to the ejection member 2 from the roller. The guide rollers 48 are disposed on both sides of the elongate hole 35 for driving in pairs each sandwiching the ejection member 2, thus applying a force in a direction perpendicular to the moving direction of the ejection member 2 from each guide roller 48. With such an arrangement, the guide rollers 48 function to hold the ejection member 2 in the linear posture, and to ensure the smooth movement of the ejection member 2. As in the case of the direction turning rollers 42 to 44, mount holes into which shafts of the rollers 48 are fitted are each preferably formed as an elongate hole such that a roller position can be adjusted in a direction in which a force is applied to the ejection member 2 from the roller (see dotted lines in Fig. 1). In principle, it is just enough that the mount holes for the guide rollers 48 are formed as elongate holes only for a series of

the guide rollers on either side. The reason is that the ejection member 2 is held in the linear posture by pressing one series of guide rollers on the side where the mount holes are elongate holes against the other series of guide rollers on the side where the mount holes are not elongate holes (i.e., where positions of the rollers are fixed).

[0039] With the provision of the lateral side plate 15, the ejection member 2 can be made less apt to flex downwards in the vertical direction without needing any special support. However, a support roller 49 is preferably disposed near the third direction turning roller 44 to make the ejection member 2 less apt to flex with higher reliability (see Figs. 2 and 3). The support roller 49 is rotatably mounted to a support roller mount plate 50 that has an L-shape when viewed from above. The support roller mount plate 50 is fixed to a base plate folded portion 51 that is formed at a right end of the base plate 22. Thus, an upper end of the support roller 49 is positioned in contact with a bottom surface of the ejection member 2. With the arrangement of not only providing the lateral side plate 15, but also supporting the bottom surface of the ejection member 2 by the support roller 49, the ejection member 2 can be made less apt to flex downwards in the vertical direction when the ejection member 2 is advanced. In addition, since the support roller 49 is disposed to be rotatable in the same direction as the moving direction of the ejection member 2, the support roller 49 will not impede the movement of the ejection member 2.

[0040] <Operation>

The operation of the ejection device 1, particularly the operation of the ejection member 2, having the above-mentioned constitution will be described below. The operation of advancing the ejection member 2 is

started from the state illustrated in Fig. 1 and then proceeds to a state illustrated in Fig. 7.

When the driver (air cylinder) is operated, the ejection member 2 starts to move forwards through movement of the driving blocks a 33 and b 34. The following description is made with attention focused on one connecting piece 3. With the forward movement of the ejection member 2, the connecting piece 3 positioned above a fore end of the elongate hole 35 for driving reaches the first direction turning roller 42 in a little while. Upon reaching the first direction turning roller 42, the connecting piece 3 is inclined to the right by the action of the first direction turning roller 42 with the second projection 7 of the connecting piece 3 serving as a fulcrum. At that time, the relevant connecting piece 3 and the other connecting pieces 3 are kept in the interconnected state by the connecting string 12 having the expandable and contractible properties.

[0041] When the relevant connecting piece 3 is further moved and reaches the second direction turning roller 43, the connecting string 12 is further extended and the relevant connecting piece 3 is further inclined with the second projection 7 serving as a fulcrum. At a time when the relevant connecting piece 3 reaches the third direction turning roller 44, it is oriented in a direction perpendicular to the direction of its movement up to that time. In such a state, the connecting string 12 is contracted to exert a force acting to hold the successive connecting pieces 3 in a linear posture. After having passed the third direction turning roller 44, the relevant connecting piece 3 is continuously moved to advance by the action of both the connecting string 12 and the lateral side plate 15 while holding the posture after the direction turning.

In such a manner, the plural connecting pieces 3 are successively

moved forwards, and the ejection member 2 is advanced to push out the workpiece 55 from the magazine 54. When the moving body 30 is moved through a distance corresponding to its full stroke, the ejection operation of the ejection member 2 is also ended. An operation of retracting the ejection member 2 is performed in sequence reversed to that of the above-described operation.

[0042] Details of the present invention will be described below with reference to Examples, but the present invention is in no way limited by the following Examples.

Example 1

[0043] Example 1 relates to a loader equipped with the ejection device 1 according to the present invention. Fig. 8 is a perspective view of the loader according to Example 1, the view partly illustrating the interior of the loader in a seeing-through way.

A loader 53 according to this Example has a basic structure of raising and lowering the magazine 54 by an elevator 56, and pushing out the workpieces 55 one by one from the magazine 54 by the ejection device 1 such that the workpieces 55 are successively supplied to a processing apparatus.

[0044] The magazine 54 stores the plural workpieces 55 each in the form of a plate in an array of multiple stages at a certain spacing therebetween. Pairs of recesses for supporting respective lateral ends of the workpieces 55 are formed in inner lateral surfaces of the magazine 54 in opposing relation. A space between the workpieces arranged adjacent to each other in the up-and-down direction is not partitioned by a plate (floor). A workpiece loading port is formed in one lateral surface of the magazine 54, and a workpiece unloading port is formed in the other lateral surface of the

magazine 54, which is opposed to the one lateral surface thereof.

[0045] The magazine 54 is placed on a magazine placement stage 57 and is fixedly held by a magazine fixing member 58. The magazine placement stage 57 is mounted onto an elevating block 59 that is moved up and down by a magazine elevator 56. The magazine 54 and the ejection device 1 are positioned close to each other by adjusting a height of the magazine placement stage 57. While this Example discloses a structure including one magazine placement stage 57, the magazine placement stage 57 may be disposed plural to allow placement of a plurality of magazines 54.

[0046] The magazine 54 and a region where the magazine 54 is moved up and down are covered with a cover 60. A door 61 capable of being opened and closed is disposed in a front surface of the cover 60, and an ejection member entry port 62 and a workpiece taking-out port 63 are formed in opposing relation in lateral surfaces of the magazine 54. The ejection device 1 according to this Example is disposed outward of a left-side lateral surface of the cover when looking at the door 61 from a direction facing it. The constitution of the ejection device 1 is the same as that illustrated in Fig. 1, and hence description of the constitution of the ejection device is omitted here. The ejection member 2 has a thickness of about 4 mm.

The ejection device 1 moves the ejection member 2 to advance and retract through the ejection member entry port 62 formed in the cover 60. The workpiece taking-out port 63, i.e., a hole through which the workpiece 55 having been pushed out by the ejection device 1 passes, is formed in a right-side lateral surface of the cover when looking at the cover from a direction facing it.

[0047] The workpiece 55 is supplied through the following procedures.

First, the magazine elevator 56 is operated to align a horizontal level position of the ejection member 2 of the ejection device 1 with that of the workpiece 55 in the magazine 54. Then, the ejection member 2 of the ejection device 1 is advanced to push out the workpiece 55 from the magazine 54, thereby supplying the workpiece 55 through the workpiece taking-out port 63. When another workpiece 55 is to be taken out subsequently, the magazine 54 is raised or lowered by the magazine elevator 56 through a distance corresponding to one workpiece 55 such that a position of the other workpiece 55 is aligned with the position of the ejection member 2 of the ejection device 1. The ejection device 1 is then operated. When still another workpiece 55 is to be taken out subsequently, the above-described operation is repeated.

By employing the above-described ejection device 1 according to this Example, the thickness of the ejection member 2 can be reduced, and therefore the interval between adjacent stages of the magazine 54 can be narrowed. Moreover, even when the ejection device 1 and the elevator 56 are arranged side by side, an increase of the loader width can be suppressed.

Example 2

[0048] Fig. 9 is a schematic perspective view to explain a connecting piece according to Example 2.

The connecting piece 3 according to Example 2 is different from the connecting piece illustrated in Fig. 4 in positions of the recess and the projection. More specifically, the first recess 8 and the second projection 7 are formed in a lower half of the connecting piece 3. In this Example, the plural connecting pieces 3 are similarly interconnected by the connecting string 12 that is inserted through the insertion holes 5 of the

connecting pieces 3. The other constitution is the same as that described above in the embodiment (Figs. 1 to 7), and hence description of the other constitution is omitted here.

The connecting piece 3 according to this Example is effective in increasing durability against deformation in the vertical direction, e.g., durability against swing in the up-and-down direction and twisting about an axis defined in the advancing direction, in comparison with the connecting piece 3 illustrated in Fig. 4.

Example 3

[0049] Fig. 10 is a schematic perspective view to explain a connecting piece according to Example 3. This Example is intended to further increase durability against deformation in the vertical direction, e.g., durability against swing in the up-and-down direction and twisting about an axis defined in the advancing direction, in comparison with the connecting pieces illustrated in Figs. 4 and 9, which are interconnected by one connecting string 12.

[0050] The connecting piece 3 according to this Example is mainly different from the connecting pieces illustrated in Figs. 4 and 9 in having a third projection 65 and a third recess 66. The third projection 65 is formed under the first recess 8 and has substantially a circular shape when viewed from above. A connecting hole 67 vertically penetrating through the third projection 65 is formed at a center of the circle defined by the third projection 65. The third recess 66 is formed under the second projection 7 and has substantially a circular shape when viewed from below. Stated in another way, the projection 7 and the recess 66 on the rear surface side have shapes resulting from reversing positions of the first recess 8 and the third projection 65 on the front surface side in the

up-and-down direction. As in the third projection 65, a connecting hole 67 penetrating through the second projection 7 is formed at a center of the circle defined by the second projection 7. The connecting holes 67 and 67 formed respectively in the projections (7, 65), which are positioned on the inner peripheral side of the connecting piece 3, are in concentric relation in a state where the projection 7 and the projection 65 are stacked in the up-and-down direction.

In this embodiment, the third projection 65, the third recess 66, and the connecting holes 67 are disposed on the side in the same direction in which the connecting piece 3 is turned (i.e., on the inner peripheral side of the ejection member 2 to be bent). This is intended to provide a fulcrum when the connecting piece 3 turns its direction. However, the side where those elements are disposed is not limited to only the side in the same direction in which the connecting piece 3 is turned (i.e., on the inner peripheral side). The connecting holes 67 may be formed in the projections on both sides (right and left sides) of the connecting piece 3 to be able to optionally select the side where the connecting string 12 is inserted to the connecting holes 67 (i.e., the side to which the direction turning is to be made).

[0051] String latching holes a 68 and b 69 are formed substantially at a center of the connecting piece 3 to penetrate through the connecting piece 3 from an upper surface to a lower surface thereof. The string latching hole a 68 is formed substantially at a midpoint of a line connecting the first recess 8 and the second projection 7, and the string latching hole b 69 is formed substantially at a midpoint of a line connecting the first projection 6 and the second recess 9. Threads are cut in inner peripheral surfaces of the string latching holes a 68 and b 69, and those threads are used when

the connecting string 12 is fastened in place by fixing members 73. A low-head screw or bolt is suitably used as each of the fixing members 73. The connecting piece 3 further includes the insertion hole 5 extending to penetrate through its center between a pair of contact surfaces 4 thereof.

[0052] In this Example, the connecting pieces 3 are interconnected in combination of the method of stretching one connecting string 12 through the insertion holes 5 of the connecting pieces 3 and one of three kinds of methods of stretching one or plural connecting strings 12, which are illustrated in Figs. 11 to 13. The three kinds of methods of coupling one connecting hole and one string latching hole and coupling the relevant string latching hole and the other connecting hole by one or plural connecting strings 12 will be described below with reference to Figs. 11 to 13. It is to be noted that, while the connecting string 12 is illustrated in a loosed state in Fig. 11 for the sake of explanation, the connecting string 12 is in fact stretched in a tight state between the holes.

[0053] (a) Connection by Plural Linearly-Stretched Connecting Strings 12 (Fig. 11)

The following description is made with attention focused on two basic connecting pieces (70, 71). One end of the connecting string 12 is wound around a fixing member 73, and the relevant fixing member 73 is fitted to the string latching hole a 68 of the front connecting piece 70 and is tightened, whereby the one end of the connecting string 12 is fastened (as denoted by 74). The other end of the connecting string 12 is passed through the respective connecting holes 67 and 67 in the second projection of the front connecting piece 70 and the third projection of the intermediate connecting piece 71, which projections are stacked one above the other, and is guided to a lower surface of the intermediate

connecting piece 71 (as denoted by 75). The connecting string 12 having been guided to the lower surface of the intermediate connecting piece 71 is passed through the respective connecting holes 67 and 67 in the second projection of the intermediate connecting piece 71 and the third projection of a rear connecting piece 72, which projections are stacked one above the other, and is guided to an upper surface of the intermediate connecting piece 71 (as denoted by 76). The other end of the connecting string 12 having been guided to the upper surface of the intermediate connecting piece 71 is wound around a fixing member 73, and the relevant fixing member 73 is fitted to the string latching hole a 68 of the intermediate connecting piece 71 and is tightened, whereby the other end of the connecting string 12 is fastened (as denoted by 77).

A required number of connecting pieces 3 are successively interconnected by repeating the above-described basic method of connecting the two connecting pieces. With the above-described method, as indicated by an empty arrow in the drawing, a rearward pulling force is exerted on the ejection member 2 to lift the same, thus preventing the ejection member 2 from suspending in the vertical direction. The above-described method is particularly effective on the right side (inner peripheral side) of the ejection member 2. It is to be noted that, when the above-described connecting method is employed, the string latching hole a 68 is not necessarily to be a through-hole.

[0054] (b) Connection by Zigzag-Stretched Connecting String 12 (Fig. 12)

The following description is made with attention focused on two basic connecting pieces (70, 71). The connecting string 12 is guided to extend from a lower surface of the front connecting piece 70 to an upper

surface thereof through the string latching hole b 69 (as denoted by 78), and is then guided to the lower surface of the intermediate connecting piece 71 after passing through the respective connecting holes 67 and 67 in the second projection of the front connecting piece 70 and the third projection of the intermediate connecting piece 71, which projections are stacked one above the other (as denoted by 79). The connecting string 12 having been guided to the lower surface of the intermediate connecting piece 71 is further guided to the upper surface of the intermediate connecting piece 71 after passing through the string latching hole b 69 of the intermediate connecting piece 71 (as denoted by 80). The connecting string 12 having been guided to the upper surface of the intermediate connecting piece 71 is guided to the lower surface of the intermediate connecting piece 71 again after passing through the respective connecting holes 67 and 67 in the second projection of the front connecting piece 70 and the third projection of the intermediate connecting piece 71, which projections are stacked one above the other (as denoted by 81). The connecting string 12 having been guided to the lower surface again is further guided to the upper surface again after passing through the string latching hole b 69 of the intermediate connecting piece 71 (as denoted by 82).

A required number of connecting pieces 3 are successively interconnected by repeating the above-described basic connecting method. In this method, opposite ends of the connecting string 12 are fastened respectively to the leading end side connecting piece 13 and the tailing end side termination piece 14, which are not illustrated in Fig. 12. With the above-described method, as indicated by an empty arrow in the drawing, a force acting to pull the string latching hole b 69 toward the

connecting hole 67 is exerted on the ejection member 2 to lift the same, thus preventing the ejection member 2 from suspending in the vertical direction. The above-described method is particularly effective on the left side (outer peripheral side) of the ejection member 2.

[0055] (c) Connection by Linearly-Stretched Connecting String 12 (Fig. 13)

This method linearly stretches the connecting string 12 as in the above-described method (a), but it is different from the method (a) in using one connecting string.

The following description is made with attention focused on two basic connecting pieces (70, 71). The connecting string 12 is guided to the lower surface of the intermediate connecting piece 71 after passing through the respective connecting holes 67 in the second projection of the front connecting piece 70 and the third projection of the intermediate connecting piece 71, which projections are stacked one above the other (as denoted by 89), and is then guided to the upper surface of the intermediate connecting piece 71 after passing through the respective connecting holes 67 in the second projection of the intermediate connecting piece 71 and the third projection of the rear connecting piece 72, which projections are stacked one above the other (as denoted by 90). The connecting string 12 is further stretched from the upper surface of the intermediate connecting piece 71 to go around the outer side of the connecting piece (i.e., the inner peripheral side of the bent ejection member), and is guided from the lower side to the upper side of the same connecting holes 67 (as denoted by 90). In other words, the connecting string 12 turns around portions surrounding the connecting holes 67. The connecting string 12 having been guided to the upper side again is

stretched to go around the fixing member 73 that is fastened to the string latching hole a 68 of the intermediate connecting piece 71 (as denoted by 91). The connecting string 12 is then guided to the lower side after passing through the respective connecting holes 67 in the second projection of the intermediate connecting piece 71 and the third projection of the rear connecting piece 72, which projections are stacked one above the other (as denoted by 92). The connecting string 12 is further stretched from the lower surface of the intermediate connecting piece 71 to go around the outer side of the connecting piece (i.e., the inner peripheral side of the bent ejection member), and is guided from the upper side to the lower side of the same connecting holes 67 (as denoted by 92). In other words, the connecting string 12 turns around the portions surrounding the connecting holes 67.

A required number of connecting pieces 3 are successively interconnected by repeating the above-described basic connecting method. In this method, as in the above method (b), opposite ends of the connecting string 12 are fastened respectively to the leading end side connecting piece 13 and the tailing end side connecting piece 14, which are not illustrated in Fig. 13. With the above-described method, as indicated by an empty arrow in the drawing, a rearward pulling force is exerted on the ejection member 2 to lift the same, thus preventing the ejection member 2 from suspending in the vertical direction. The above-described method is particularly effective on the right side (inner peripheral side) of the ejection member 2. It is to be noted that, when the above-described connecting method is employed, the string latching hole a 68 is not necessarily to be a through-hole.

[0056] The above-described methods (a) and (b) or the methods (b) and

(c) may be combined with each other. In such a case, forces acting to pull the ejection member 2 toward both the right and left sides are exerted on the ejection member 2 to lift the same, thus more effectively preventing the ejection member 2 from suspending in the vertical direction. Furthermore, since the ejection member 2 is pulled from both sides, twisting of the ejection member 2 can also be prevented.

The above-described methods (a), (b) and (c) are preferably used in combination with the method of stretching one connecting string 12 through the insertion holes 5, which has been described in the embodiment. However, any one of the above-described methods (a), (b) and (c) may be used solely.

The above-described methods of interconnecting the connecting pieces 3 can realize stronger durability against deformation in the vertical direction, e.g., against swing in the up-and-down direction and twisting about an axis defined in the advancing direction.

Example 4

[0057] Fig. 14 is a schematic perspective view to explain a connecting piece according to Example 4. The connecting piece 3 according to this Example has the same basic constitution as that of the connecting piece 3 according to Example 3 (Fig. 10). Therefore, description of the same points is omitted, and different points will be described below.

In the connecting piece 3 according to this Example, its two surfaces facing the lateral side plate 15 are formed as curved surfaces extending along a curve that defines the path of the direction turning. Stated in another way, the lateral surface positioned on the inner side during the direction turning is formed as a curved surface 93 having a moderate concave shape, and the lateral surface positioned on the outer

side during the direction turning is formed as a curved surface 94 having a moderate convex shape. The projection 6 and the recess 9 are each formed in a circular arc shape having an acute angle.

By employing the connecting piece 3 according to this Example, which has right and left lateral surfaces formed as the above-mentioned curves surfaces, it is possible to make the lateral side plate 15 curved following the connecting pieces 3 in more well-matched relation during the direction turning, and to further smoothen the movement of the ejection member 2.

Example 5

[0058] The ejection member 2 according to Example 5 is constituted to be able to prevent the lateral side plate 15 from separating from the connecting pieces 3 when a force beyond a design value is exerted on the ejection member 2, for example, upon application of an overload.

Fig. 15 is an explanatory view to explain a method of fixing the lateral side plate according to Example 5. Each connecting piece 3 has the same constitution as that of the connecting piece 3 according to Example 3 (Fig. 10).

In this Example, an auxiliary connecting string 95 is used which is prepared separately from the connecting string 12. The auxiliary connecting string 95 may be made of the same material as that of the connecting string 12. However, because the auxiliary connecting string 95 come into a state rubbing against the lateral side plate 15 during the direction turning, it is preferably made of a fluorocarbon resin fiber having good wear resistance.

[0059] The auxiliary connecting string 95 is stretched through the following procedures in a direction (widthwise direction) perpendicular to

the moving direction (lengthwise direction) of the ejection member 2. First, the auxiliary connecting string 95 is guided to extend from the upper surface of the connecting piece 3 to the lower surface thereof through the string latching hole b 69. The auxiliary connecting string 95 having been guided to the lower surface is further guided to go around the outer peripheral side of both the connecting piece 3 and the lateral side plate 15, and to reach the upper surface of the connecting piece 3. The auxiliary connecting string 95 is then guided to the lower surface through the string latching hole b 69 again. The auxiliary connecting string 95 having been guided to the lower surface of the connecting piece 3 is further guided to extend along the lower surface, to go around the inner peripheral side of both the connecting piece 3 and the lateral side plate 15, and to the upper surface of the connecting piece 3. Thereafter, opposite ends of the auxiliary connecting string 95 are tied to each other near the string latching hole a 68 (denoted by 96). The auxiliary connecting string 95 may be fixedly fastened by employing the fixing member 73 instead of tying the opposite ends of the auxiliary connecting string 95 at a position denoted by 96. The lateral side plate 15 is fixed to the connecting pieces 3 at multiple points by stretching the auxiliary connecting string 95 in a way of fixedly holding the individual connecting pieces as mentioned above.

With the above-described ejection member 2 according to this Example, the lateral side plate 15 can be prevented from separating from the connecting pieces 3 with the aid of the auxiliary connecting string 95 even when a force beyond a design value is exerted on the ejection member 2, for example, upon application of an overload.

List of Reference Symbols

[0060] 1: ejection device, 2: ejection member, 3: connecting piece, 4: contact surface, 5: insertion hole, 6: first projection, 7: second projection, 8: first recess, 9: second recess, 10: thickness, 11: width, 12: connecting string, 13: leading end side connecting piece, 14: tailing end side termination piece, 15: lateral side plate, 15a: lateral-side plate folded portion (front), 15b: lateral-side plate folded portion (rear), 16: hole, 17: workpiece contact member, 18: projected end, 19: recessed groove, 20: elongate hole for fixation, 21: fixing member (for ejection member), 22: base plate, 23: driving unit, 24: driving-unit mount plate, 25: tube, 26: coupling, 27: pipe, 28: flow rate adjusting thumb, 29: guide rail, 30: moving body, 31: moving block a, 32: moving block b, 33: driving block a, 34: driving block b, 35: elongate hole for driving, 36: overload detection mechanism, 37: spring, 38: sensor, 39: detection plate, 40: optical axis of sensor, 41: direction turning section, 42: first direction turning roller, 43: second direction turning roller, 44: third direction turning roller, 45: start point of direction turning, 46: midpoint of direction turning, 47: end point of direction turning, 48: guide roller, 49: support roller, 50: support roller mount plate, 51: base plate folded portion, 52: fixing member (for support roller), 53: loader, 54: magazine, 55: workpiece, 56: magazine elevator 57: magazine placement stage, 58: magazine fixing member, 59: elevating block, 60: cover, 61: door, 62: ejection member entry port, 63: workpiece taking-out port 64: magazine opened surface, 65: third projection, 66: third recess, 67: connecting hole, 68: string latching hole a, 69 string latching hole b, 70: front connecting piece, 71: intermediate connecting piece, 72: rear connecting piece, 73: fixing member (for connecting piece), 74 to 82: positions of connecting string, 83: ejection device, 84: magazine, 85: workpiece, 86: driver, 87: rod, 88: workpiece contact member, 89 to

92: positions of connecting string, 93: curved surface on inner side, 94: curves surface on outer side, 95: auxiliary connecting string, 96: position of connecting string

CLAIMS

1. A workpiece ejection device comprising an ejection member and a driving unit that pushes the ejection member in a first direction, the ejection member pushing a workpiece in a second direction that is different from the first direction,

wherein the ejection member includes a plurality of connecting pieces and an expandable and contractible string-like member that interconnects the plural connecting pieces in a bendable fashion, and

a direction turning section is provided to turn an advancing direction of the ejection member to the second direction.

2. The workpiece ejection device according to claim 1, wherein the ejection member includes a lateral side plate surrounding respective two opposing lateral surfaces of the plural connecting pieces that are interconnected, and the lateral side plate is formed of a thin plate having flexibility.

3. The workpiece ejection device according to claim 1 or 2, wherein the connecting pieces have insertion holes penetrating therethrough in the same direction as a direction in which the connecting pieces are interconnected, and the string-like member is inserted through the insertion holes.

4. The workpiece ejection device according to claim 1, 2 or 3, wherein the connecting pieces are each a plate-like member having a projection and a recess, and are interconnected in a state that the projection of each connecting piece is engaged in the recess of another adjacent connecting piece.

5. The workpiece ejection device according to claim 4, wherein the

projection and the recess have a thickness equal to or less than a half of a thickness of the connecting piece, and are arranged substantially in point symmetric relation with respect to a center of a lateral surface of the connecting piece.

6. The workpiece ejection device according to claim 4, wherein the projection and the recess have a thickness equal to or less than a half of a thickness of the connecting piece, and are arranged substantially in line symmetric relation with respect to a vertical center line in a lateral surface of the connecting piece.

7. The workpiece ejection device according to claim 6, wherein the connecting piece has a projection, a recess arranged above the projection, a projection, and a recess arranged under the latter projection, the latter projection and recess being provided in opposing relation to the former recess and projection, on inner peripheral side when the connecting pieces are in a bent posture, while the connecting piece has a projection and a recess provided in opposing relation to the projection on outer peripheral side when the connecting pieces are in the bent posture.

8. The workpiece ejection device according to claim 7, wherein the connecting piece includes connecting holes formed in the two projections provided on the inner peripheral side when the connecting pieces are in the bent posture, and a string latching hole formed in the connecting piece.

9. The workpiece ejection device according to claim 8, wherein the string-like member is stretched in a state coupling one of the connecting holes and the string latching hole and coupling the string latching hole and the other connecting hole.

10. The workpiece ejection device according to any one of claims 1 to 9,

wherein the driving unit includes a driver that reciprocally moves a moving body to which the ejection member is coupled directly or indirectly, and a sensor that detects application of an overload to the moving body, and the driver is stopped upon detection of the overload by the sensor.

11. The workpiece ejection device according to any one of claims 1 to 10, wherein the direction turning section includes one or more rollers that are disposed on inner peripheral side when the ejection member is in a bent posture, and that are in contact with one lateral surface of the ejection member, and one or more rollers that are disposed on outer peripheral side when the ejection member is in the bent posture, and that are in contact with the other lateral surface of the ejection member.

12. The workpiece ejection device according to any one of claims 1 to 11, further including a support roller that supports, from below, the connecting piece of which direction has been turned to the second direction.

13. A workpiece supply device comprising:

the workpiece ejection device according to any one of claims 1 to 12,

a magazine placement unit; and

an elevator that moves the magazine placement unit up and down.